ROBOSCIENTISTS PROJECT

Motivating secondary school students towards STEM careers through robotic artefact making

Erasmus+ KA2 2018-1PL01-KA201-051129

Validation report

IO3, Task 6
A validation report that bring together the results of:

Case studies in schools in Poland, Greece and Latvia from 2 pilot rounds.

Responsible Organization: University of Latvia
Country: Latvia
Date 15/11/2021

The objectives of the project

- Motivate school students (13-17 years old) to explore STEM disciplines by engaging them in creative hands-on practices towards robotic artefact creation.
- Enact activities and workshops that promote teacher professional growth and development.
- Motivate students in developing interest in STEM studies and careers by engaging them in making practices following the ideas underpinning the Maker Movement pedagogical trend.
- Encourage equal opportunities in STEM education for boys and girls.
- Create OERs that will support school community members to apply the RoboScientists learning intervention.
- Build synergies among schools, business and academia towards STEM Clubs establishment in school settings.

Sources for collecting feedback

STUDENTS

A PRE and POST Questionnaires have been conducted in order to get feedback by all the participant students.

TEACHERS

The teachers involved in the RoboScientists learning activity also provided feedback through questionnaires:

- The impact to their teaching/professional development.

- How the whole intervention was perceived by them (focus on their students' learning, motivation towards STEM, difficulties and challenges).

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Evaluation criteria and indicators

	Quantitative indicators	Method
01	Number of designed and built robots by students	Teachers POST Questionnaire (after all project activities)
02	Percentage of participant students that expressed more positive attitudes towards STEM related disciplines	Students PRE Questionnaire (before project activities) Students POST Questionnaire (after all project activities)
03	Percentage of teachers in position to continue carrying out the RoboScientists learning intervention in schools (Confidence level)	Teachers POST Questionnaire (after all project activities)
04	Teacher's satisfaction level from the training offered (C1, C2, C3 and C4)	Teachers POST Questionnaire (after all project activities)
05	Participation of students in the pilot stages | Target >= 40 in each country – SHOULD BE 120, WE HAVE REACHED 120 in total, but not 40 per country	Teachers POST Questionnaire (after all project activities)
06	Percentage of active teachers in the online class | Target > 15 per country	• WEB
07	Final acceptance rate of the RoboScientists methodology and pedagogical framework by the teachers | Target> 80%	Teachers POST Questionnaire (after all project activities)
08	To what extent educational resources for teachers and students were completed successfully.	Teachers POST Questionnaire (after all project activities)

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2 Evaluation criteria and indicators

	Qualitative indicators	Method
01	Teachers' perceptions on the value of the RoboScientists curriculum and resources for enhancing students' interest in STEM education	Teachers' POST Questionnaire (after all project activities)
02	Students' perceptions on the RoboScientists activities	Students' PRE Questionnaire (before project activities) Students' POST Questionnaire (after all project activities)
03	Students' perceptions related to the value of STEM subjects	Students' PRE Questionnaire (before project activities) Students' POST Questionnaire (after all project activities)
04	Students' motivation towards STEM related careers and educational paths	Teachers' POST Questionnaire (after all project activities)
05	Feedback generated through threads in the forum of the online class related to the teaching practice with RoboScientists resources.	• WEB

Students' Questionnaires

Pre and post Questionnaires have been conducted in order to get feedback from all the participant students.

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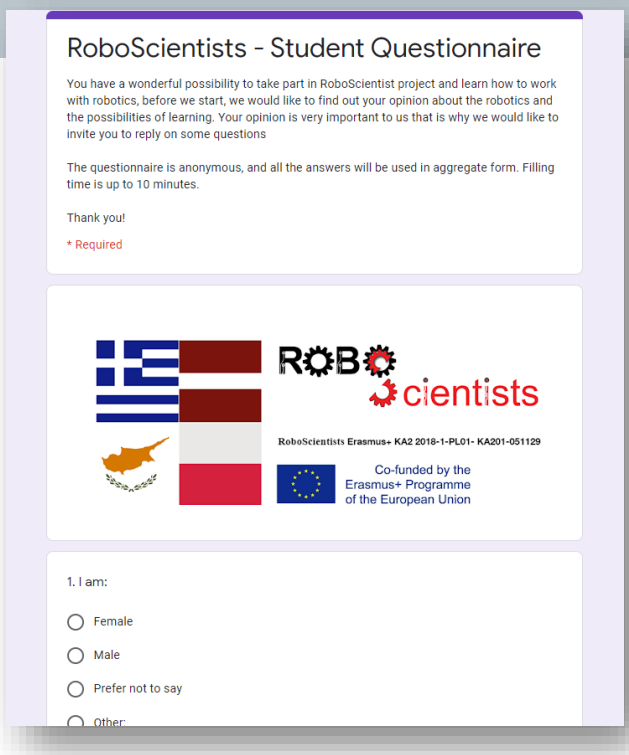
Student PRE and POST Questionnaires

- Students' questionnaires have been conducted **prior to the pilot classes** in all schools involved in the project;
- The questionnaire was created in English and translated into the languages of the Project member countries - **Greek, Polish and Latvian;**
- The questionnaire consisted of **14 questions and 44 subquestions;**
- Questionnaire was created by using **Google Forms and it was shared online;**
- A total of **120 pre and 119 post questionnaires** were received;
- The results gathered were compiled (in English), **coded and analyzed using SPSS data processing software.**

The questionnaire consisted of 6 parts in the following categories:

1. **Knowledge**
2. **Motivation**
3. **Problem solving skills**
4. **Collaboration and work on sessions**
5. **Creativity**
6. **STEAM**

More detailed information on all questions of the questionnaire can be found in **Annex 1**


RoboScientists - Student Questionnaire

You have a wonderful possibility to take part in RoboScientist project and learn how to work with robotics, before we start, we would like to find out your opinion about the robotics and the possibilities of learning. Your opinion is very important to us that is why we would like to invite you to reply on some questions

The questionnaire is anonymous, and all the answers will be used in aggregate form. Filling time is up to 10 minutes.

