



GI Learner

Creating a learning line on spatial thinking

GEOSPATIAL THINKING

TEST ANALYSIS

Maria Luisa de Lazaro Y Torres (coord.)

Luc Zwartjes (coord.)

Rafael de Miguel González

Fien Desmidt

Karl Donert

Alan Parkinson

Michaela Lindner-Fally

Diana Prodan

Isaac Buzo Sánchez



Content

1	INTRODUCTION.....	3
2	GLOBAL RESULTS OF THE LEARNING LINE FROM K7 TO K12.....	6
2.1	PARTICIPANTS	6
2.2	GLOBAL IMPROVEMENTS.....	7
3	GLOBAL RESULTS OF THE LEARNING LINE FROM K7 TO K12 BY COUNTRY.....	9
3.1	AUSTRIA	9
3.2	BELGIUM	10
3.3	ROMANIA	11
3.4	SPAIN	12
3.5	UNITED KINGDOM.....	13
	ALL COUNTRIES	14
4	RESULTS FROM THE LEARNING LINE FROM K7 TO K9 BY COUNTRY.....	15
4.1	AUSTRIA	17
4.2	BELGIUM	17
4.3	ROMANIA	22
4.4	SPAIN	25
4.5	UNITED KINGDOM.....	30
5	RESULTS OF THE LEARNING LINE FROM K10 TO K12: ALL COUNTRIES.....	33
6	RESULTS OF THE LEARNING LINE FROM K10 TO K12 BY COUNTRY	40
6.1	AUSTRIA	40
6.2	BELGIUM	44
6.3	ROMANIA	47
6.4	SPAIN	50
6.5	UNITED KINGDOM.....	50
7	OTHER EVALUATIONS	52
7.1	FEEDBACK ON THE EXERCISES	52
7.2	FINAL PRODUCTS.....	53
8	CONCLUSIONS AND RECOMMENDATIONS.....	55
9	SOME REFLECTIONS ON THE TOOL ITSELF FOR FUTURE TESTS AND LIMITATIONS.....	56
10	APPENDIX I.....	57

Funded by the
Erasmus+ Programme
of the European Union



The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

© 2018, GI Learner project, 2015-1-BE02-KA201-012306

www.gilearner.eu

GI Learner



3

1 Introduction

The big challenge of how to measure the extent of learning progression was solved, following a big debate, through the use of a self-evaluation test. The assessment of progress from the beginning to the end of the project (summative evaluation) has been carried out through self-evaluation tests, carried out at the beginning and end of the project, which have made it possible to verify what pupils have learned. The students self-evaluate using the Likert scale, which has been used for its simplicity¹. The tests of self-evaluation seem to have offered a good measure of progression. They have helped to make students become more responsible for the tasks. The process has not been without difficulties, mainly arising from the different timetables and curriculum structure of the five schools involved in the project. It has been impossible to achieve a perfect synchronisation between each of the schools because of the pattern of the school calendars. Agreement has, however, been possible on all the main project areas, and also on other project issues because of the excellent working relationship between all partners involved.



Sometimes there are not very big differences apparent between levels. This can be explained because the examples used for the questions have been increasing in their difficulty. However, on those questions about interrelations and patterns, and other ways to reflect on data, students have completed a self-assessment considering a clear improvement as a result of their involvement in the project.

The project has considered three test models, according to the level of difficulty of the learning line involved (Table 1 reflects which learning outcomes are covered by each question). Each level has different elements.

Test A (basic level) has three parts:

- Reading and interpreting maps and images
- Gathering, communicating and using geographical information
- Making sense of geographical information

Test B and C have added a fourth part:

- Reading and interpreting maps and images
- Communicating and using geographical information (GI)
- Gathering geographical information (GI)
- Interrelations and meaning from geographical information (GI) to build and apply knowledge (GIScience)

¹ Corbeta, P. (2003): Metodología y técnicas de investigación social. McGrawHill, Madrid.

Table 1 reflects which learning outcomes are covered by each question:

- Test A for K7, which could be also used in the medium term for K8.
- Test B for K9, final test, which will be the same as the initial K10 test. Some questions are the same but with different figures increasing the difficulty.
- Test C for K12, the final test of the project was used. Some extra questions have been added for specific competencies.

Table. 1. The learning outcomes / competencies covered by each question of any test, according with the learning line of the project.

Test	Comp 1			Comp 2			Comp 3			Comp 4			Comp 5			Comp 6			Comp 7			Comp 8			Comp 9			Comp 10		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
K7	4			6			7			10			8			9			5			11			12			13		
K8																														
K9																														
K10		4			8			7			10			9			5			8			11			12			13	
K11																														
K12			2			3			7			1			9		10&15			5			11			12			13&14	

Test A (K7)

Test B (K9 & K10)

Test C (K12)

2 Global results of the learning line from K7 to K12

2.1 Participants

The learning line has been followed by more than two hundred students from five European countries, with over 300 students involved in some way during the lifetime of the project. There were initially 223 students (2016), and it was completed by 120 of them (2018), but not all of them replied to the tests on time (we provided a deadline to allow us time to analyse the results for the completion of this and other documents), thus a total of 311 self-evaluation tests has been considered in this study, distributed as follows (see Table 2).

Only 50% of students were on the project since the beginning and attended the final Madrid meeting. Some of those students are no longer at their original school, as schools' student rolls are fluid, and there are pupils who transfer in and out. Some students joined for the final meeting who were not part of the original cohort but had carried out some of the work in the learning line. The final year at school in all the countries is especially hard to make time for additional work, because students have important exams to allow access to university and further education courses. In spite of this, more than a hundred students attended the Madrid final meeting and mobility in February 2018 (see Table 3). All of them were very sorry that the project had come to an end. In fact, we have seen a high level of general satisfaction of the students with the project.

Thus, the percentage of the analysed tests were quite equal in the end, 50.8 % female and 49.2 % male students. There were also other students involved in draft / pilot testing, and some small element of the project e.g. completing some of the project materials on units which matched their national curriculum.

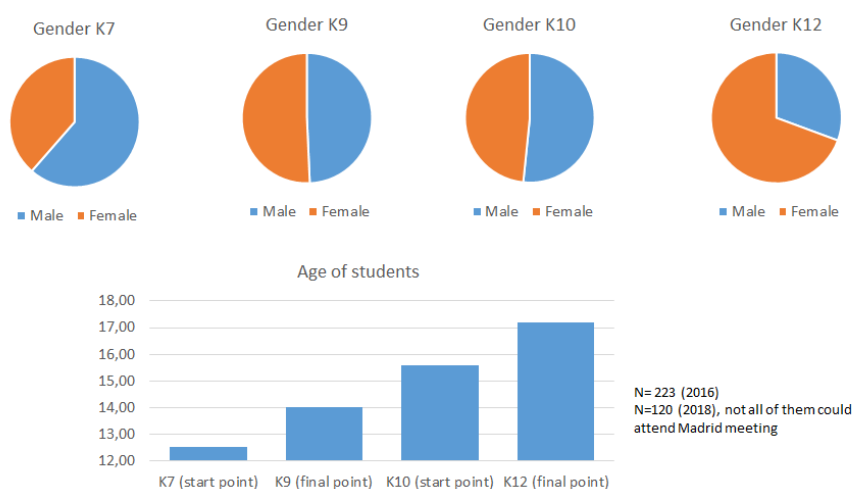


Figure 1. Gender and age of the student participant, Valid test 203 (2016) & 108 (2018)

Table.2. Students involved on the project with valid tests results

Level	Average age	Female	Male	Total	Female (%)	Male (%)
K7	12.54	27	42	69	39.13	60.87
K9	14.01	27	32	59	45.76	54.24
K10	15.58	67	67	134	50.00	50.00
K12	17.2	34	15	49	69.39	30.61
Total	-	155	156	311	49.84	50.16

Table 3. Students that follow the project since the beginning by countries.

Level	Austria	Belgium	Romania	Spain	United Kingdom	Total
K7-K9	-	14	14	7	7	42
K10-K12	11	6	12	4	5	38
Total	11	20	26	11	12	80

2.2 Global improvements

The common questions of the test have allowed us to compare the improvement in several tasks. The self-evaluation tests show an improvement in the learning of all the countries (Figure 2). A pilot test in the middle years also showed us that the continuity of the improvement was working (see Appendix 1) and as the project has been additional work for students, it was more advisable to use the lesson time for the completion of the project tasks better than on additional tests.

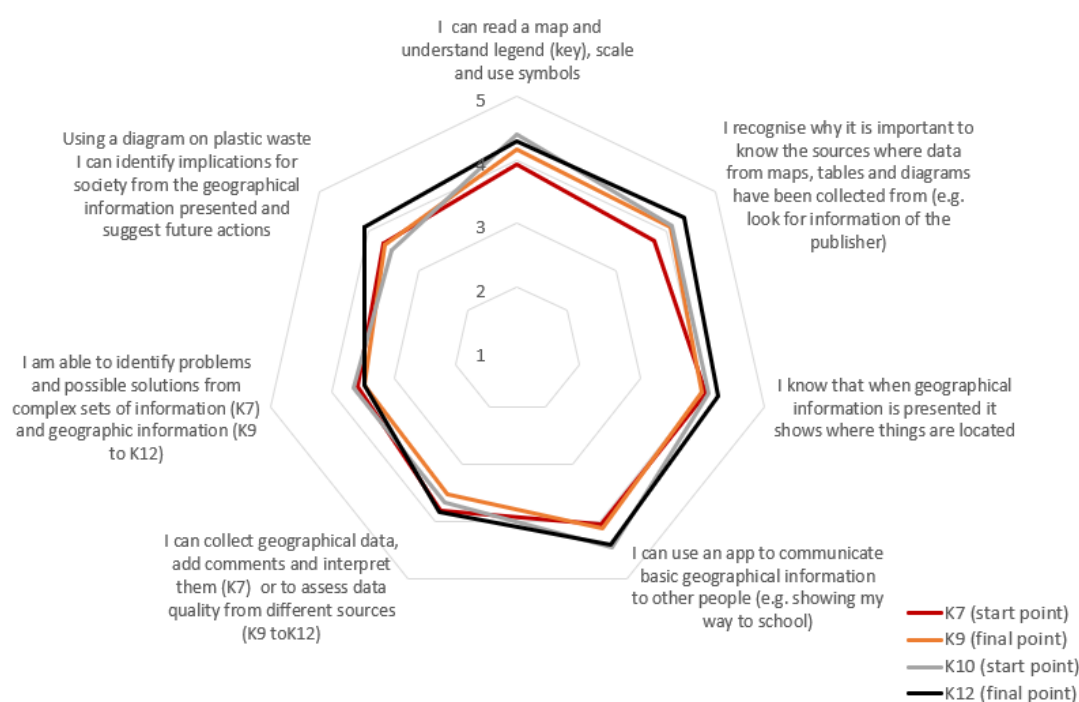


Figure 2. Improvement of several tasks/competencies along the project

The results show:

a) Regarding reading and interpreting maps and images ('I can read a map and understand legend (key), scale and use symbols') there is a clear improvement from K7 to K 12. Curiously K10 has better self-assessment than K12. This can be explained as students are more cautious in the self-evaluation and they have seen many possibilities for applications of GIScience. The learning of the students helps them to know better the limits of their own knowledge.

The next two questions show an undoubted improvement: 'I recognise why it is important to know the sources where data from maps, tables and diagrams have been collected from (e.g. look for information of the publisher)' and 'I know that when geographical information is presented it shows where things are located'. Students have learned that geographic information shows not only *where* things are located, but *why*, perhaps this is the reason for the slowdown in improvement in the question about geographical information.

b) Regarding to gathering, communicating and using quality geographical information (GI), there are two clear levels, the K7-K9 and the K10-K12, with an imperceptible improvement in the task *'I can use an app to communicate basic geographical information to other people (e.g. showing my way to school)'*. Most students feel able to use an app, maps and images to show to other people, for example, indicating their way to school or the institute, and even the K7 group gave one of the highest scores on the Likert scale (4.57) to the identification of a place through Google Earth. However, when we add some nuance about the quality of these data, self-assessment is reduced, as in the answers to *'I can collect geographical data, add comments and interpret them'* (K7) or *'to assess data quality from different sources'* (K9 to K12). In fact, in K7 (Test A) was not contemplated to integrate the assessment of data quality, perhaps this is the reason for their higher scores. Test C talks about the quality of the data, that the students identified as a difficult question. Although an example was shown in the Test C, and most chose the map that showed the highest accuracy, we would point out that this aspect be emphasized from the teaching classrooms because we live in an information society. Students have seen the complexity of the world and the huge quantity of data ('Big geodata'), as in the current world, the raw material begins to be the data (Kerski 2015)

c) Regarding *'making sense of geographical information (GIScience) by interrelations and meaning from geographical information (GI) to build and apply knowledge (GIScience)'*, there were low scores on *'I am able to identify problems and possible solutions from complex sets of information'* (K7) and geographic information (K9 to K12). In general, students are more confident in the use of the closest data than in the use of data far from the place where they live and are more familiar with. But in *'using a diagram on plastic waste I can identify implications for society from the geographical information presented and suggest future actions'* their scores raised. This question is perhaps the most important of all, since it requires students to use all the skills and competences of the learning line that has been designed. The students provided, year on year, a greater wealth of nuances, in relation to the contamination by plastics in the ocean.

To recap: there has been an improvement in general terms, not only by all quantitative data collected during the self-evaluation tests, but also, because students were happy following the project.

3 Global results of the learning line from K7 to K12 by country

In detail, country by country, the results can be observed from the following graphs. The table with the detailed number of students by country considered on the study have added prior to the graphs.

3.1 Austria

There were no students from K7 to K9 in the partner school, thus data corresponds to students from K10 to K12 who took part in the project, in greater numbers than in some of the other schools to compensate for the lack of K7-9.

Table 4. Students involved on the project with valid tests results:

Level	Average age	Female	Male	Total	Female (%)	Male (%)
K7		-	-	-	-	-
K9		-	-	-	-	-
K10	16.25	26	10	36	72.22	27.78
K12	17.66	7	2	9	77.78	22.22
Total	-	33	12	45	73.33	26.67

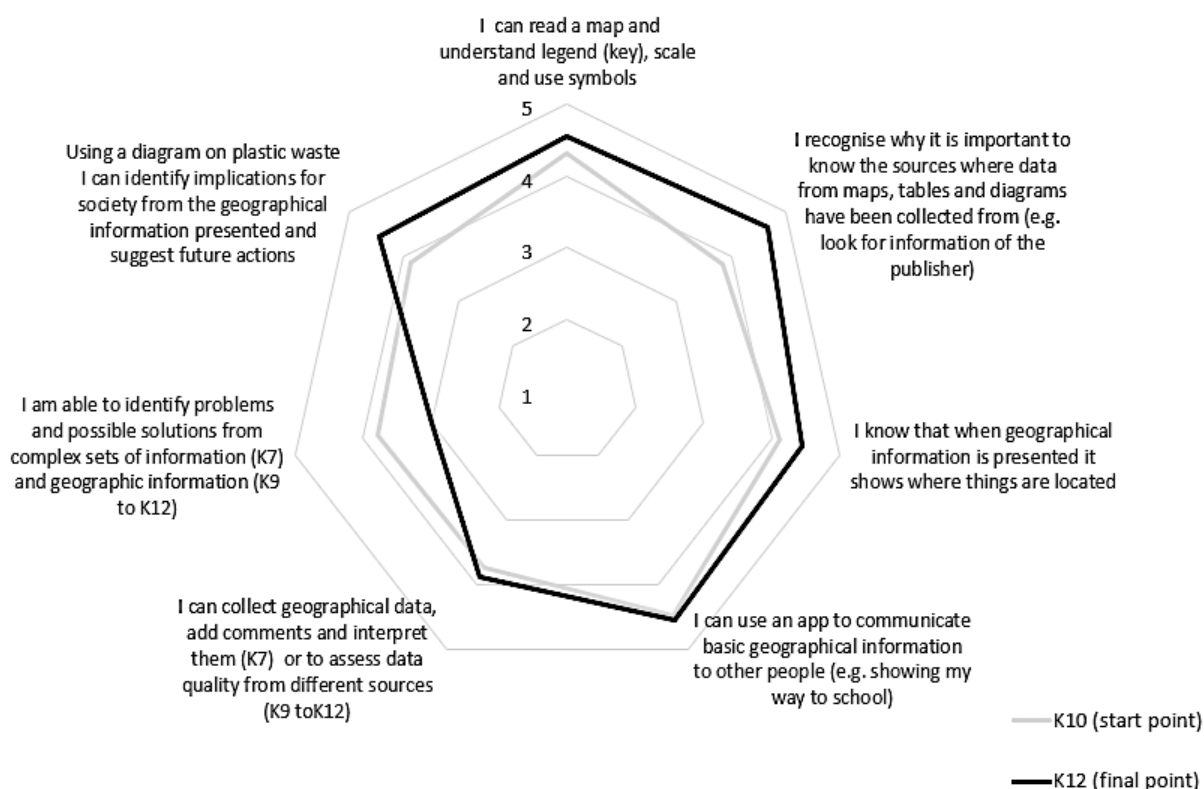


Figure 3. Improvement of several tasks/competencies along the project

3.2 Belgium

Table 5. Students involved on the project with valid tests results

Level	Average age	Female	Male	Total	Female (%)	Male (%)
K7	12.33	6	12	18	33.33	66.67
K9	14.54	5	8	13	38.46	61.54
K10	15.59	25	20	45	55.56	44.44
K12	17.00	13	7	20	65.00	35.00
Total	-	52	44	96	54.17	45.83

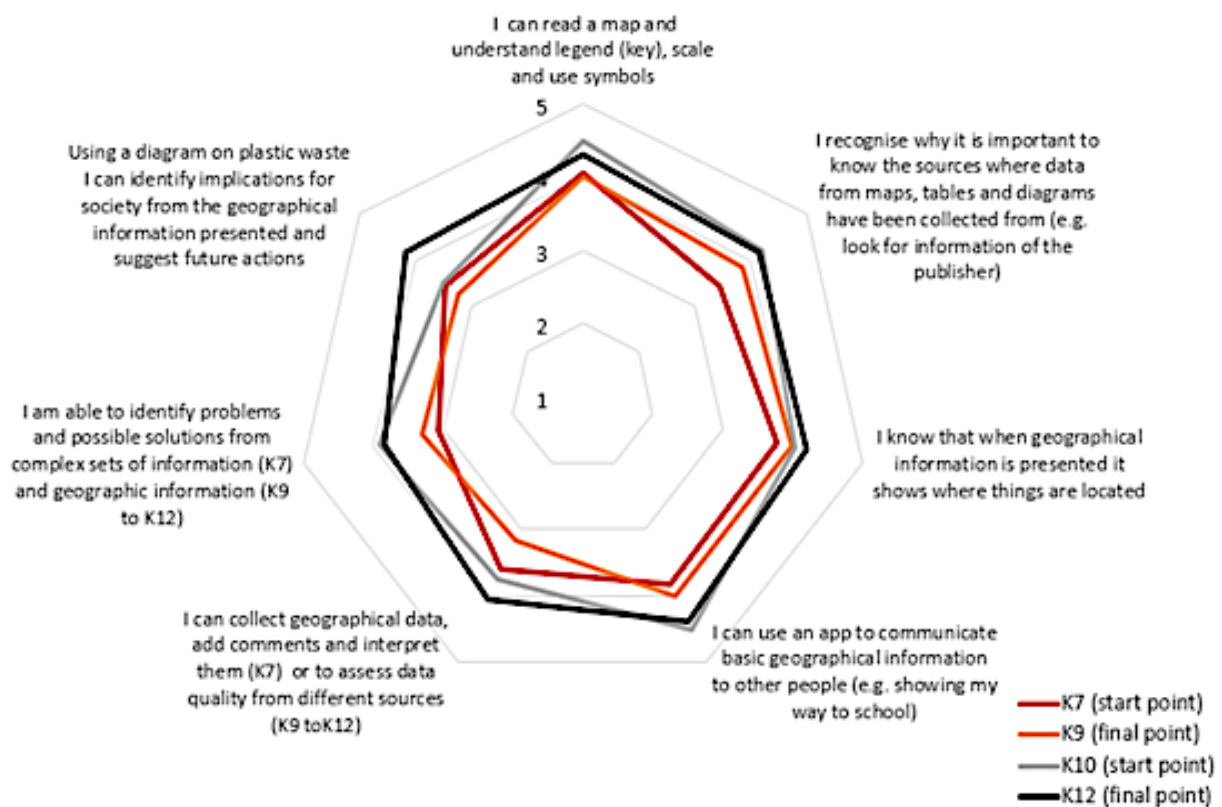


Figure 4. Improvement of several tasks/competencies along the project

3.3 Romania

Table 6. Students involved on the project with valid tests results

Level	Average age	Female	Male	Total	Female (%)	Male (%)
K7	11.67	6	3	9	66.67	33.33
K9	13.63	13	6	19	68.42	31.58
K10	15.46	8	5	13	61.54	38.46
K12	17.08	9	3	12	75.00	25.00
Total	-	36	17	53	67.92	32.08

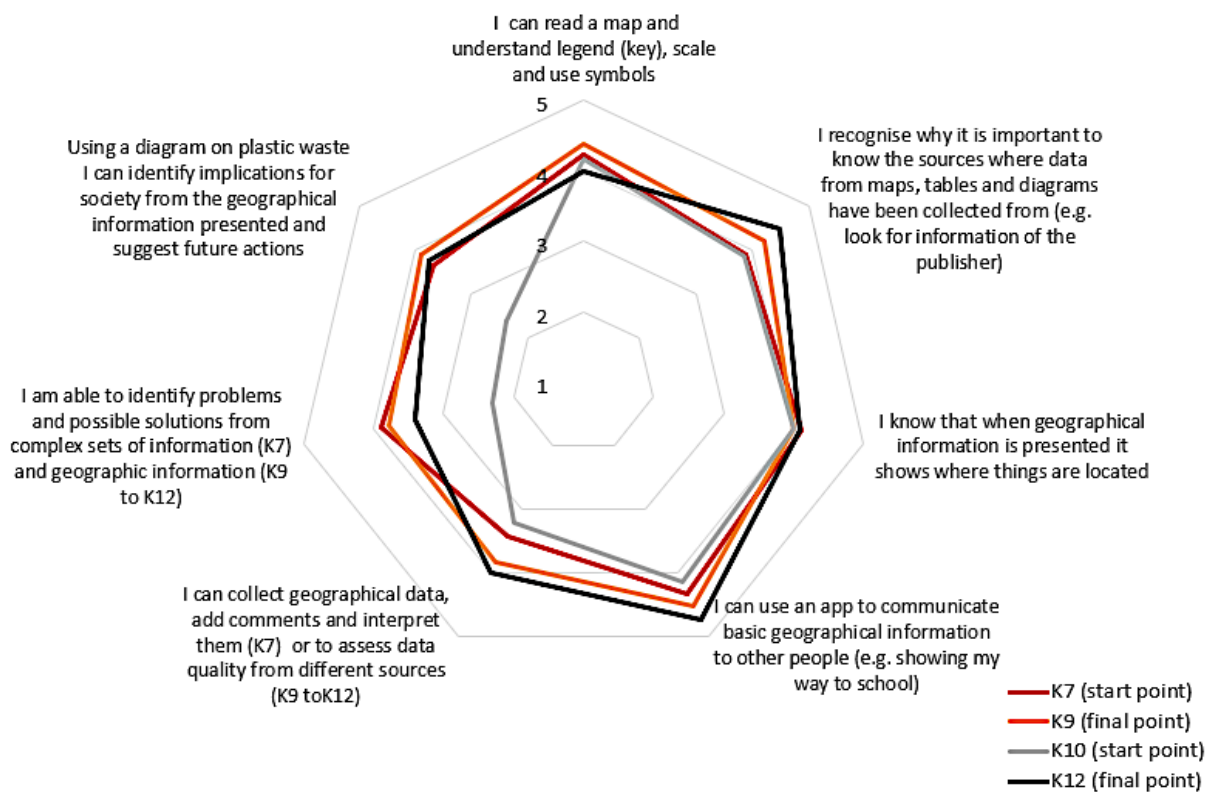


Figure 5. Improvement of several tasks/competencies along the project

3.4 Spain

The Spanish education system does not have Geography as a separate subject, except at K12 level (Spanish Geography) as an optional subject for some bachelor options. Geography is taught jointly with History in K7 to K9. At K10, only some topics such as Globalization are on the curriculum, again jointly with History, also at K11. Other Science subjects are related to Geography however, and they provide some curriculum opportunities for GISciences units. Thus, the project has not been running during normal lessons in the Spanish schools and has been run by voluntary students as extra lessons in the school day. The teachers of these subjects have been helping throughout the project.

Project has been run by voluntary students as extra lessons. The teachers of these subjects have been helping along the project. We will compare in detail test results from K7 to K12 that is one of the indicators of the learning line results.

Table 7. Students involved on the project with valid tests results:

Level	Average age	Female	Male	Total	Female (%)	Male (%)
K7	13.06	12	20	32	37.50	62.50
K9	14.00	5	2	7	71.43	28.57
K10	15.46	2	11	13	15.38	84.62
K12	17.37	5	3	8	62.50	37.50
Total	-	24	36	60	40.00	60.00

The average age of K7 Spanish students is higher, because the test was not possible to pass at the very beginning of the project. After that, the sequence of developing the project has been following.

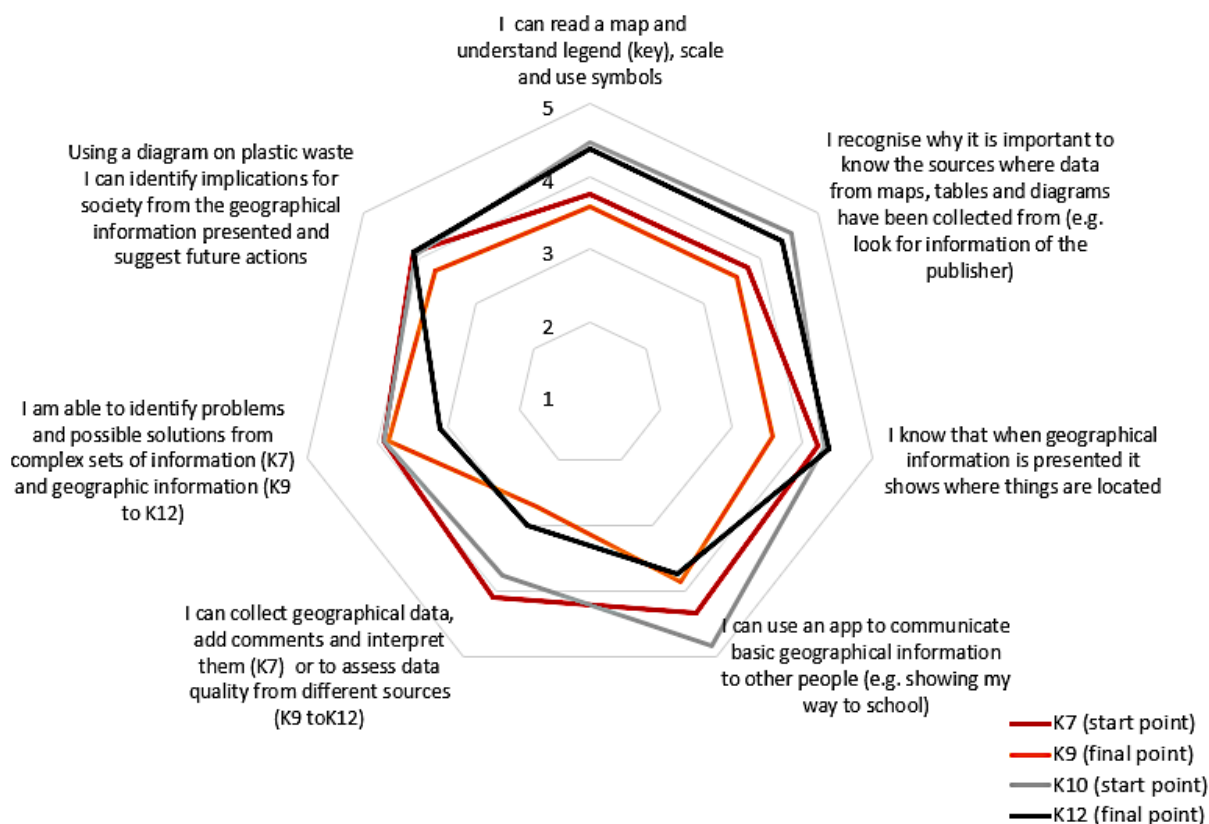


Figure 6. Improvement of several tasks/competencies along the project

3.5 United Kingdom

K7-9 students took part in the project, along with some students from K10-12 (although this was a little less straight-forward)

There were no students from K10 to K12 who completed both tests because of the fluidity of the student roll in the UK school. Many students leave at the end of K10 to pursue their studies in other colleges. We did, however have many discussions with students during the process and during their time at the school and captured some of the thinking of the students on how their understanding of GI tools had developed through their secondary involvement in the scheme. We also involved a range of students in some aspect of the project, and the wider impact of the project will continue in the school curriculum beyond the lifetime of the project.

Table 8. Students involved on the project with valid tests results:

Level	Average age	Female	Male	Total	Female (%)	Male (%)
K7	11.66	3	7	10	30.00	70.00
K9	14.2	4	16	20	20.00	80.00
K10	14.59	6	21	27	22.22	77.78
K12	-	-	-	-	-	-
Total	-	13	44	57	22.81	77.19

K10: The student mobility to Madrid was an opportunity to involve other students, and the final cohort from the school also involved K9-K11 students, who could liaise with students from the other schools and get a flavour for the work that they had been doing, but also to compare their own understanding of some of the GI competencies.

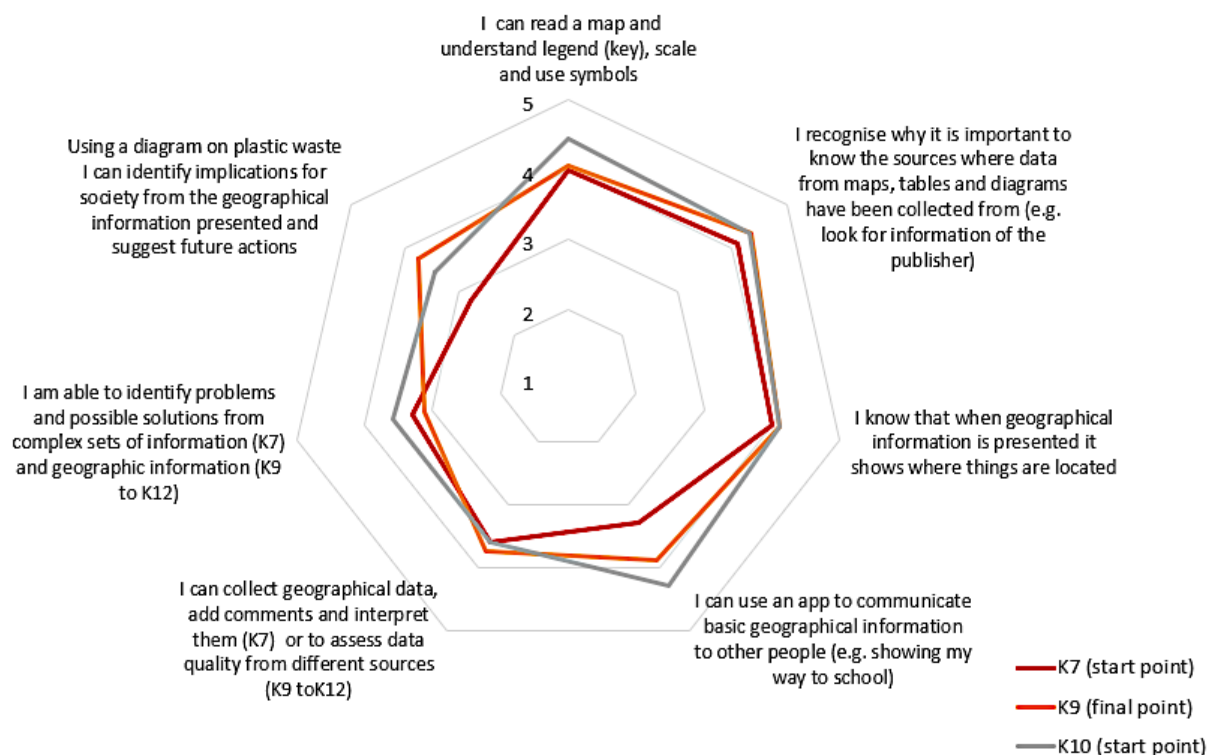


Figure 7. Improvement of several tasks/competencies along the project

All countries

Table 9. Students involved on the project with valid tests results by level and country:

Level	Austria (AT)	Belgium (BE)	Romania (RO)	Spain (ES)	United Kingdom (UK)	Total
K7	-	18	9	32	10	69
K9	-	13	19	7	20	59
K10	36	45	13	13	27	134
K12	9	20	12	8	-	49
Total	45	96	53	60	57	311

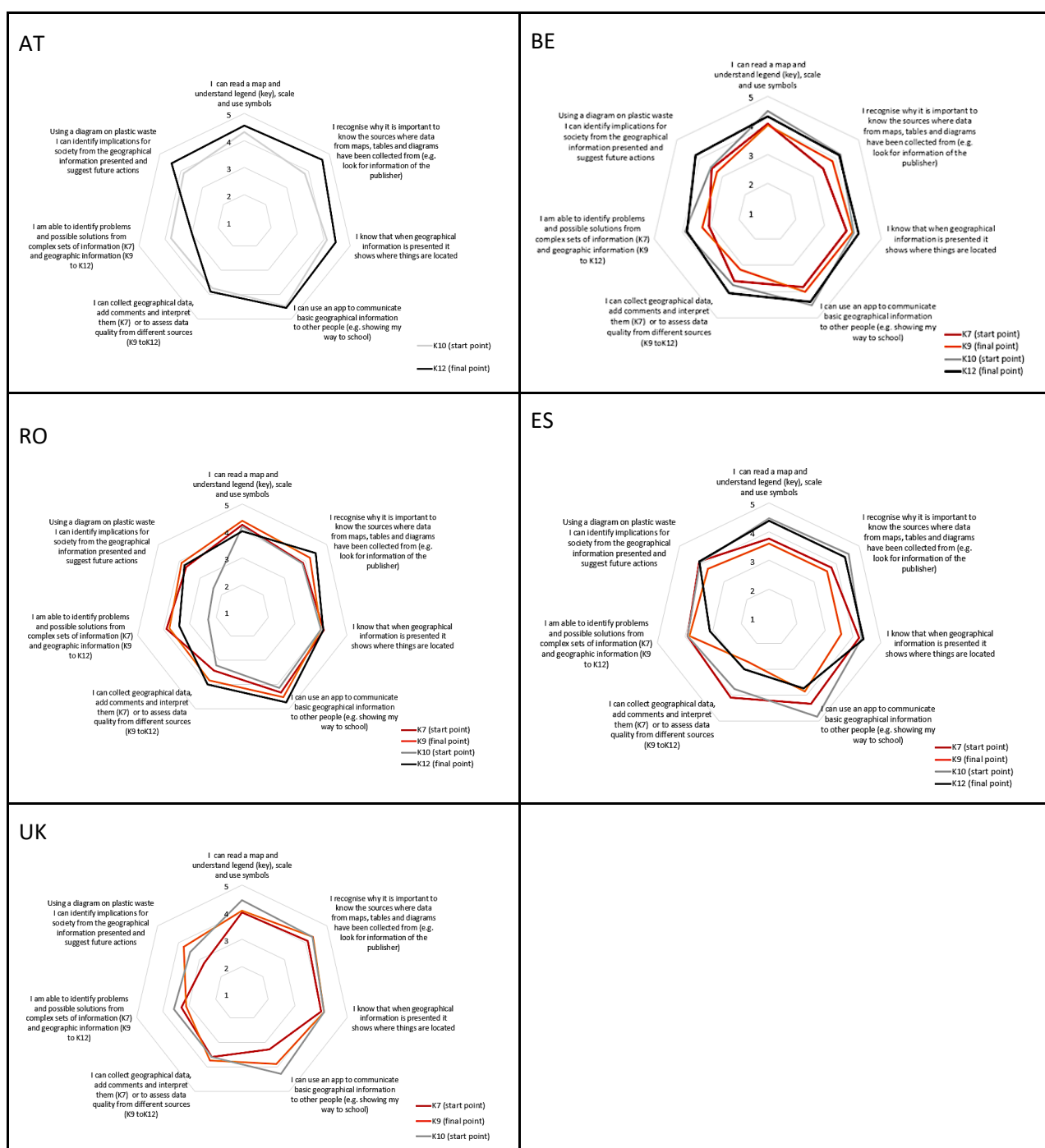
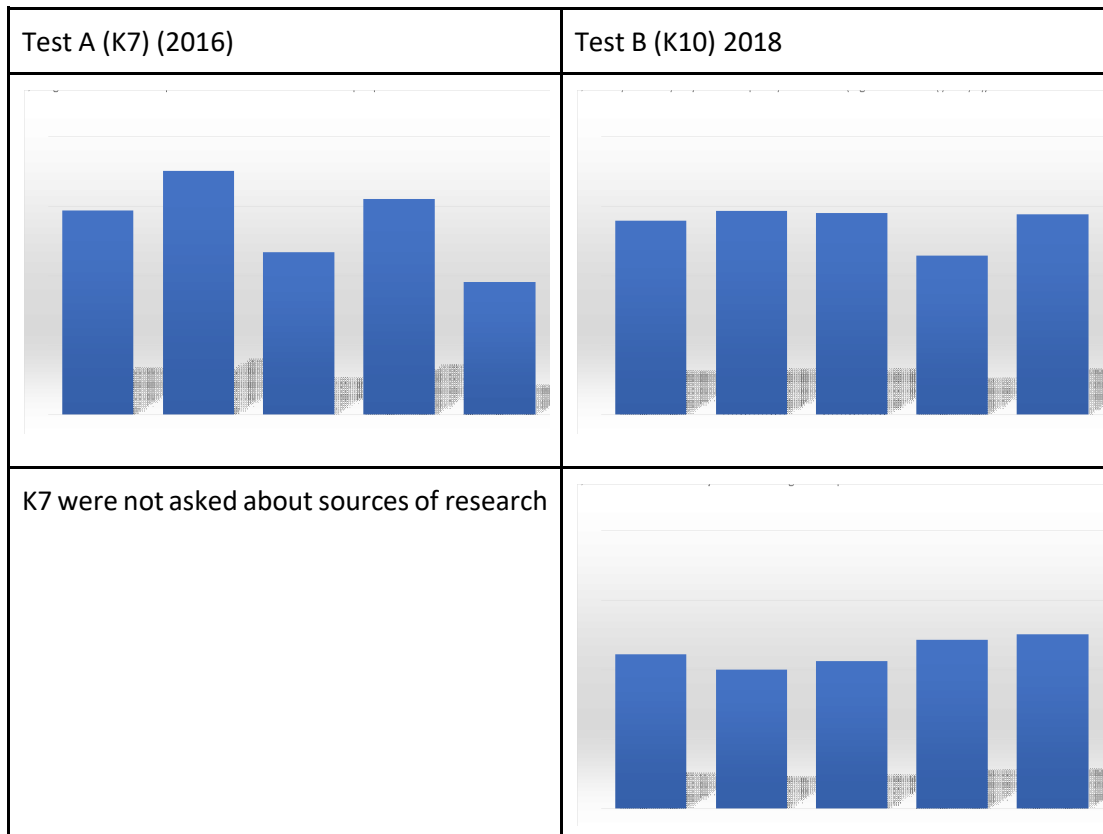


Figure 8. Improvement of several tasks/competencies along the project. All countries

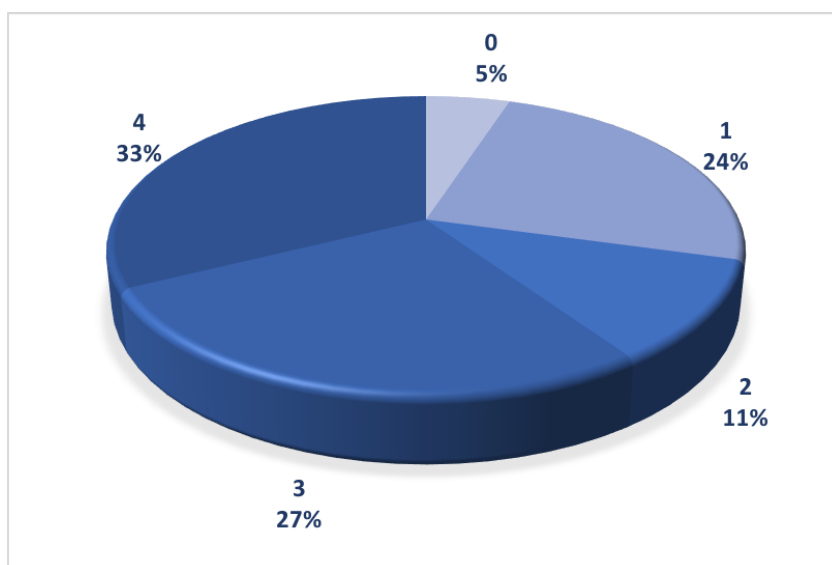
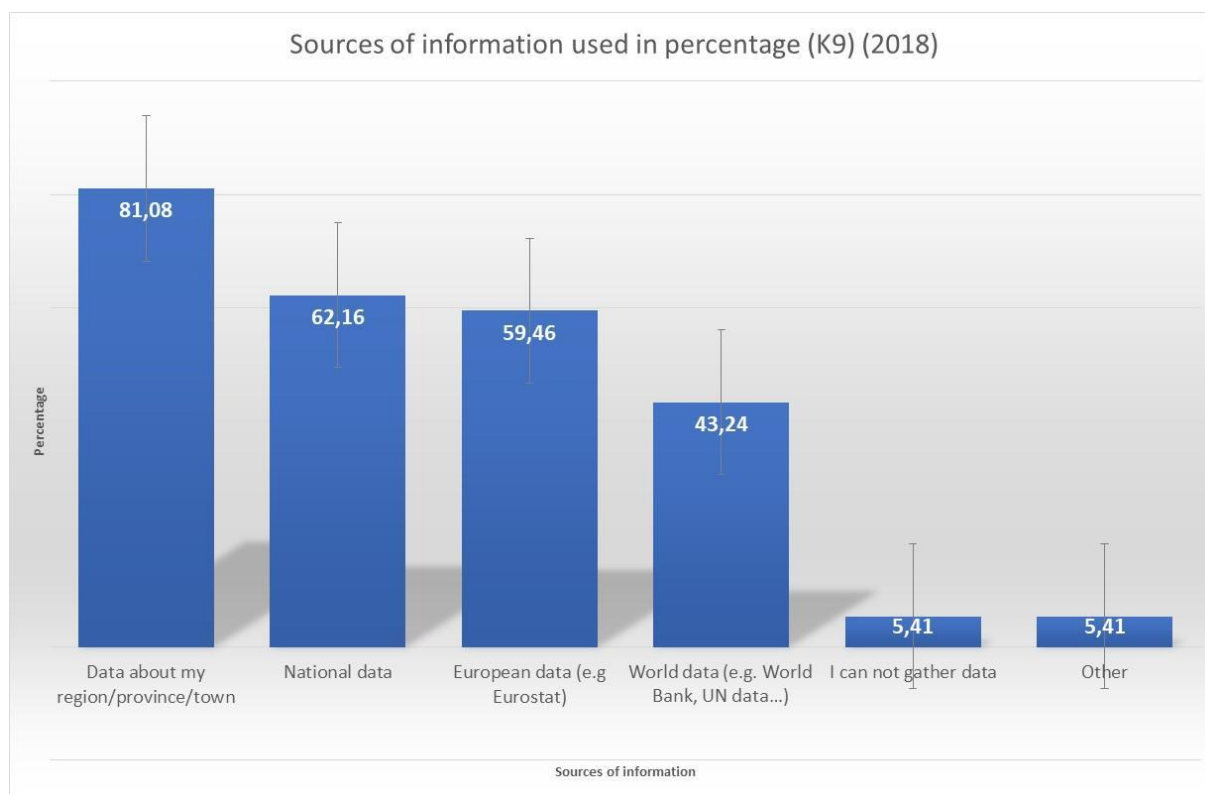
4 Results from the learning line from K7 to K9 by country

The previous section gave us an overview. We will refer globally here to the questions which have not been dealt with on the previous sections. Some of them it is not necessary to show data, such as the question which says that most of the students show at the beginning that they use Google Earth and Google Maps with more than 4 points on Likert scale (K7) and the question on the reply on K9 about the apps they think they are appropriate for a particular task, they also include both of them. At the end of the project all of them have used these tools and many other geoinformation tool, to assist with the completion of tasks on the learning line.



On the question about 'What might those implications be, and what future action can be taken?' an increased number of arguments have been considered along the project.

About gathering information from different sources, only K9, at the end of the project, was asked with the following satisfactory results:



Percentage of the students according to the number of sources (0 → 4) of information used

4.1 Austria

Had no students from K7 to K9.

4.2 Belgium

The test group consisted of 18 pupils, 12 boys and 6 girls. The second test was answered by 13 of them, 8 boys and 5 girls.

K7-9 progress

I can read a map and understand legend (key), scale and use symbols																																					
Test A: At the beginning	Test B: At the end																																				
<p>4. I can read a map and understand legend (key), scale and use symbols</p> <p>18 responses</p> <table><tr><th>Response</th><th>Count</th><th>Percentage</th></tr><tr><td>1</td><td>0</td><td>0%</td></tr><tr><td>2</td><td>0</td><td>0%</td></tr><tr><td>3</td><td>1</td><td>5.6%</td></tr><tr><td>4</td><td>15</td><td>83.3%</td></tr><tr><td>5</td><td>2</td><td>11.1%</td></tr></table>	Response	Count	Percentage	1	0	0%	2	0	0%	3	1	5.6%	4	15	83.3%	5	2	11.1%	<p>4. I can read a map and understand legend (key), scale and use symbols</p> <p>14 responses</p> <table><tr><th>Response</th><th>Count</th><th>Percentage</th></tr><tr><td>1</td><td>0</td><td>0%</td></tr><tr><td>2</td><td>0</td><td>0%</td></tr><tr><td>3</td><td>1</td><td>7.1%</td></tr><tr><td>4</td><td>12</td><td>85.7%</td></tr><tr><td>5</td><td>1</td><td>7.1%</td></tr></table>	Response	Count	Percentage	1	0	0%	2	0	0%	3	1	7.1%	4	12	85.7%	5	1	7.1%
Response	Count	Percentage																																			
1	0	0%																																			
2	0	0%																																			
3	1	5.6%																																			
4	15	83.3%																																			
5	2	11.1%																																			
Response	Count	Percentage																																			
1	0	0%																																			
2	0	0%																																			
3	1	7.1%																																			
4	12	85.7%																																			
5	1	7.1%																																			
There is a no progress on Likert scale (4 to 4 mean) in cartography, with very similar results on this test item.																																					

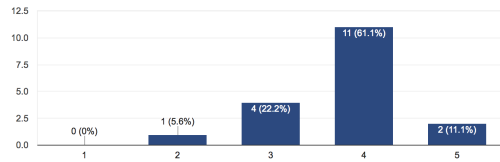
I recognise the importance of the data sources of maps, tables and diagrams and I know how to see it looking for authors and publishers																																					
Test A: At the beginning	Test B: At the end																																				
<p>5. It is important to know the sources where data from maps, tables and diagrams have been collected from? (e.g. look for information of the publisher)</p> <p>18 responses</p> <table><tr><th>Response</th><th>Count</th><th>Percentage</th></tr><tr><td>1</td><td>0</td><td>0%</td></tr><tr><td>2</td><td>1</td><td>5.6%</td></tr><tr><td>3</td><td>8</td><td>44.4%</td></tr><tr><td>4</td><td>9</td><td>50%</td></tr><tr><td>5</td><td>0</td><td>0%</td></tr></table>	Response	Count	Percentage	1	0	0%	2	1	5.6%	3	8	44.4%	4	9	50%	5	0	0%	<p>5. I recognise why it is important to know the sources where data from maps, tables and diagrams have been collected for information of the publisher)</p> <p>14 responses</p> <table><tr><th>Response</th><th>Count</th><th>Percentage</th></tr><tr><td>1</td><td>0</td><td>0%</td></tr><tr><td>2</td><td>0</td><td>0%</td></tr><tr><td>3</td><td>4</td><td>28.6%</td></tr><tr><td>4</td><td>8</td><td>57.1%</td></tr><tr><td>5</td><td>2</td><td>14.3%</td></tr></table>	Response	Count	Percentage	1	0	0%	2	0	0%	3	4	28.6%	4	8	57.1%	5	2	14.3%
Response	Count	Percentage																																			
1	0	0%																																			
2	1	5.6%																																			
3	8	44.4%																																			
4	9	50%																																			
5	0	0%																																			
Response	Count	Percentage																																			
1	0	0%																																			
2	0	0%																																			
3	4	28.6%																																			
4	8	57.1%																																			
5	2	14.3%																																			
There is a progress (3.4 to 3.8), indicating the fact that pupils get more acquainted with the importance of good data through their involvement in the project.																																					

I know that when geographical information is presented it shows where things are located

Test A: At the beginning

6. I know that when geographical information is presented it shows where things are located

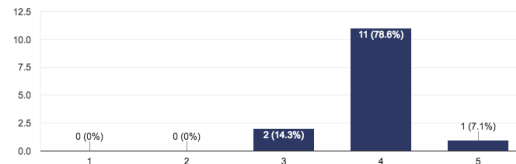
18 responses



Test B: At the end

6. I know that when geographical information is presented it shows where things are located

14 responses



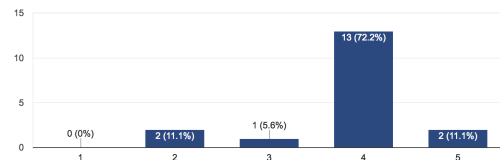
It can be observed a light improvement from 3.7 to 3.9 on Likert scale. These means a little improvement on this field of learning through the project involvement.

I can use different maps and images to communicate basic geographical information to other people (e.g. showing my way to school)

Test A: At the beginning

7. I can use different maps and images to communicate basic geographical information to other people (e.g. showing my way to school)

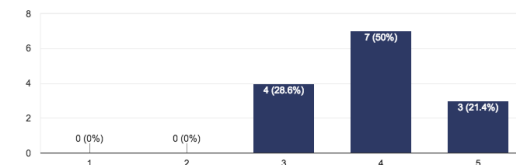
18 responses



Test B: At the end

7. I can use an app to communicate basic geographical information to other people (e.g. showing my way to school)

14 responses



Students advance from 3.8 to 3.9 on Likert scale. They have previous knowledge on these tools, as they show identifying places on Google Earth and Google Maps. There are slightly better results towards the end of the project, where they were also aware of other tools in addition to these.

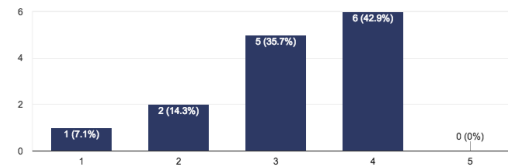
I am able to assess (evaluate or identify) data quality from different sources

Test A: At the beginning

Test B: At the end

8. I am able to assess (evaluate or identify) data quality from different sources

14 responses



This question was only asked to the students at the end of the programme, as it is not considered appropriate for K7 students who haven't been introduced to the project ideas. They recognised the fact that it is very difficult to assess data quality, but it is an essential task in the Information Society that they are living in.

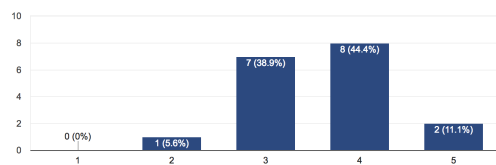
I am able to collect geographical data: I can mark my location in the field or online, add comments and interpret them

Test A: At the beginning

Test B: At the end

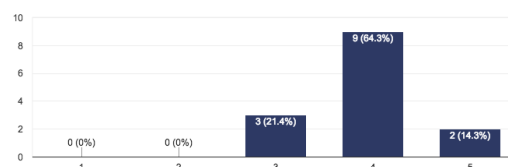
8. I am able to collect geographical data: I can mark my location in the field or online, add comments and interpret them

18 responses



9. I can obtain the coordinates of a place, collect and make use of data (altitude, land use, weather, etc) from ...ource (e.g. online map viewer, GPS, ...)

14 responses



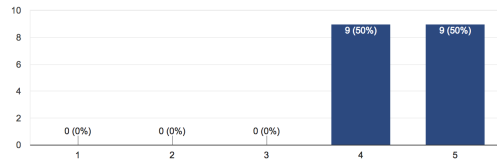
Students are becoming more confident in the use of local data, rather than using world data (a change from 3.6 to 3.9 on the Likert Scale).

I recognize interrelationships and connections between where people live and the environment

Test A: At the beginning

11. I recognize interrelationships and connections between where people live and the environment (see the map below)

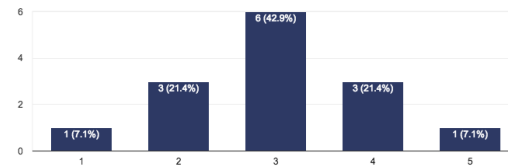
18 responses



Test B: At the end

11. I am able to undertake a detailed investigation of possible reasons behind the evolution of the economy (e.g. using map and data above)

14 responses



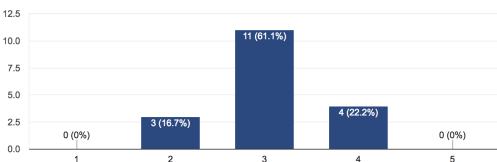
This item provided a wide range of outcomes. To begin with students were perhaps confident that they could identify interrelationships but discovered this was more difficult than they anticipated.

I am able to summarize important ideas from complex sets of information (e.g. climate change -see the information below-)

Test A: At the beginning

12. I am able to summarize important ideas from complex sets of information (e.g. climate change -see the information below-)

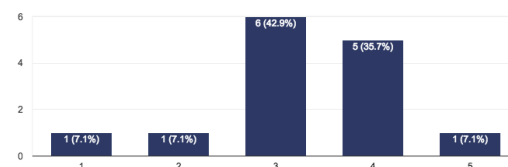
18 responses



Test B: At the end

12. I am able to identify problems and possible solutions from geographic information (e.g. on climate change see video images below)

14 responses



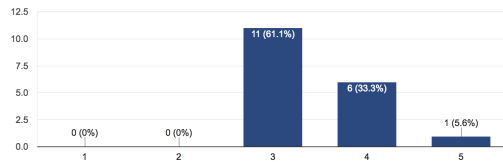
Students improve their learning on this learning outcome (a change from 3.0 to 3.2 on the Likert scale)

Using the diagram below on plastic waste I can identify implications for society from the geographical information presented

Test A: At the beginning

13. Using the diagram below on plastic waste I can identify implications for society from the geographical information presented

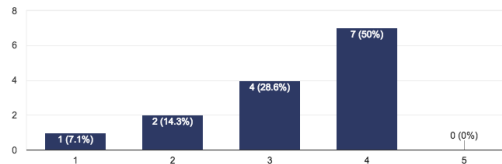
18 responses



Test B: At the end

13. Using the diagram below on plastic waste I can identify implications for society from the geographical information presented and suggest future actions

14 responses



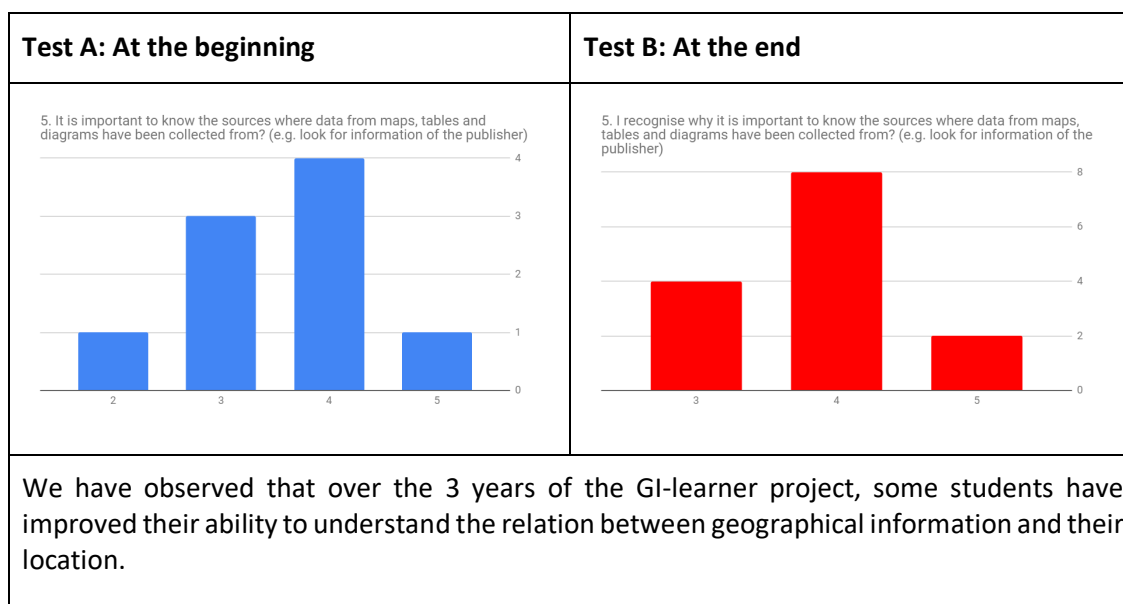
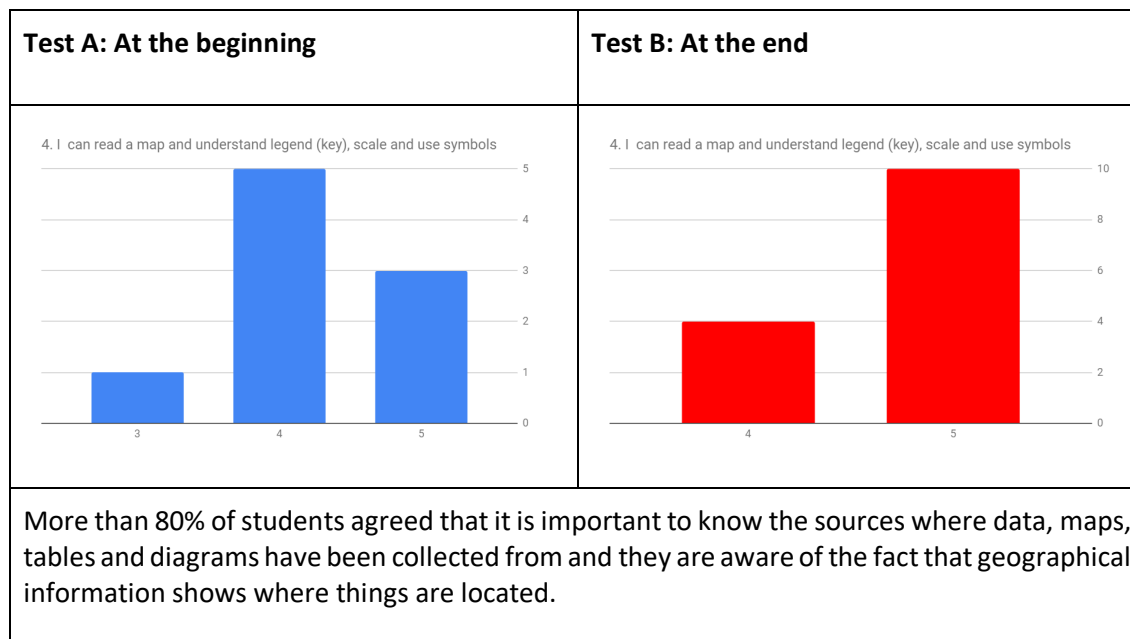
There is no improvement on the Likert scale (which moves from 3.4 to 3.2), but not only by the mean data, but from the replies at the beginning of the project and at the end of it. At the beginning they only speak about climate change and ocean contamination, but at the end they also are able to argue about concrete future actions such as not throwing out waste to the sea, improving plastic recycling, reducing contamination, recycling plastic bottles and food, and making greater use of public transport. This is perhaps a consequence of the focus of the learning materials.

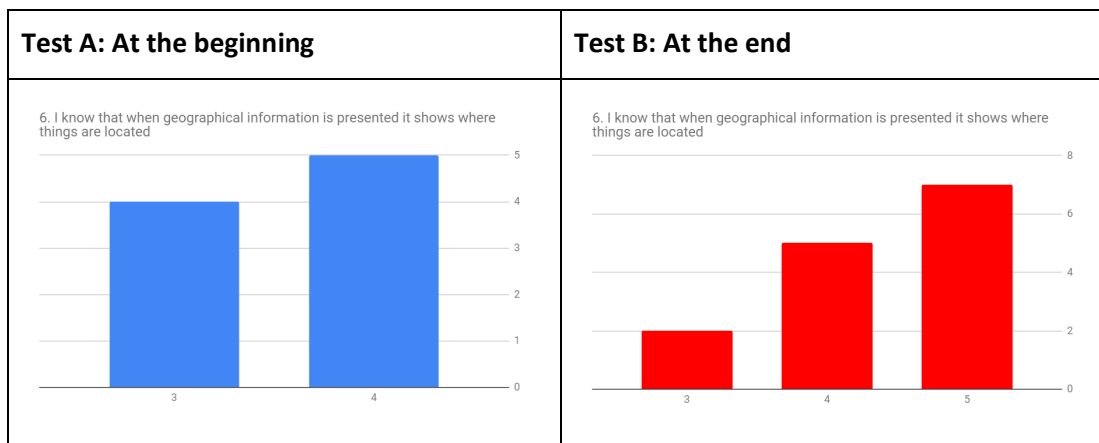
4.3 Romania

Self-Evaluation - level A test - Interpretation

Our target group of K7-K9 students has included at the beginning 12 students but only 9 have submitted the self-evaluation test. For the K9 - Level B, 14 students submitted their answer.

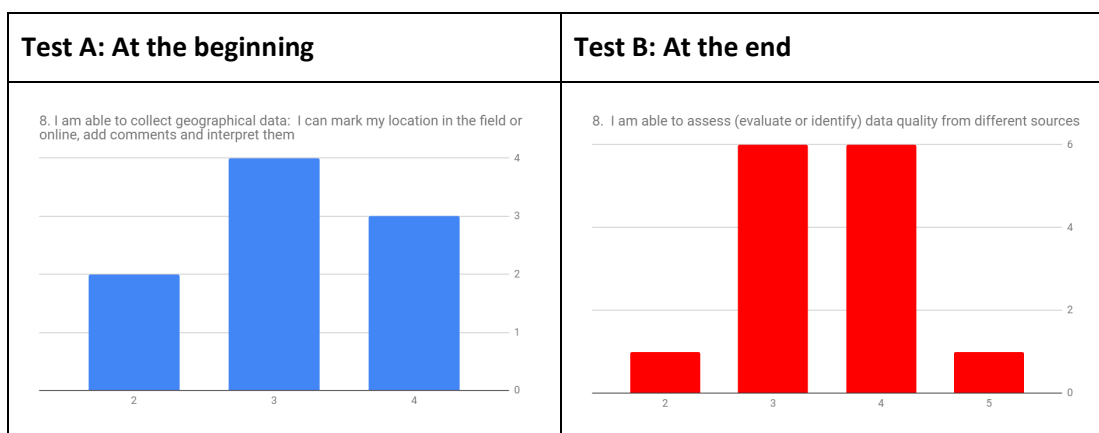
For the level A *"Reading and interpreting maps and images"* the students have shown that they are situated on a scale from 3 to 5 with more answers for point 4. For the level B there were similar answers with a highest point on 5.



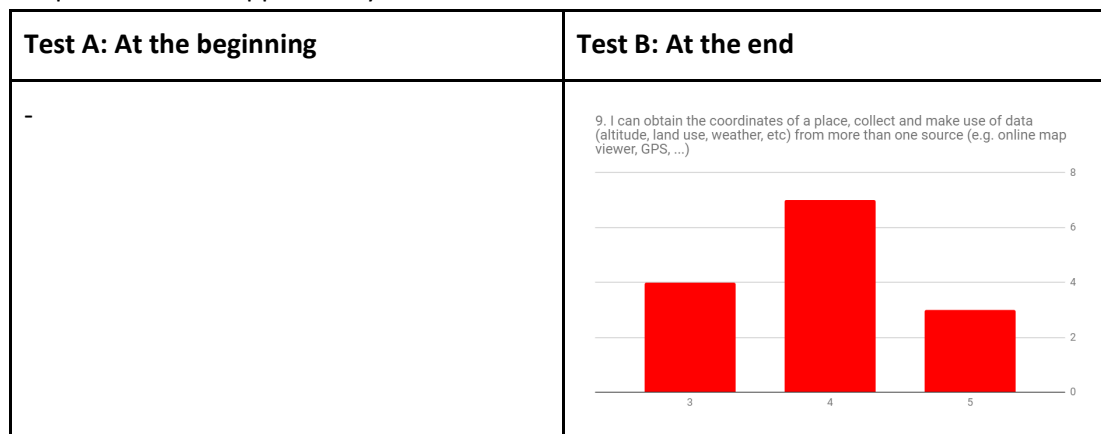


Concerning the student's ability to communicate geographical information a significant part declared that they are familiar with this issue, but they can mainly deal with looking for locations on Google Earth or Google Maps and to use a GPS.

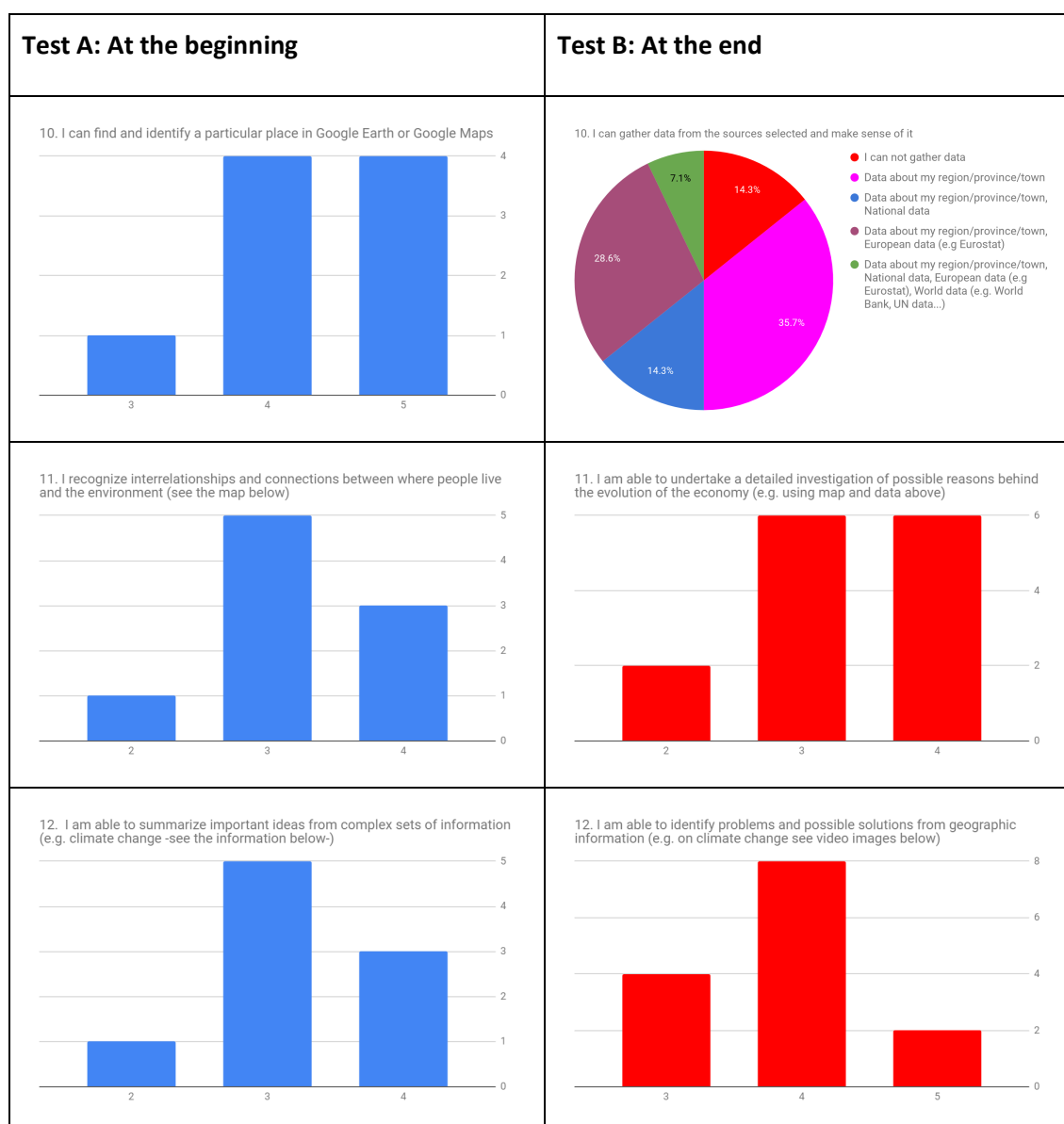
The ability to assess data quality is not so well managed by our students, many of them showing a neutral - (3) and (4) option on the scale.

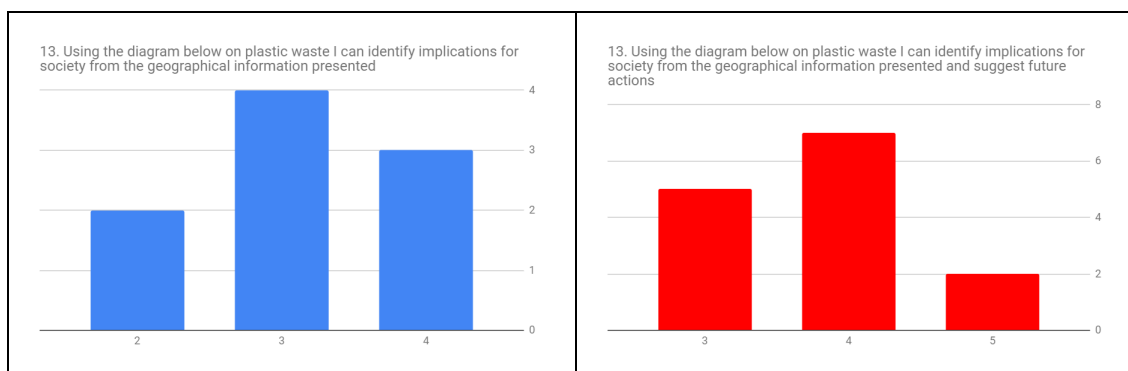


The question 9 was applied only to the B level:



The next question was different for the 2 levels. At level A most respondents have indicated their ability to identify a place in Google Earth while the level B - the vast majority declared the ability of gathering data about its region/country (local data) and interpret them.





As beginners in dealing with geographical information, many K7 students encounter difficulties in recognizing the interrelationships and connections between where people live and the environment, and only two students considered they could easily do this.

Another task was to summarize important ideas from complex sets of information based on diagrams, multipurpose maps (e.g. climate change, plastic waste, population density etc.) and some students dealt with it, but some others are not so familiar with these competences.

That's why we need to enhance this ability in the future, as GI-Learners, and ensure that our learning lines offer the potential for this development to take place.

4.4 Spain

Self-evaluation test A and B results show the K7-K9 progress

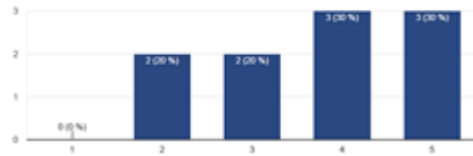
I can read a map and understand legend (key), scale and use symbols																																					
Test A: At the beginning	Test B: At the end																																				
<p>4. I can read a map and understand legend (key), scale and use symbols</p> <p>10 responses</p> <table><thead><tr><th>Category</th><th>Count</th><th>Percentage</th></tr></thead><tbody><tr><td>1</td><td>2</td><td>20%</td></tr><tr><td>2</td><td>3</td><td>30%</td></tr><tr><td>3</td><td>2</td><td>20%</td></tr><tr><td>4</td><td>2</td><td>20%</td></tr><tr><td>5</td><td>1</td><td>10%</td></tr></tbody></table>	Category	Count	Percentage	1	2	20%	2	3	30%	3	2	20%	4	2	20%	5	1	10%	<p>4. I can read a map and understand legend (key), scale and use symbols</p> <p>7 responses</p> <table><thead><tr><th>Category</th><th>Count</th><th>Percentage</th></tr></thead><tbody><tr><td>1</td><td>0</td><td>0%</td></tr><tr><td>2</td><td>1</td><td>14,3%</td></tr><tr><td>3</td><td>2</td><td>28,6%</td></tr><tr><td>4</td><td>3</td><td>42,9%</td></tr><tr><td>5</td><td>1</td><td>14,3%</td></tr></tbody></table>	Category	Count	Percentage	1	0	0%	2	1	14,3%	3	2	28,6%	4	3	42,9%	5	1	14,3%
Category	Count	Percentage																																			
1	2	20%																																			
2	3	30%																																			
3	2	20%																																			
4	2	20%																																			
5	1	10%																																			
Category	Count	Percentage																																			
1	0	0%																																			
2	1	14,3%																																			
3	2	28,6%																																			
4	3	42,9%																																			
5	1	14,3%																																			
There is a clear progress on Likert scale (2.7 to 3.57 mean) in cartography, as there are many curricula mentions of this area.																																					

I recognise the importance of the data sources of maps, tables and diagrams and I know how to see it looking for authors and publishers

Test A: At the beginning

5. It is important to know the sources where data from maps, tables and diagrams have been collected from? (e.g. look for information of the publisher)

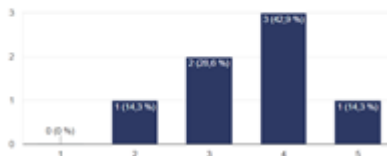
10 responses



Test B: At the end

5. I recognise why it is important to know the sources where data from maps, tables and diagrams have been collected from? (e.g. look for information of the publisher)

7 responses



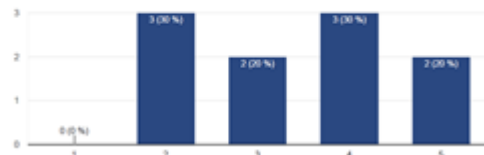
Both are very similar, but the slow down can be explained because they learn about the topic, thus the reply is more confident than at the beginning of the project where they may have been unsure of the real meaning without some teacher guidance.

I know that when geographical information is presented it shows where things are located

Test A: At the beginning

6. I know that when geographical information is presented it shows where things are located

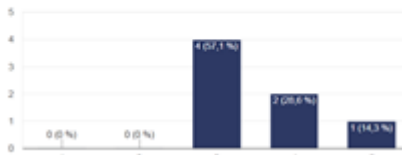
10 responses



Test B: At the end

6. I know that when geographical information is presented it shows where things are located

7 responses



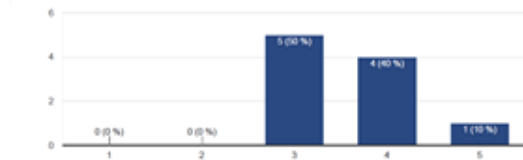
It can be observed that there is a light improvement from 3.4 to 3.6 on the Likert scale. This means a little improvement on this field of learning, again as a result of a focus on this in the project learning materials.

I can use different maps and images to communicate basic geographical information to other people (e.g. showing my way to school)

Test A: At the beginning

7. I can use different maps and images to communicate basic geographical information to other people (e.g. showing my way to school)

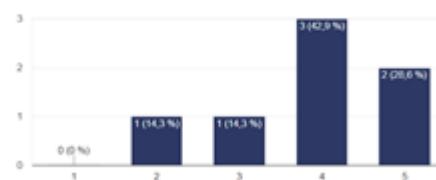
10 respuestas



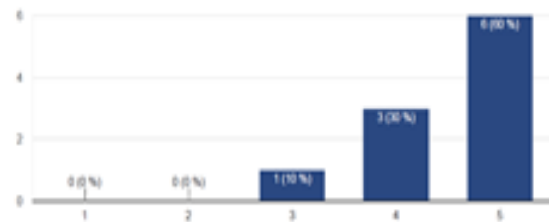
Test B: At the end

7. I can use an app to communicate basic geographical information to other people (e.g. showing my way to school)

7 respuestas



At the end of the project all students said that they used Google Maps, and 30% used Google Earth. They advanced from 3.6 to 3.86 on Likert scale. They have previous knowledge on these tools, as they showed by identifying places on Google Earth and Google Maps.



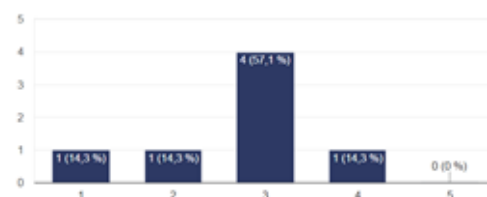
I am able to assess (evaluate or identify) data quality from different sources

Test A: At the beginning

Test B: At the end

8. I am able to assess (evaluate or identify) data quality from different sources

7 respuestas



This question was only asked to the students at the end of the programme, as it is not considered adequate for K7 students. They recognised the fact that it is very difficult to assess data quality, but it is an essential task on the Information Society that they are living in.

I am able to collect geographical data: I can mark my location in the field or online, add comments and interpret them

Test A: At the beginning

8. I am able to collect geographical data: I can mark my location in the field or online, add comments and interpret them

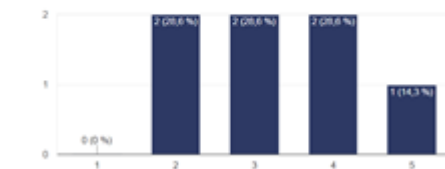
10 respuestas



Test B: At the end

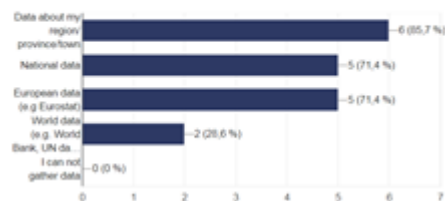
9. I can obtain the coordinates of a place, collect and make use of data (altitude, land use, weather, etc) from more than one source (e.g. online map viewer, GPS, ...)

7 respuestas



10. I can gather data from the sources selected and make sense of it

7 respuestas



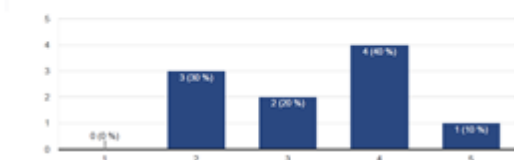
Students are more confident on using local data than world data. However, at the end of the project Spanish students still are not sure about using a GPS from smartphone or to obtain coordinates or other data.

I recognize interrelationships and connections between where people live and the environment

Test A: At the beginning

11. I recognize interrelationships and connections between where people live and the environment (see the map below)

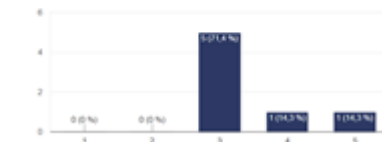
10 respuestas



Test B: At the end

11. I am able to undertake a detailed investigation of possible reasons behind the evolution of the economy (e.g. using map and data above)

7 respuestas



There is not a significant difference from 3.3 to 3.4 on Likert scale on this test item.

I am able to summarize important ideas from complex sets of information (e.g. climate change -see the information below-)

Test A: At the beginning

12. I am able to summarize important ideas from complex sets of information (e.g. climate change -see the information below-)

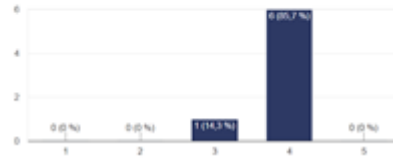
10 responses



Test B: At the end

12. I am able to identify problems and possible solutions from geographic information (e.g. on climate change see video images below)

7 responses



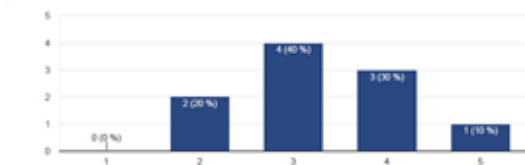
Students improve their learning on this learning outcome (moving from 3.4 to 3.9 on Likert scale). The understanding of the test item was an element of this change.

Using the diagram below on plastic waste I can identify implications for society from the geographical information presented

Test A: At the beginning

13. Using the diagram below on plastic waste I can identify implications for society from the geographical information presented

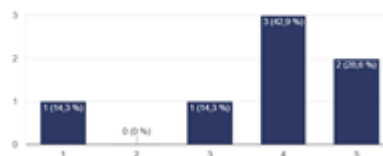
10 responses



Test B: At the end

13. Using the diagram below on plastic waste I can identify implications for society from the geographical information presented and suggest future actions

7 responses



There is a clear improvement on Likert scale (from 3.3 to 3.7), but not only by the mean data, but from the replies at the beginning of the project and at the end of it. At the beginning they only speak about climate change and ocean contamination, but at the end they argue also about concrete future actions such as not throwing out waste to the sea, improving plastic recycling, reducing contamination, recycling plastic bottles and food, and making greater use of public transport.

4.5 United Kingdom

UK pupils took the test at the start of the project, they were the first to see the utility of the tool. Some of those students are no longer at the school, as the school's roll is fluid, and there are pupils who transfer in and out. Some students joined for the final meeting who were not part of the original cohort.

A larger group of UK pupils took the pilot tests at the start of the project to help shape the test items and refine the language. A group then took the final test, when they were K7 pupils and we also introduced some K8 pupils to the materials as a way of assessing the relative 'level' of the materials was at an appropriate level (a benchmarking task)

The language of the tests was picked up on by the students as their first language was English (in most cases), but the tests weren't developed by partners with English as their first language. This led to a few issues with interpretation, which were discussed at the time.

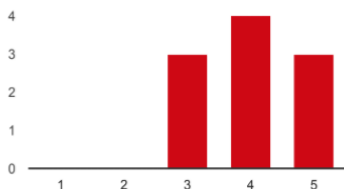
The K7 materials were developed by the UK partner, so this was an initial focus for the trialling, which was also a way to assess the value of the template that we developed for the way that the resources were put together.

We were pleased to see in the later feedback, that the overall layout of the materials was felt to be suitable.

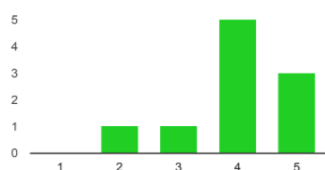
There were also a small number taking the test for K10. Some of those students were no longer at the school at the time of the second testing, as the school's roll is a little more fluid than many being a fee-paying school, and there are pupils who transfer in and out. Some students joined for the final meeting who were not part of the original cohort, so the overall impact of the whole learning line could not be fully assessed (although the impact of the student mobility was more pronounced for them).

Analysis of the results:

K7-K9 progress

I can read a map and understand legend (key), scale and use symbols																
Test A: At the beginning	Test B: At the end															
<p>4. I can read a map and understand legend, scale and use symbols</p>  <table><tr><td>I completely disagree: 1</td><td>0</td><td>0%</td></tr><tr><td>2</td><td>0</td><td>0%</td></tr><tr><td>3</td><td>3</td><td>30%</td></tr><tr><td>4</td><td>4</td><td>40%</td></tr><tr><td>I fully agree: 5</td><td>3</td><td>30%</td></tr></table>	I completely disagree: 1	0	0%	2	0	0%	3	3	30%	4	4	40%	I fully agree: 5	3	30%	<p>Students were interviewed and felt that they had a better appreciation of mapping as a result of using the learning materials.</p>
I completely disagree: 1	0	0%														
2	0	0%														
3	3	30%														
4	4	40%														
I fully agree: 5	3	30%														
<p>70% of students agreed that it is important to know the sources where data, maps, tables and diagrams have been collected from and they are aware of the fact that geographical information shows where things are located.</p>																

6. I know that when geographical information is presented it shows where things are located



I completely disagree: 1 0 0%

2 1 10%

3 1 10%

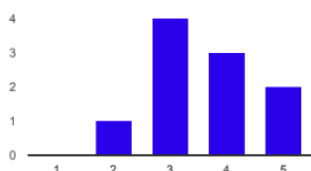
4 5 50%

I fully agree: 5 3 30%

All students were aware of the value of geographical information by the end of their involvement in the project.

80% of students were familiar with the role of geographical information, which is good to see.

8. I am able to collect geographical information: I can mark my location, add comments and interpret them



I completely disagree: 1 0 0%

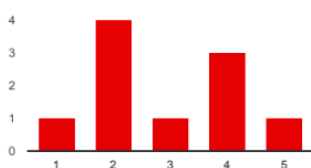
2 1 10%

3 4 40%

4 3 30%

I fully agree: 5 2 20%

10. I recognize interrelationships and connections between people and the environment (e.g. main roads and protected areas -see the map below-)



I completely disagree: 1 1 10%

2 4 40%

3 1 10%

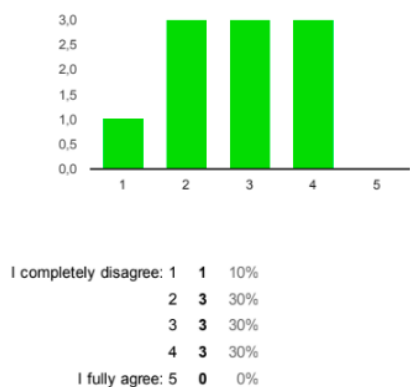
4 3 30%

I fully agree: 5 1 10%

This was an area which we feel the project tackled well. The way that students interpret maps, and perhaps use them to make decisions is an important part of GI. For many people GIS is about maps, but actually it is more about making decisions, and students became more aware of this.

This was a more mixed response, as might have been expected.

12. Using the diagram below on plastic waste I can see implications for society from the geographical information presented



Plastic waste was not an issue that all of the students were familiar with when the project started but has become more mainstream in the time since.

The students who attended the Madrid mobility were able to complete some additional assessments, and there were some excellent discussions between schools, which they particularly valued.

We have noticed a greater engagement in some of the Geographical themes since they returned, and several have described the mobility as being a highlight of their school year.

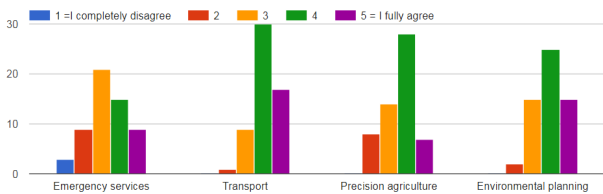
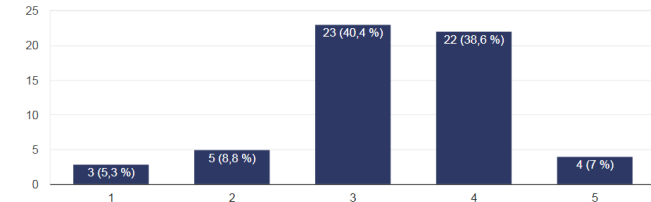
5 Results of the learning line from K10 to K12: All countries

In general terms we can see a line of improvement, but not as strong as we expected to see in quantitative data. But there are many qualitative questions, such as the increased number of applications to communicate geographical information, and a better awareness of students about geographical problems, and how they improve the way in looking for solutions for environmental problems. But there are other tasks that they are not very strong, as can be seen on this graph. For example, the task requiring them to discriminate between the reliability of different sources. In a world with data as a raw material, it would be very interesting to add learning on this topic as a future necessity in a learning line on geographical learning.

We will see the global test results of all schools together following every part of it, downloading from Google Forms data.

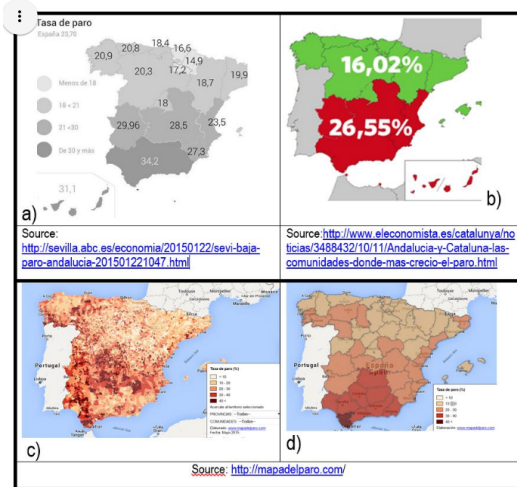
Reading and interpreting maps and images

The first three questions were only for K12, as the learning line consider this learning outcomes for this level.

At the end of the project students think GI is useful for many services.	<p>1. How is GI useful for these services?</p>  <table><caption>Data for Question 1: How is GI useful for these services?</caption><thead><tr><th>Service</th><th>1 (completely disagree)</th><th>2</th><th>3</th><th>4</th><th>5 (fully agree)</th></tr></thead><tbody><tr><td>Emergency services</td><td>2</td><td>8</td><td>20</td><td>15</td><td>8</td></tr><tr><td>Transport</td><td>0</td><td>1</td><td>8</td><td>30</td><td>17</td></tr><tr><td>Precision agriculture</td><td>0</td><td>8</td><td>14</td><td>28</td><td>7</td></tr><tr><td>Environmental planning</td><td>0</td><td>2</td><td>15</td><td>25</td><td>15</td></tr></tbody></table>	Service	1 (completely disagree)	2	3	4	5 (fully agree)	Emergency services	2	8	20	15	8	Transport	0	1	8	30	17	Precision agriculture	0	8	14	28	7	Environmental planning	0	2	15	25	15
Service	1 (completely disagree)	2	3	4	5 (fully agree)																										
Emergency services	2	8	20	15	8																										
Transport	0	1	8	30	17																										
Precision agriculture	0	8	14	28	7																										
Environmental planning	0	2	15	25	15																										
At the end of the project students are aware of the reliability issue with maps.	<p>2. Are all maps reliable?</p> <p>57 respuestas</p>  <table><caption>Data for Question 2: Are all maps reliable?</caption><thead><tr><th>Response</th><th>Count</th><th>Percentage</th></tr></thead><tbody><tr><td>1</td><td>3</td><td>5,3 %</td></tr><tr><td>2</td><td>5</td><td>8,8 %</td></tr><tr><td>3</td><td>23</td><td>40,4 %</td></tr><tr><td>4</td><td>22</td><td>38,6 %</td></tr><tr><td>5</td><td>4</td><td>7 %</td></tr></tbody></table>	Response	Count	Percentage	1	3	5,3 %	2	5	8,8 %	3	23	40,4 %	4	22	38,6 %	5	4	7 %												
Response	Count	Percentage																													
1	3	5,3 %																													
2	5	8,8 %																													
3	23	40,4 %																													
4	22	38,6 %																													
5	4	7 %																													
<p>Students are able to argue about these issues with their own words:</p> <ul style="list-style-type: none">- <i>The maps are useful, you can switch the information on and off.</i>- <i>The maps are very detailed and accurate, and this help a lot.</i>- <i>Most of the maps nowadays are checked out by geographers or even made by them but there also are some fake maps that send you fake information, but they are very rare.</i>- <i>Usually maps are reliable, but sometimes you can't be located with extreme precision due to some connectivity or GSP issues.</i>- <i>The maps seem to be very correct and detailed, but everyone can change it easily in a few seconds. All of us can make a map, so I don't think that all maps are checked. Everybody can make maps and you aren't sure that all maps are reliable, I could create a map with a lot of fake data and share this on my account.</i>- <i>Most maps are reliable but sometimes the information is wrong (e.g. incorrect legend or colours, size of areas) or maps are outdated. Not all of them are clear and not always could be easily understood.</i>- <i>There are also maps that are bias to try to show trends that suit political opinions. Thus, every map is in someone's interest, so they can be subjective. "The maps look kind of decent and reliable", but it is not always true.</i>- <i>Maps can always be modified to make something look better or worse. The creators of the maps might have left out data, etc.</i>																															

- Most of the maps contain a lot of information. Some maps can show information wrong or chaotic thus making it less reliable. Different types of maps are useful for different things, some can be more precise hence more useful, and others give just basic information.
- No, I don't think all the maps are reliable. A part of them can be wrongly created. I mean, not all the maps are detailed or precise when it comes about locations and scales.
- Thus, some maps give a wrong image. Information is easily manipulated, and it is important to verify if the map comes from a reliable source that works with real data.
- Some maps are all together wrong with information that are not to be trusted.
- Sometimes they might be modified due to some natural disasters and weather. Some people might also distort some locations and in that case, if the maps are not updated, they can give you false information.
- Because maps can be made to show what the creator wants to show, so you have to check the creator and what the map is for. Not all maps are reliable, you don't know who made it and why.

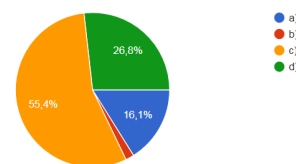
Unemployment in Spain 2015. Different maps, different conclusions?



At the end of the Project most students were able to distinguish the most 'precise' map.

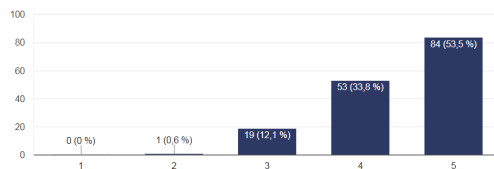
3. Which of these maps is the most precise one to say which is the place with more unemployment in Spain?

56 respuestas



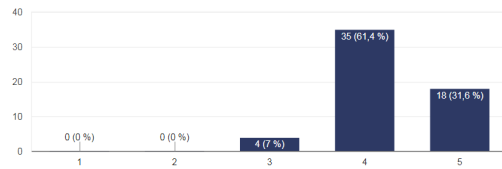
4. I can read a map and understand legend (key), scale and use symbols

157 respuestas



4. I can read a map and understand legend (key), scale and use symbols

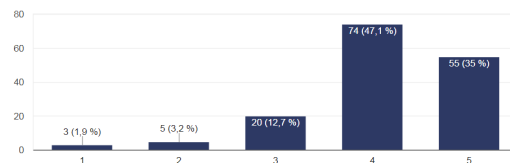
57 respuestas



The self-assessment becomes more accurate at the end of the project, due to exposure to thinking and critical analysis of the work that students have produced. There were also some good comparisons made during the student mobility when conversations could take place face-to-face.

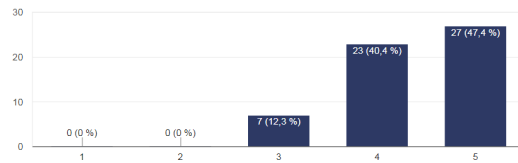
5. I recognise why it is important to know the sources where data from maps, tables and diagrams have been collected from? (e.g. look for information of the publisher)

157 respuestas

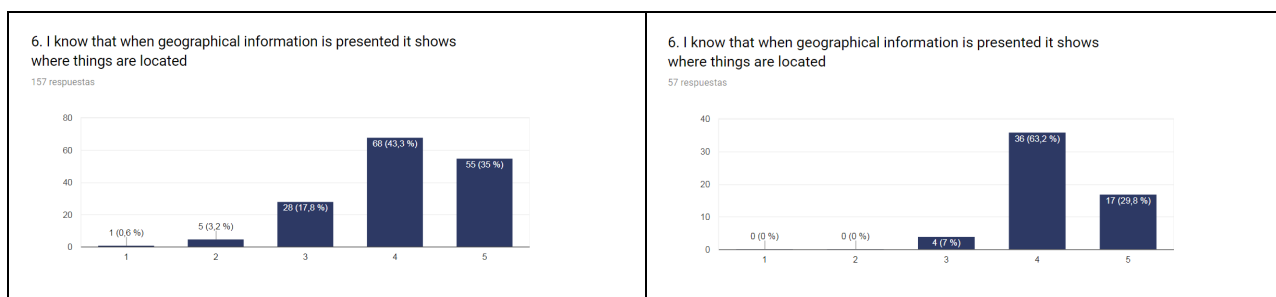


5. I recognise why it is important to know the sources where data from maps, tables and diagrams have been collected from? (e.g. look for information of the publisher)

57 respuestas

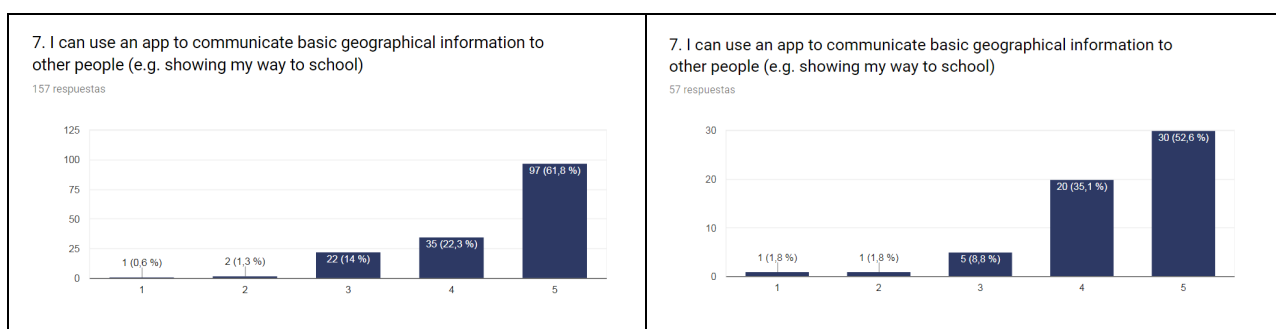


There are no big differences between the Likert results on this item, which move from 4.11 to 4.34, but we can observe that most of the students know many sources of information and become aware of others during their involvement in the project.



A slight increase is observed, from 4.10 to a mean of 4.22 on the Likert scale. What we could interpret here is an improvement in the learning obtained. What is essential here is the absence of students in answer levels 1 and 2, which shows that these areas have been covered during the project using the learning materials, and all students are now more aware of the value of GI.

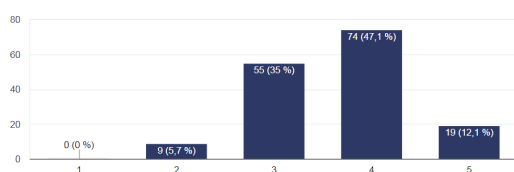
Communicating and using geographical information (GI)



Students made a self-assessment which was stricter at the end of the project than at the beginning. Most of them can use an app to communicate geographical information. The most cited applications here are Google Earth and Google Maps, but at the end they add also ArcGIS Online, as it was a platform used during the Project, and which has also developed in its usability. ArcGIS Online is very useful and allows users to share data. There has also been an improvement in accessibility in schools in many EU countries during the lifetime of the project, partly as a result of the efforts of project partners. However, there are many other applications that are cited by different countries themselves such as: Waze, Karten, Sygic, Sagis & OpenStreetMaps (Austria); Maps.Me, Gmaps Pedometer (Belgium); Madrid Transport (Spain); Waze, Survey123, GPS (Romania) and Apple Maps, Bing Maps, Snapmap on Snapchat, Find My Friend, Geonet, What 3 Words & Mappy (UK). Thus, there are important differences between countries as geolocation aims seem to be less important for Spain. Many UK students use apps to interact with their friends, and once this was pointed out as a GI activity they were often surprised.

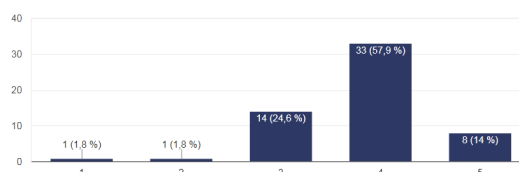
8. I am able to assess (evaluate or identify) data quality from different sources

157 respuestas



8. I am able to assess (evaluate or identify) data quality from different sources

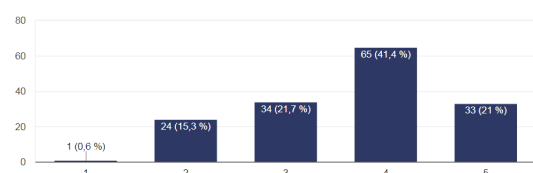
57 respuestas



Students recognize the difficulty of assessing data quality from different sources, although they see a little improvement on it (from 3.66 to 3.80 average on the Likert scale during the project).

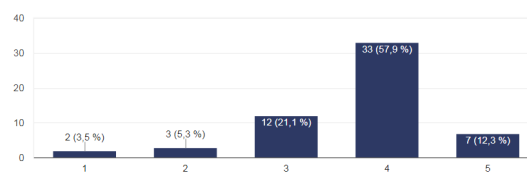
9. I can obtain the coordinates of a place, collect and make use of data (altitude, land use, weather, etc) from more than one source (e.g. online map viewer, GPS, ...)

157 respuestas



9. I can obtain the coordinates of a place, collect and make use of data (altitude, land use, weather, etc) from more than one source (e.g. online map viewer, GPS, ...)

57 respuestas

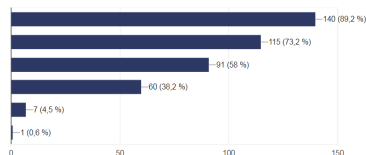


Students showed a little improvement from 3.67 to 3.70 on the Likert scale with the use of co-ordinates of a place. They were not very confident on the topic at the start of the project, but this was partly tackled through some of the learning materials, which started off with a Local focus and introduced some tools such as What 3 Words, and the use of their own smartphones to provide a range of co-ordinate options.

Gathering geographical information (GI)

10. I can gather data from the sources selected and make sense of it

157 respuestas



Data about my region/province/town

National data

European data (e.g Eurostat)

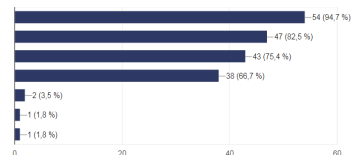
World data (e.g. World Bank, UN data...)

I can not gather data

Otra...

10. I can gather data from the sources selected and make sense of it

57 respuestas

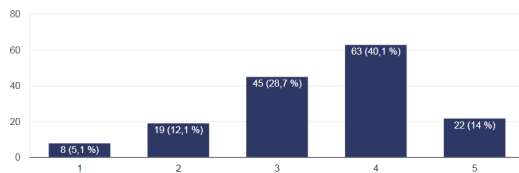


Students showed more confidence in using the closest data than the data on a global scale. This is an interesting area, and one which would be worth investigating in more detail as to the causes of this particular preference.

Interrelations and meaning from geographical information (GI) to build and apply knowledge (GIScience)

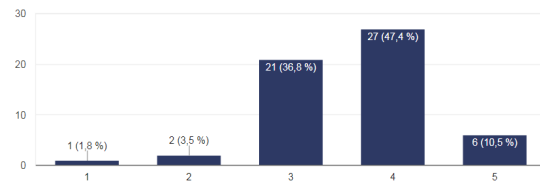
11. I am able to undertake a detailed investigation of possible reasons behind the evolution of the economy (e.g. using map and data above)

157 respuestas



11. I am able to undertake a detailed investigation of possible reasons behind the evolution of the economy (e.g. using map and data above)

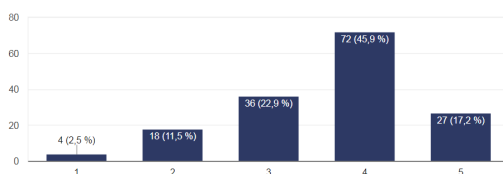
57 respuestas



With a move from 3.46 to 3.61 on the Likert options, there is not a very significant difference from the start to the end. Students seemed able to complete a detailed investigation, but their original self-assessment was not always true perhaps when they were actually given the task to complete one.

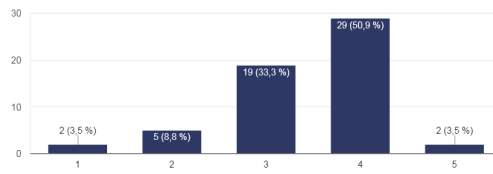
12. I am able to identify problems and possible solutions from geographic information (e.g. on climate change see video images below)

157 respuestas



12. I am able to identify problems and possible solutions from geographic information (<http://storymaps.esri.com/stories/LandsatCompare/>)

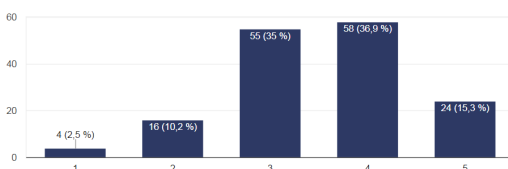
57 respuestas



We went from 3.64 to 3.42 in Likert scale, which, as in the previous case, is not a big change, perhaps due to the increasing difficulty of the example provided, and the students unfamiliarity with what that might involve when they answered at the start of the project.

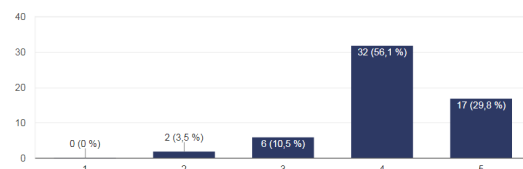
13. Using the diagram below on plastic waste I can identify implications for society from the geographical information presented and suggest future actions

157 respuestas



13. I can identify how to help in reducing plastic waste suggesting future actions (source: <https://www.plasticoceans.org/infographic-reduce-plastic-pollution/>)

57 respuestas



There is a clear improvement in self-assessment on this part of the test, not only because the Likert scale, goes from 3.52 (K10) to 4.12 (K12), but also for the replies to the questions, some of which we can summarize below:

K10:

- Problem has implications on society and environment:
 - The amount of waste plastic is too much
 - The creatures of the sea are endangered
 - Increase plastic pollution in ocean
 - There is lots of plastic that we can't manage
- Solutions:
 - Recycle plastic,
 - Reduce plastic waste by using cotton etc. Also, we can try to use alternative stuff. Create the same products with other resources
 - Reduce plastic production
 - Stricter rules on plastic waste inputs
 - Stricter rules in producing plastic

- Make new things with waste plastic, e.g. art
- Filtering the ocean
- *"Plastic can be eaten by animals and fish which might hurt a bit. To stop this, we could try to clear up the plastic and stop putting it into the environment"*
- *"270 million metric tons of plastic are produced globally per year and a majority of that plastic is put into landfills and put into oceans. If we continue at this rate there will be more plastic than fish in the ocean by 2050. Have a greater accessibility for recycling worldwide everywhere is the answer".*

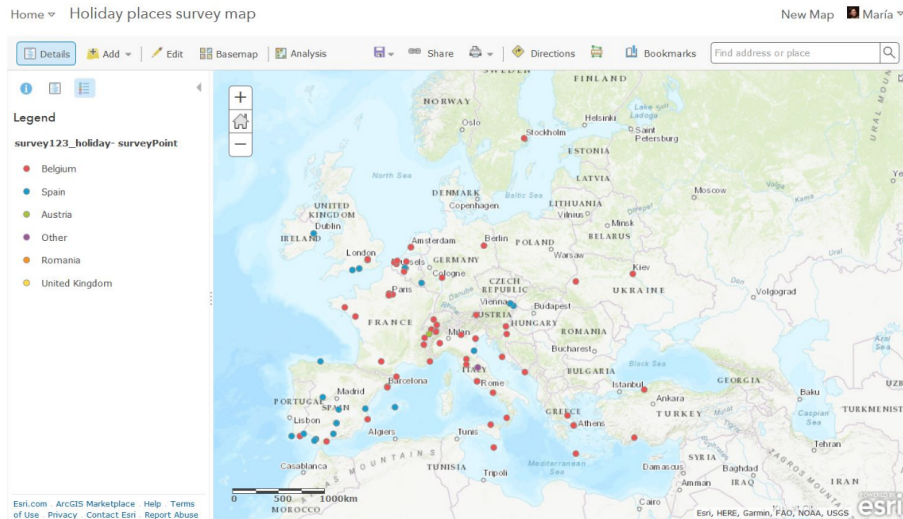
At the end of the Project K12 students became more critical and add future actions based on education, sustainability and campaign to persuade decision makers and citizens. Some of their own suggestions are:

- *More work to promote their steps above - it's all good having these posters but they are no use if no one uses them.*
- *Less polyester materials made each year or a removal of all plastic waste in our oceans.*
- *Implications could include loss of vital food stocks leading to hunger, unemployment and possible starvation in some areas. We could take steps such as forced recycling of bottles. Lobbying government and EU organizations to try to change policy, offer fishermen rewards for bringing back waste that gets caught in their nets if it gets recycled.*
- *To do more publicity to warn and maybe scare a little people of the consequences*
- *We have to use more reusable things instead of throwing away*
- *Making fewer plastic products*
- *Everyone should try to reduce pollution as much as we can because we are killing the environment. We should use as less plastic as possible and to recycle as much as we can because we and our kids will live in the damaged environment if we do not take care of it.*
- *It can be horrible for the environment and easy to solve if we are cautious*
- *We can implement harsher penalties for people who throw in the water or buy/sell plastic bags.*
- *We should be educated not to be indifferent and have the education to not use anymore plastic bags*
- *Promoting recycling but also making it easier for people, place a fine on those who don't recycle. It's obvious that it's easy for people to get away with littering plastic which is harmful for the environment.*
- *Maybe not to buy food or other things that are packed in plastic*
- *Better educating people about the harmful consequences that plastic debris has and banning free plastic bags and straws are a few of the easier measures to take.*

Since the start of the project, the issue of Ocean Plastics has also become more important, and the media now focus on this issue. Students will hopefully be armed with the skills to be more critical of diagrams and data they are presented with, as a result of their involvement in the project.

The last question: How to interpret these survey data about the holidays of some of the project students replying to: What European country did you go for holidays?

My cool holidays in Europe



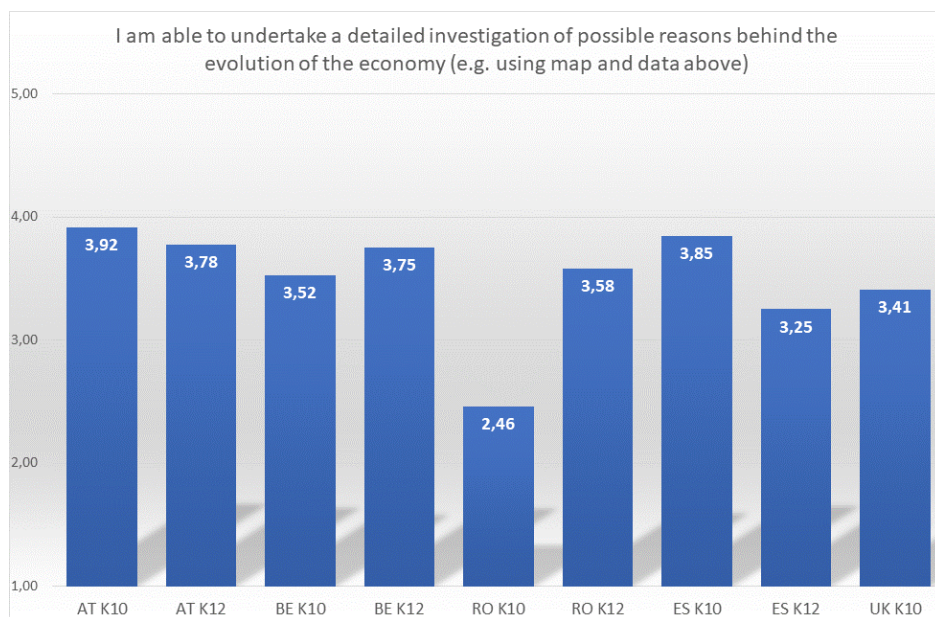
We can classify the answers to the question as:

- a) A reply about the country they would like to go for holidays
- b) Interpreting the map:
 - Most of the people were in or near their home country on holiday or went to the south, with the reason of maybe cost or simplicity or because of the warm climate
 - Italy and Spain are the most visited countries by Belgian students. France and Germany are also among their favourite tourist destinations, while Spanish students prefer to spend their holidays in their own country.
 - You could find the connection between country of origin and the holiday destination and question the reasons why.
 - Most of them understood the map as results of where the students spend their holidays.
- a) Few students replied that they don't understand the question, which was good to see.

6 Results of the learning line from K10 to K12 by country

The previous section and figures 8 gave us an overview on the learning line. We will refer globally here to the questions which have not been dealt with in the previous sections.

There is some improvement on this task, except in Spain. GPS is not something that is commonly mentioned in Geography lessons. As a result of the curriculum today there is a lack of options to make improvements in this area. The Spanish National Institute is concerned about this and have uploaded on their YouTube channel an interesting video on the Global Navigation Satellite System, GNSS: <https://www.youtube.com/watch?v=mJN3ei9h3NA&feature=youtu.be>



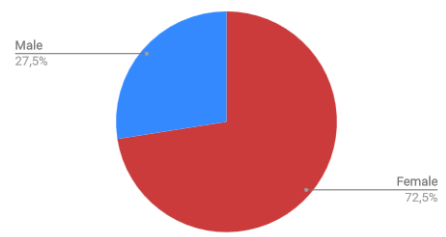
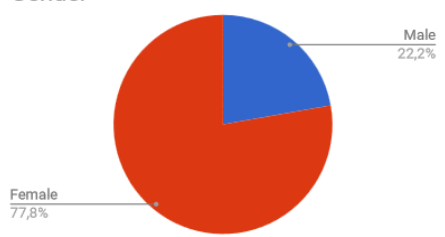
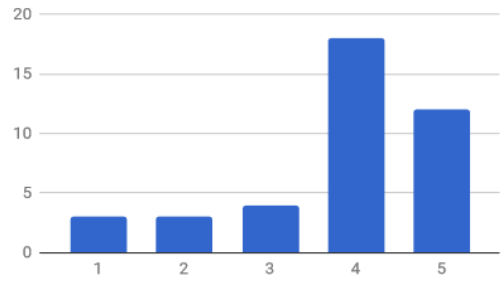
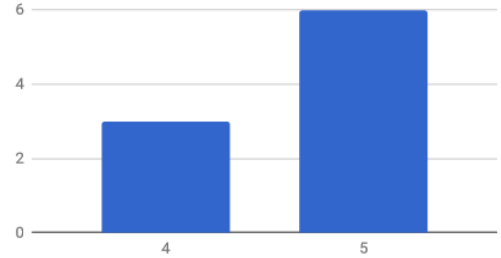
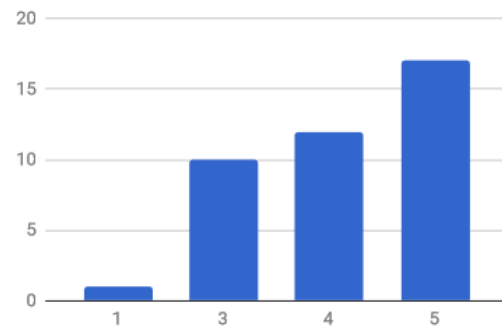
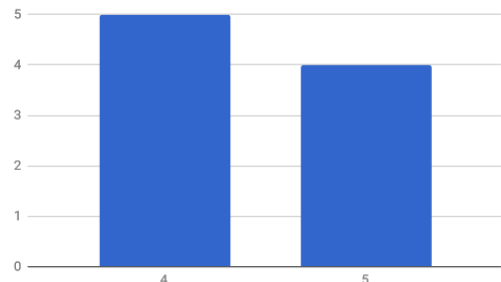
In this case, again only Spain failed, the main argument is that Spanish students are not very accustomed to work with these self-evaluation tools. Perhaps this is something to improve on, when considering future updates to the curriculum.

6.1 Austria

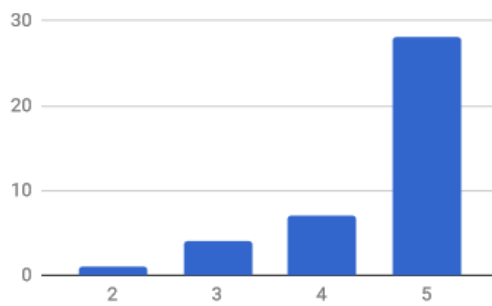
Austrian pupils completed the test in the first year of the project, when they were in K10. The second test was completed during the final meeting in Madrid in February 2018, when they were K12 students. The project started with two whole classes, although it was clear that not all of the pupils would be able and allowed to be part of the final meeting. The numbers of replies vary in that sense quite a lot as a result. At the end, due to exam commitments, and for health reasons, only 11 out of the 40+ students were able to finish the project and join the final meeting.

In the school, there are more female students than male students, which is also mirrored in the statistics shown below. Also, it has to be stated, that in the case of the two classes that were involved, the female students showed a higher motivation to participate in all aspects of the project than their male peers.

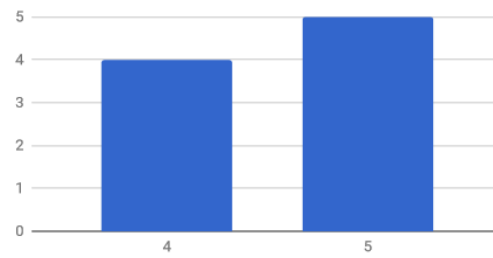
The diagrams below show that in all questions, self-evaluation results have improved from the first to the second test. Pupils estimate their knowledge and skills to be more profound and advanced in the second test. Of course, the overall number of 4 or 5 point results (5=best) are less than in 2016, but this is due to the much smaller reference group. There are no 1 and 2 scores (low), and only some 3 points (median) estimations left by the time students reach K12.

Test 2016	Test 2018
<p>Gender 2016</p>  <p>Male 27,5%</p> <p>Female 72,5%</p>	<p>Gender</p>  <p>Male 22,2%</p> <p>Female 77,8%</p>
<p>5. I recognise why it is important to know the sources of data 2016</p> 	<p>5. I recognise why it is important to know the sources of data 2018</p> 
<p>6. I know that when geographical information is presented it shows where things are located 2016</p> 	<p>6. I know that when geographical information is presented it shows where things are located 2018</p> 

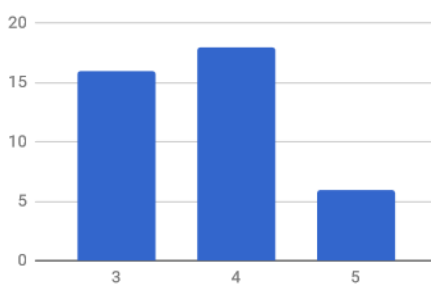
7. I can use an app to communicate geoinformation 2016



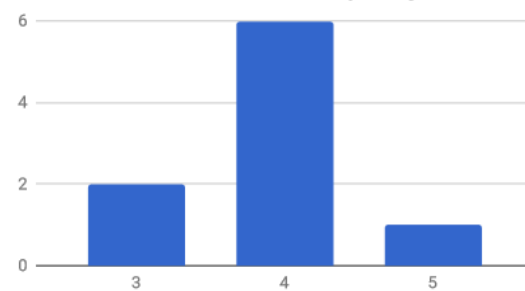
7. I can use an app to communicate basic geographical information 2018



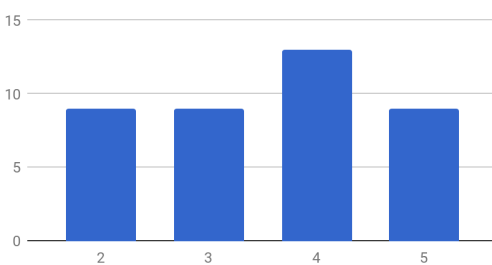
8. I am able to assess data quality from different sources 2016



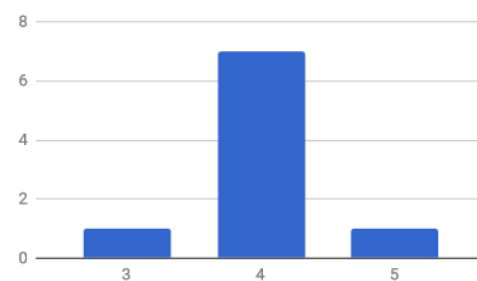
8. I am able to assess data quality from d...



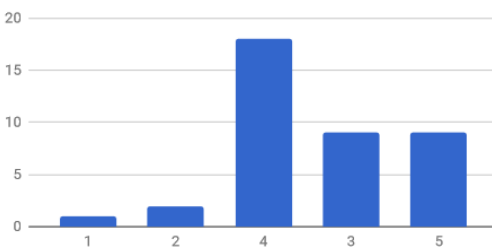
9. I can obtain geographical data from more



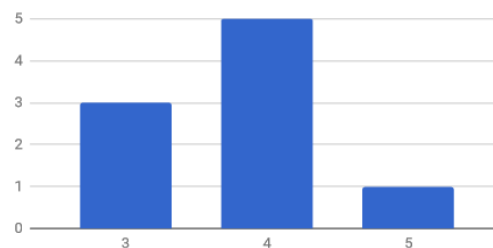
9. I can obtain geographical data from more than one source 2018

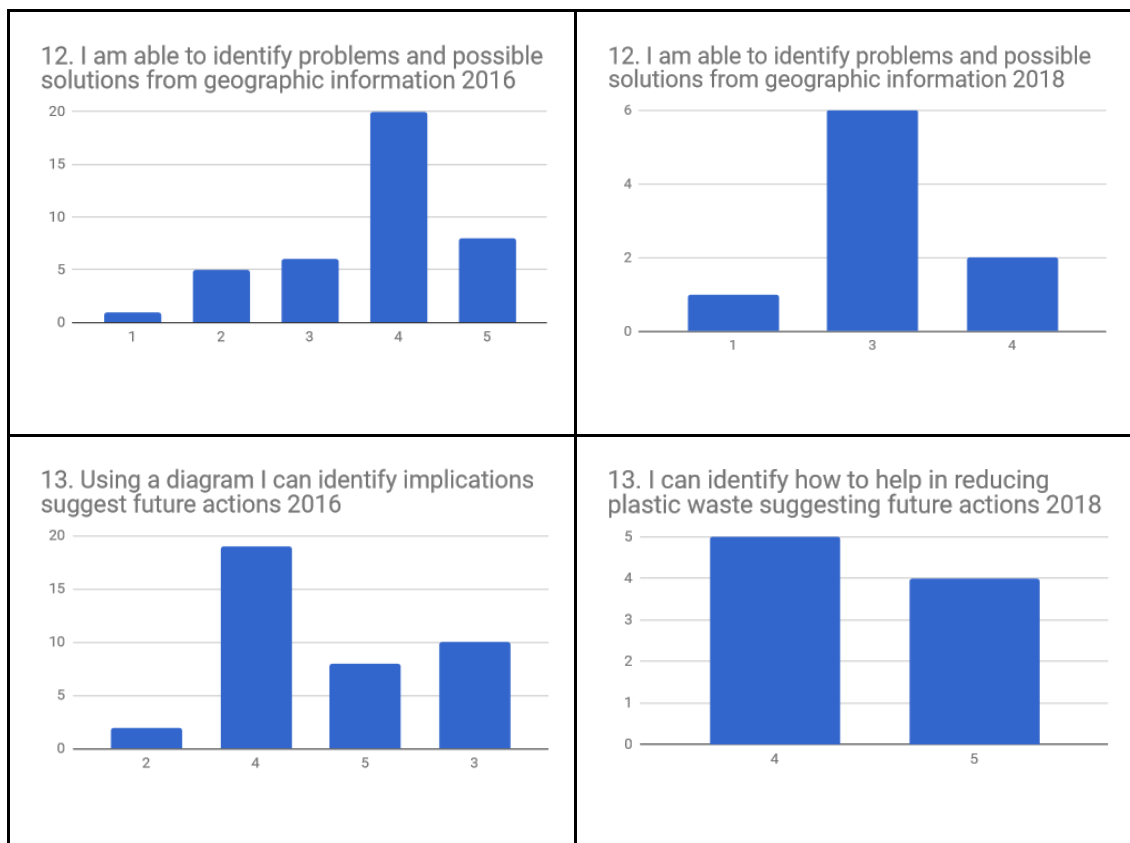


11. I am able to undertake a detailed investigation 2016



11. I am able to undertake a detailed investigation 2018





The ability to collect data from different sources has grown significantly. Whereas at the beginning, mainly local and national data resources were known, almost all Austrian students indicated that they were also able to find useful European and World data to support their work. At the end, students were definitely aware about reliability issues, e.g. they stated in their feedback that:

"...maps can be made to show what the creator wants to show, so you have to check the creator and what the map is for"

"every map is in someone's interest, so they can be subjective"

"It is often a bit unclear and maps are not always defined as they should be"

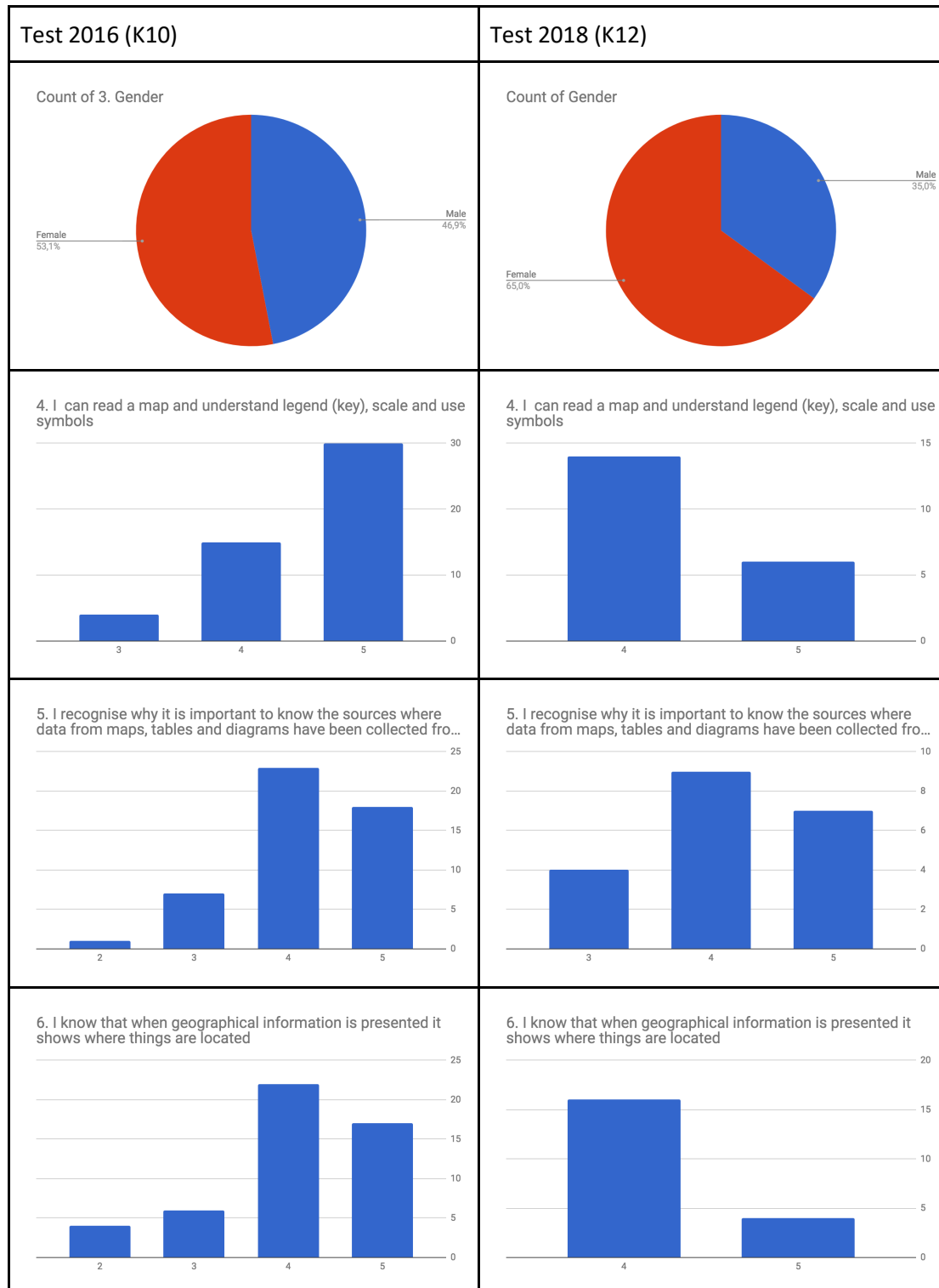
"everyone can change it easily in a few seconds"

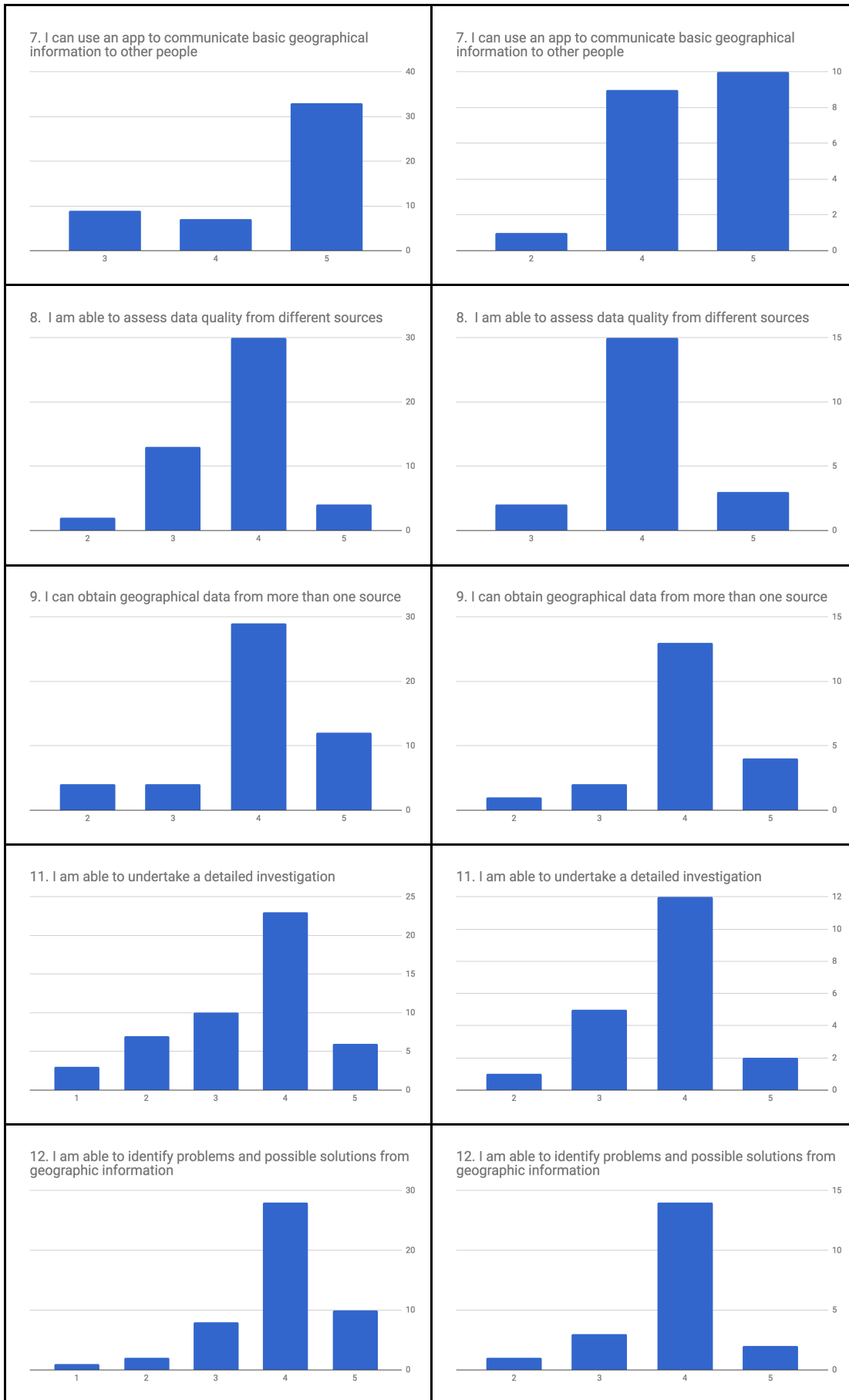
"Maps can always be modified to make something look better or worse. The creators of the maps might have left out data, etc."

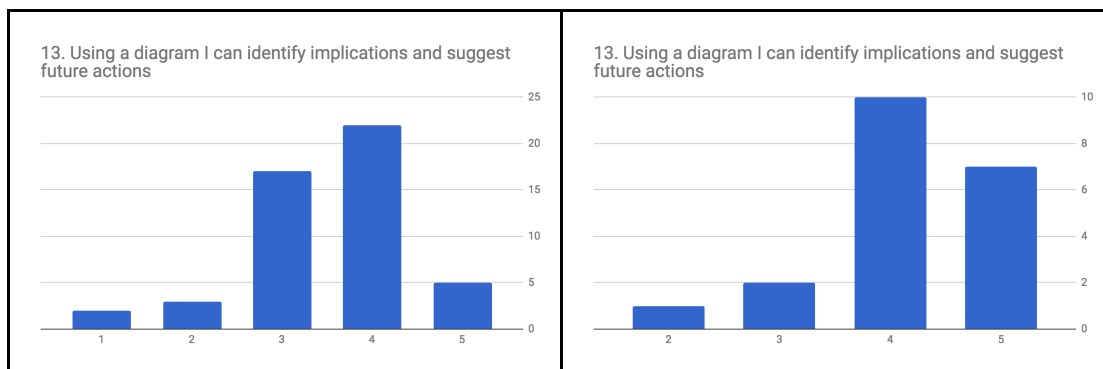
6.2 Belgium

The school system in Belgium makes students choose from a range of study options every two years. As a result, the group that started as K10 in the school year 2015-2016 got split up into different groups because they made different option choices. As the majority of them went to the same class it was decided that that class would continue as a test group for the project. To make an analysis over the three years possible, the test was redone by that new group at the beginning of the school year 2016-2017. As a result, the analysis of the Test 2016 is a bigger group.

The diagram below shows the evolution between K10 (2016) and K12 (2018).

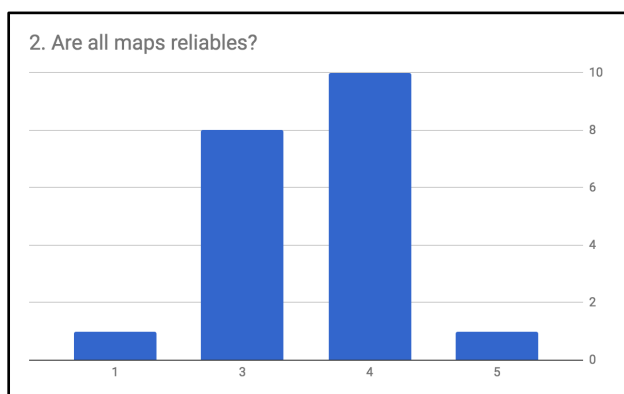






Overall, we noticed some progress in the percentage of students from a score 3-4 to 4-5. This is most visible for the questions which refer to higher thinking skills, such as question 13 ('Using a diagram I can identify implications and suggest future actions'), question 11 ('I'm able to undertake a detailed investigation') and question 7 ('I can use an app to communicate basic geographical information to other people').

In the final test K12 the question appears: 'Are all maps reliable?' (question 2):



The results show that students are aware of the fact that this is not always the case, their comments included:

"Everybody can make maps and you aren't sure that all maps are reliable, I could create a map with a lot of fake data and share this on my account."

"Because we can all make a map, so I don't think that all maps are checked"

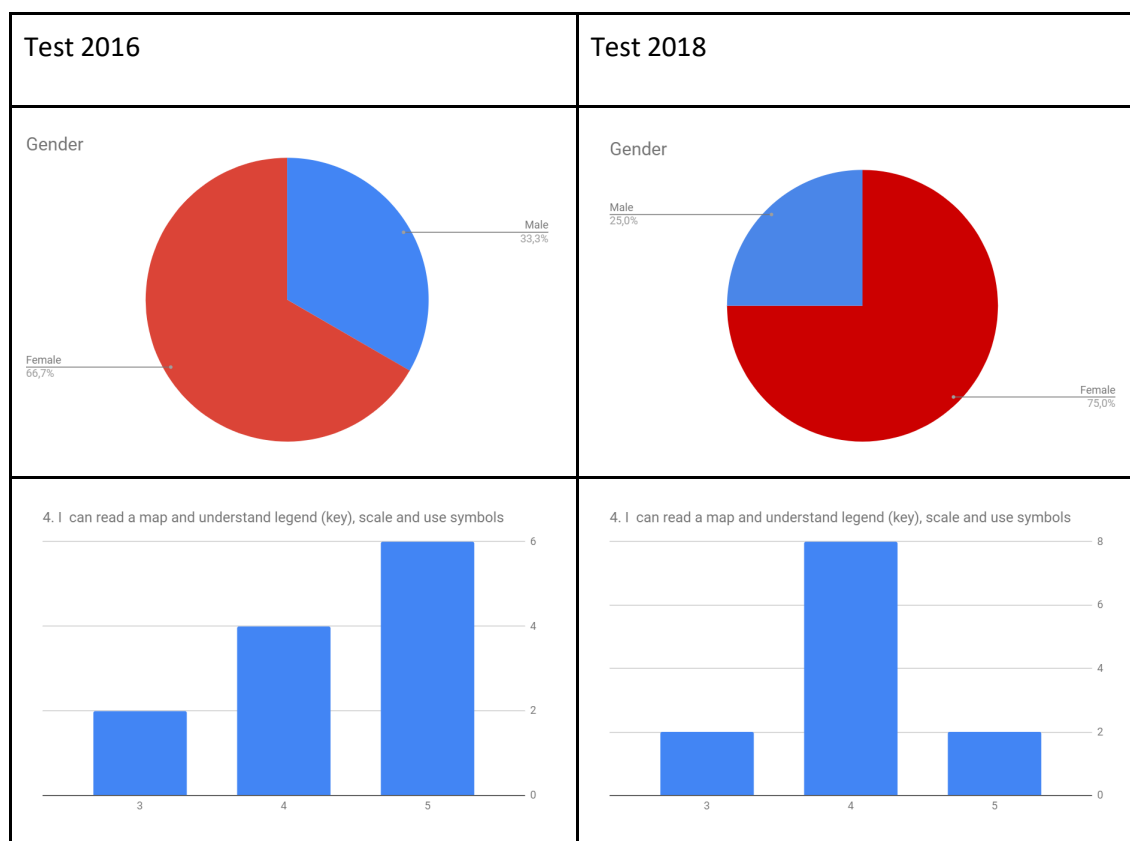
6.3 Romania

When considering geography as school subject, the curriculum is focused on two separate domains: the first one is represented by the imposed/compulsory geography national curriculum and the second one is oriented to the school decision curriculum (as optional subjects). The Romanian imposed geography curriculum does not include a GI section for any level of study. For our K10 students (15 years old) taking part in the GI - Learner project was an extraordinary experience and a strongly innovative part of their educational background. The students were selected in the first step by volunteering and then by performance and commitment to the project requests. The students' team suffered changes over the three years due moving to other schools, voluntarily quitting the project and other external reasons.

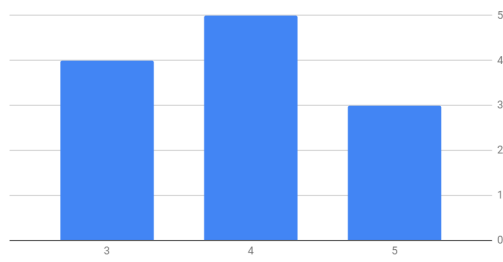
Romanian students completed the self-evaluation test in the first year of the project and there was therefore the possibility of some 'incorrect' answers caused by the lack of some knowledge regarding the subject, the misunderstanding of the English terms or an overestimation of their own skills.

The second test was completed during the final meeting in Madrid in February 2018, by 12 students while they were K12 students. We appreciate the results of these tests as being more realistic since many of the students have been involved in the project since the beginning.

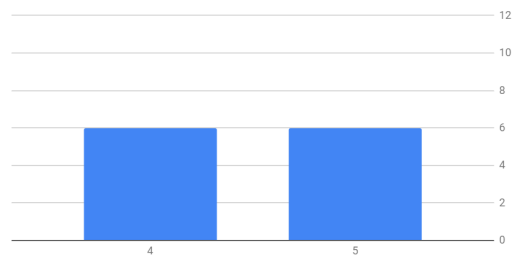
A comparative analysis of self-evaluation tests is presented below:



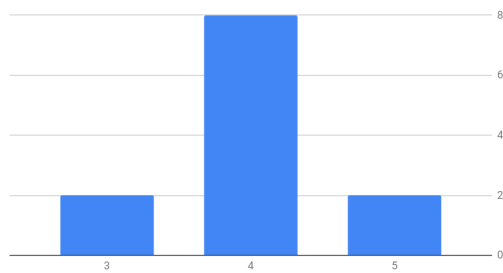
5. I recognise why it is important to know the sources where data from maps, tables and diagrams have been collected from? (e.g. look for information of the publisher)



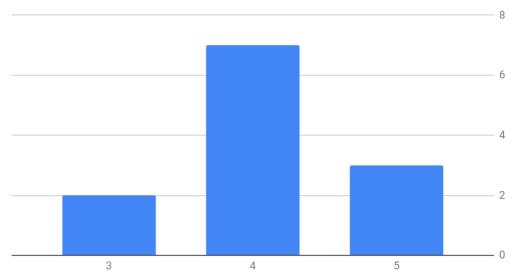
5. I recognise why it is important to know the sources where data from maps, tables and diagrams have been collected from? (e.g. look for information of the publisher)



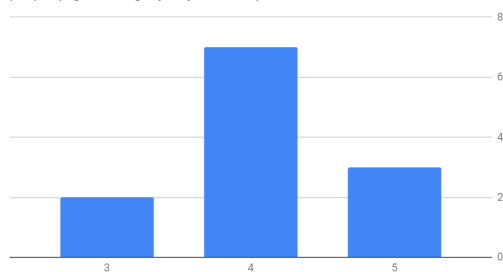
6. I know that when geographical information is presented it shows where things are located



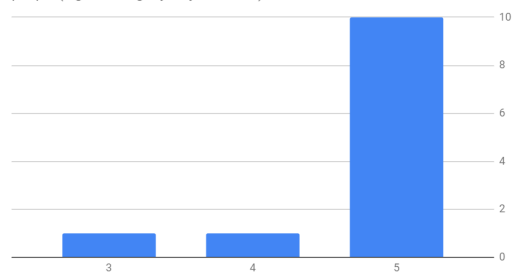
6. I know that when geographical information is presented it shows where things are located



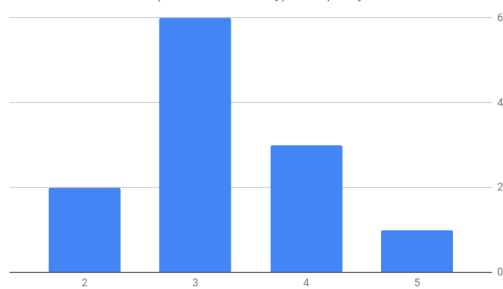
7. I can use an app to communicate basic geographical information to other people (e.g. showing my way to school)



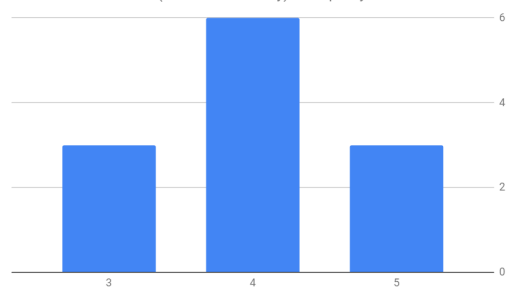
7. I can use an app to communicate basic geographical information to other people (e.g. showing my way to school)



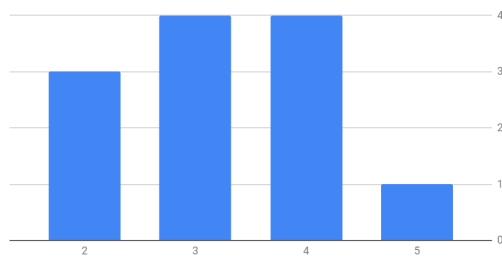
8. I am able to assess (evaluate or identify) data quality from different sources



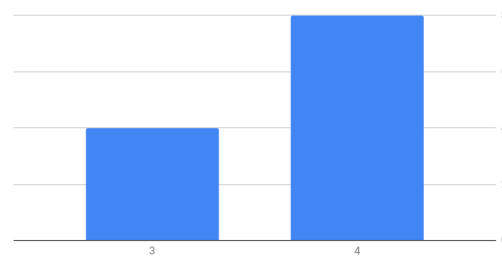
8. I am able to assess (evaluate or identify) data quality from different sources



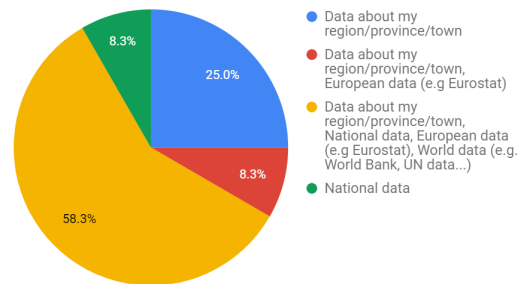
9. I can obtain the coordinates of a place, collect and make use of data (altitude, land use, weather, etc) from more than one source (e.g. online map viewer, GPS, ...)



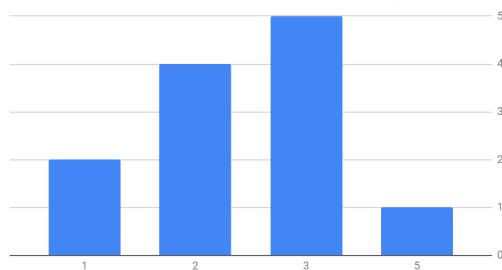
9. I can obtain the coordinates of a place, collect and make use of data (altitude, land use, weather, etc) from more than one source (e.g. online map viewer, GPS, ...)



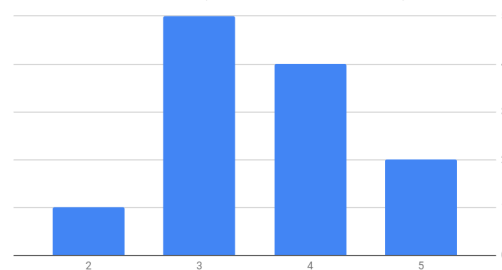
10. I can gather data from the sources selected and make sense of it



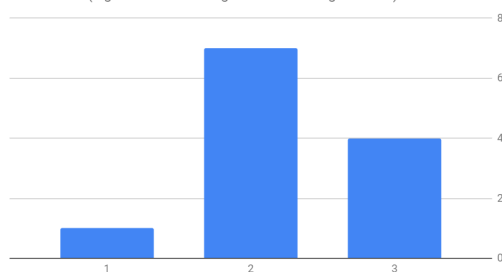
11. I am able to undertake a detailed investigation of possible reasons behind the evolution of the economy (e.g. using map and data above)



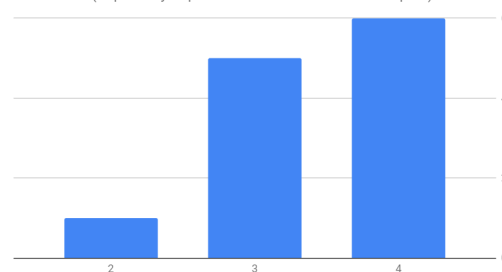
11. I am able to undertake a detailed investigation of possible reasons behind the evolution of the economy (e.g. using map and data above)

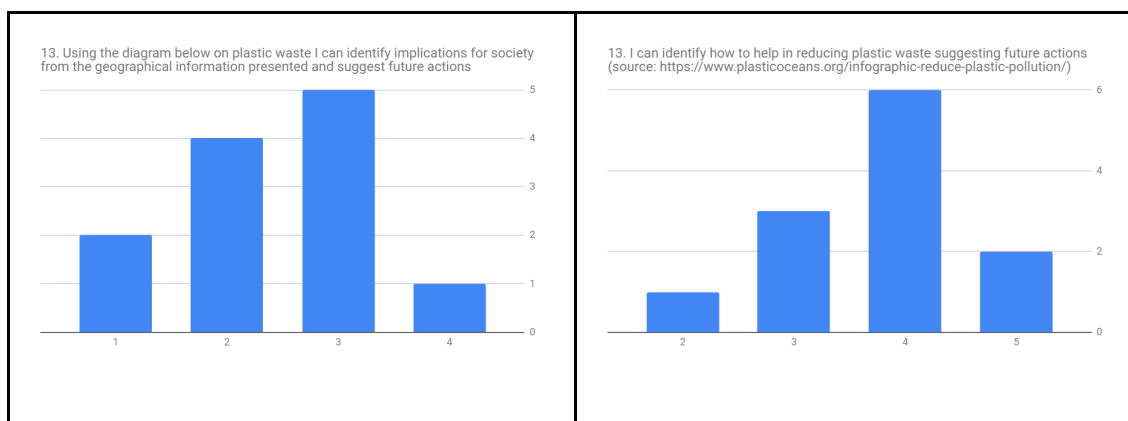


12. I am able to identify problems and possible solutions from geographic information (e.g. on climate change see video images below)



12. I am able to identify problems and possible solutions from geographic information (<http://storymaps.esri.com/stories/LandsatCompare>)





6.4 Spain

The Spanish education system does not have Geography as a separate subject, except at K12 level (Spanish Geography) as an optional subject for some bachelor options. Geography is taught jointly with History in K7 to K9. At K10, only some topics such as Globalization are on the curriculum, again jointly with History, also at K11. Other Science subjects are related to Geography however, and they provide some curriculum opportunities for GIScience units. The project has been taught using students on a voluntary basis alongside normal lessons.

The average age of the students on the initial test (2016) was 15.5 and at the end (February 2018) was 17.4.

Figures 8 and the beginning of this chapter show the lack of evolution in some tasks. Perhaps more extra lessons would be necessary, as all the project has been run outside daily lessons, as geography has been nearly disappeared from the curriculum. The other problem is that Spanish students are not accustomed in self-evaluation methods.

K9 students were specially delighted by the project. They have said that they would like to continue with K10, although it is not possible because the project has finished. They have been invited to Madrid Science Week in November 2018, in order to demonstrate some activities related to the project.

6.5 United Kingdom

There were some issues with continuity of students involved in the projects, as outlined earlier in the report.

Feedback from students showed that there were some real benefits to being involved in the project, which has fed into their other subjects as well as geography. There is a closer link to some of the tools and ideas in the UK Geography curriculum than in some other EU countries, and also greater flexibility in terms of *when* particular topics might be taught.

The project has also had a significant impact on the curriculum within the UK partner school, and the GI Learner project materials have fed into curriculum thinking. The ideas have also been shared widely within the UK education community (see dissemination section of the final report for more details of these outcomes). The benefits have also been communicated to other subject departments, and they have also been involved in Erasmus+ projects as a result.

7 Other evaluations

Other evaluations were done via feedback on the exercises the pupils made during the project and during the final meeting in Madrid.

7.1 Feedback on the exercises

As the pupils were also the 'guinea pigs' for the project materials they were asked after executing an exercise to give us feedback² on the exercise: was it clear, did everything work fine, ideas to adjust... but also feedback on what they thought of the methodology and materials used. This is an excerpt of what they wrote:

I enjoyed using the map tool.

I think the material we are learning here are very interesting and they can be useful.

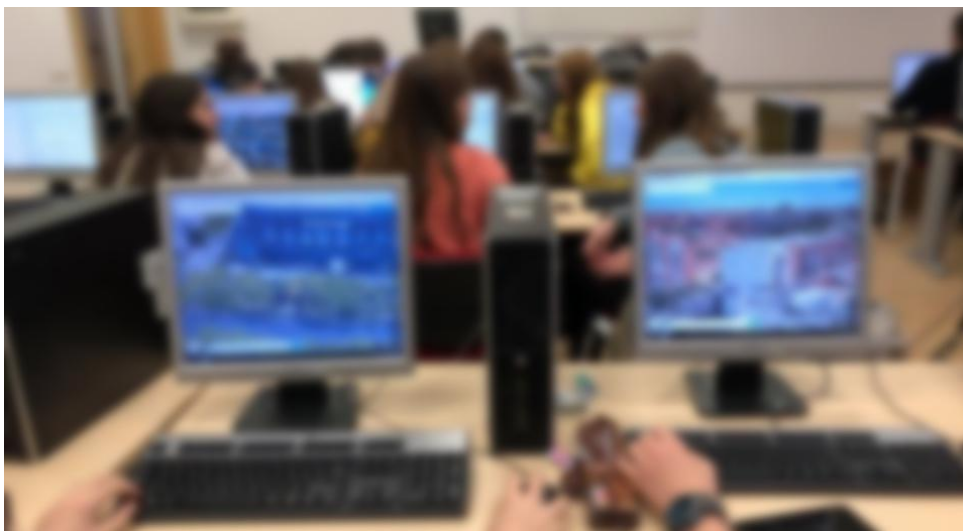
The methods are great because it is a new form of learning this type of subjects.

It was really interesting to fulfil the different tasks. My English is not the best, but it was really simple to understand.

I think this is a new form of learning about the tsunamis and the risks we have in our planet

It was really interesting the map and the different buffers who show all the risks

I have found the duties very interesting and, besides, have learnt a lot. Positive I found the website with the map, because one could read from this extremely a lot and learn



The tools themselves as well as the methods were new. I guess I improved my skills according to computer tasks. What was also new is that globalisation has many different categories in which it can be evaluated.

Working with those materials is a nice alternative to the normal lessons at

school. We learned new methods and contents of working with globalisation on the computer.

Working with the learning materials I have learnt to work with new materials for me, to orientate myself better on a map and to learn more about GIS technology.

The project gave me the opportunity to get in contact with peers from other countries, which I liked a lot!

It was new to me to test learning materials - a very interesting way of learning!

We did not only discover Madrid in our final meeting, we also met people from all over Europe. This was a very important experience for me and made me more open towards other people.

² All feedback documents can be found on <https://drive.google.com/open?id=1qC3PbxUzGZPYGG9Av2boUGL3CMyMaAdE>

The project was important for my personal development - from active learning to getting into contact with other nationalities.

I gained not only GI-skills, but also our thinking (spatial thinking!). I think it is important that other pupils have the opportunity to participate in projects like this!

Travelling to Madrid gave me both the opportunity to meet with students from other EU countries, but to explore the city in a new way using the maps and tools that we were shown.

Over the years we have learned to create and analyse maps with ArcGIS online and improve our spatial thinking. We got the opportunity to learn geographical tools while we connected with other people and share our ideas. We have gained insights into different problems of the world. Spatial thinking is a skill that is necessary in daily life and this project helped us to gain it.

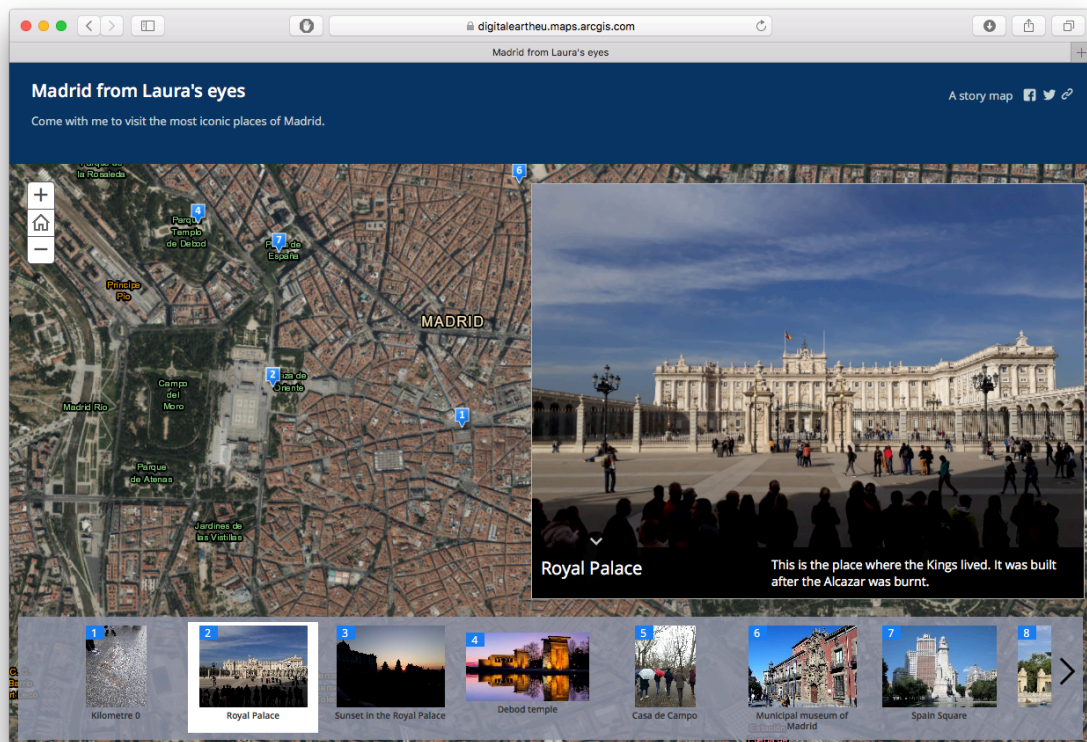
7.2 Final products

At the final meeting in Madrid pupils made ESRI Storymaps³ with a double goal:

- practice the competencies they learned (for the K9 and K12 students)
- write down what they had learned out of the project (K12 students).

For the first goal students of K9 had to create storymaps to promote Madrid, these are some results:

- Places you must visit in Madrid: <http://bit.ly/2Niqiy1>, <http://bit.ly/2CIVR5Z>
- The popular foods in Madrid: <http://bit.ly/2MPxjHd>
- Walking tours in Madrid: <http://bit.ly/2MLMH7w>, <http://bit.ly/2M2c7c5>, <http://bit.ly/2M0NXOW>, <http://bit.ly/2M2eWtw>, <http://bit.ly/2M1GbUU>, <http://bit.ly/2LZGy2n>
- Madrid girls' weekend: <http://bit.ly/2Cmha7w>



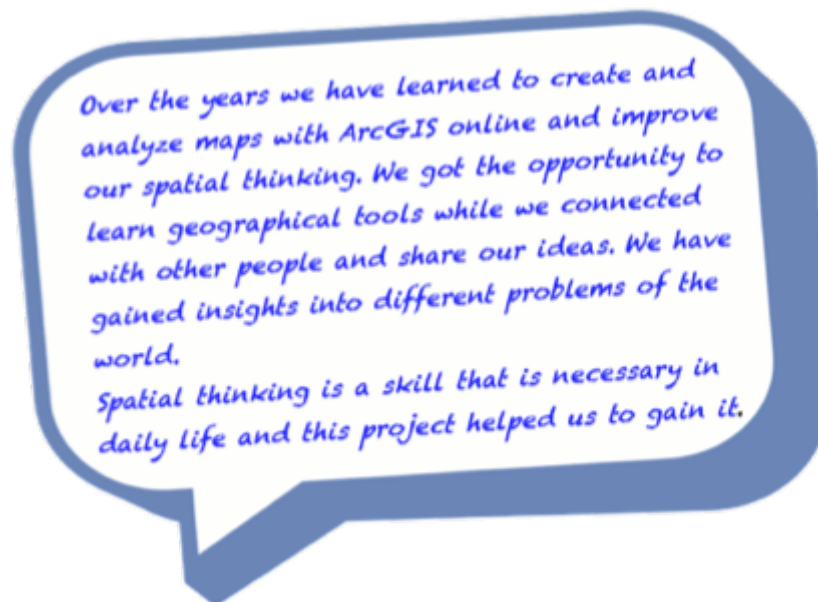
³ To make sure that the content will not be deleted accidentally, the ownership has been copied to the organization Digital-Earth.eu. The content has not changed and is still exactly what the students made.

The students of K12 had to make - in a very short time - a walking tour for the K9 students in an area inside Madrid. The walking tours were used on mobile devices using the ESRI Explorer app. These are the 4 walking tours:

- Group A:
<https://digitalearth.eu.maps.arcgis.com/apps/webappviewer/index.html?id=5dfb55a57a014e5bbe2d4cad09da4866>
- Group B:
<https://digitalearth.eu.maps.arcgis.com/apps/webappviewer/index.html?id=d8c338067299400cbb9794f19e374b47>
- Group C:
<https://digitalearth.eu.maps.arcgis.com/apps/webappviewer/index.html?id=762593caca374d6eb0088aab593dd9d2>
- Group D:
<https://digitalearth.eu.maps.arcgis.com/apps/View/index.html?appid=7e685eeb6b374bf1a0aad35258a82801>

At the end of the meeting in Madrid the students of K12 wrote down in team their reflection on the project in a storymap:

- <http://bit.ly/2ClpOTJ>
- <http://bit.ly/2LYEtUw>
- <http://bit.ly/2M12J8p>
- <http://bit.ly/2MQ4M4g>
- <http://bit.ly/2MRE2kh>
- <http://bit.ly/2MRmaFW>
- <http://bit.ly/2M1SC3c>
- <http://bit.ly/2Nfc01m>

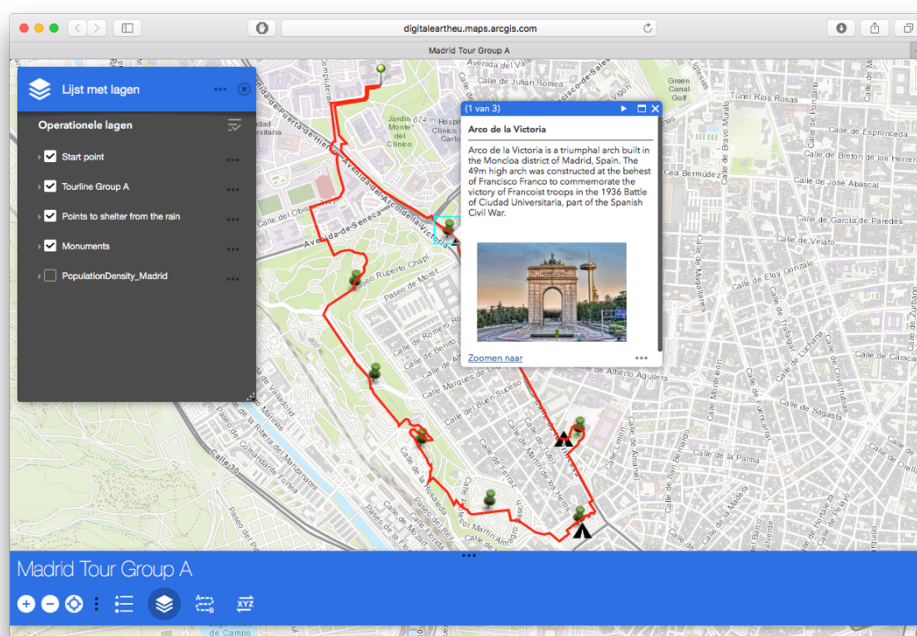


8 Conclusions and recommendations

The greatest satisfaction to emerge from the project is that the use of a learning line is an excellent way to support learning. Students increased their learning not only in geography, but also through their use of self-evaluation and their competence with ICT and other related skills. Students made a more strict, accurate and reliable self-assessment at the end of the project, perhaps because they had a better knowledge about what they had (and hadn't) achieved during the lifetime of the project. They have also seen an open window and are better able to know what is still missing in their knowledge. The student mobility was particularly useful in linking the work they had completed in the classroom with the reality of producing maps, which were followed and used by someone else on their smartphones. This gave them an audience for their work, and some more immediate feedback.

Student self-evaluations identified that some tasks are more difficult than other, for example the task of assessing the reliability of a source, or in identifying problems and possible solutions from different sources for each age: complex sets of information (K7) or geographic information (K12). There were others which were felt to be easier, but the role of a curriculum project should be to take students from the familiar to the unfamiliar, something we have certainly achieved during the project.

Students enjoyed their involvement in the whole process. Many students, because of school circumstances, were mainly involved outside their timetabled lessons, as school programs are so heavy that it was impossible to follow the completed lesson plan necessary to follow the steps of the learning line within normal timetable time.



ArcGIS Online has been a very useful tool for students to share, complete work and understand what a map can say and what it cannot say and assess the problems of accuracy and reliability. The ability to share maps with other users, and to create a web application are particularly valuable. This also moves the students away from tools like Google Earth and Google Maps, which they knew about at the start of the project, and more towards the sort of tools they might use in industry, and in their future workplaces.

The kind of activities that we developed in our project materials also encouraged the female students to progress and investigate further, as can be seen from K7 to K9 and from K10 to K12.

9 Some reflections on the tool itself for future tests and limitations

The Likert scale is straightforward to use, which is one reason for its adoption, but it has had the inconvenience of some subjectivity in some questions that were produced. A slightly more detailed rubric for the completion of the self-evaluation according to the learning line would perhaps have been useful when guiding students through the tasks. To improve the tests, particularly the final tests we have been using along the project, we propose to amend some of the questions according to these rubrics.

It would also be advisable to make an easy tool to measure learning progressions on GIScience, which could take the form of an app, perhaps a web application. This would allow for better choices of images and integration of these into the testing, and perhaps a little more reflection before making a choice. The background, and experiences that all project partners have had in their lengthy interactions with students during these three years has been very important to identify and consider the nature of strengths and weaknesses of tools to measure the learning of the students. The issue of measuring and assessing learning is of course a thorny one. The focus of the project has not so much been in knowledge, as in the critical acquisition of a particular way of looking at and working with maps and data. The GI competencies provide a framework for this work, and the learning line has provided a structure. The tests may not have been appropriately reactive to the changes observed in the students, and a more flexible tool may be required.

Some project issues have created some specific difficulties, such as the problems with keeping the same students throughout the whole three years of the project, especially in those schools characterised by higher mobility of both students and teachers.

To agree common geographical topics for lessons plan has not been very difficult, but to fit them within the appropriate national curriculum levels has been quite difficult. We have had numerous conversations between project partners, which has allowed us an insight into each other's curricula (assisted by the detailed report we completed early in the project)

The relative weight given to certain topics has also varied between countries, as they are introduced at different times. Globalisation may only appear at certain key stages in some countries but be introduced earlier in others. The expectations of students may therefore vary.

10 Appendix I

The pilot testing on the intermediate year shows that the normal improvement is working. Thus, the project partners decided to prioritise normal, class-based activities, as the test took a lot of time.