Thank you!

* Required

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Co-funded by the Erasmus+ Programme of the European Union

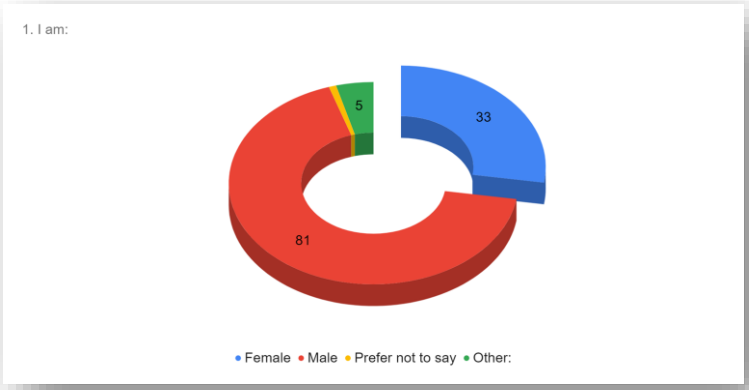
1. I am:

- Female
- Male
- Prefer not to say
- Other:

This diagram shows the gender of the students involved **at the beginning** of RoboScientists project activities.

A total of 120 students: 81 boy, 33 girls and 6 students who have chosen not to indicate their gender.

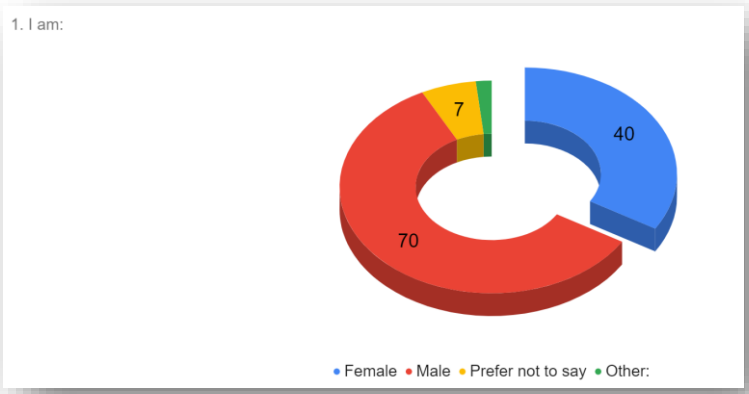
We can conclude that the majority of boys participated in the project with 67%, and 27% were girls.



This diagram shows the gender of the students involved at the end of RoboScientists project activities.

A total of 119 students: 70 boys, 40 girls and 9 students who have chosen not to indicate their gender.

We can conclude that the majority of boys participated in the project with 58%, and 33% were girls.



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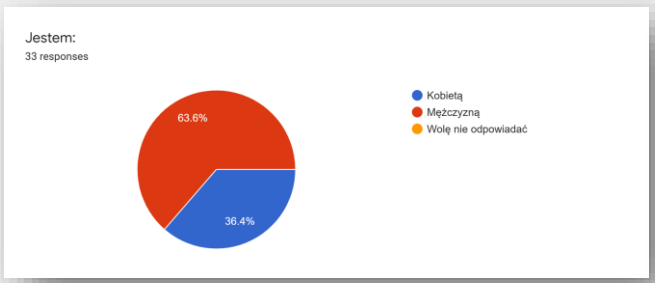
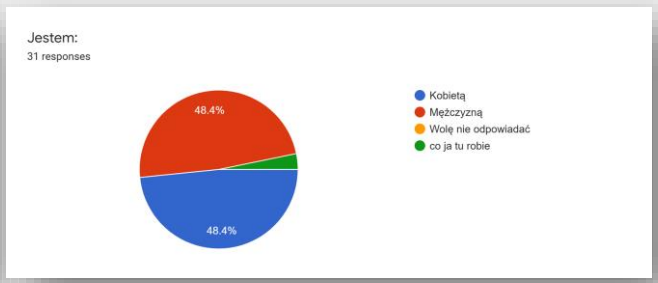
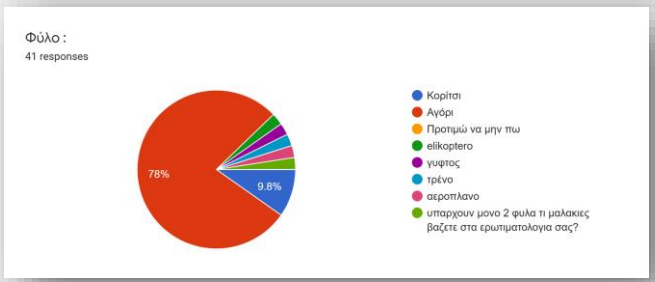
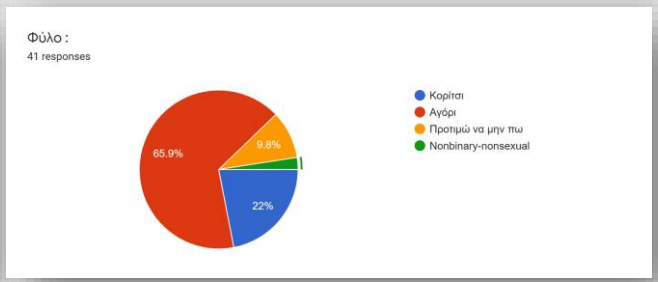
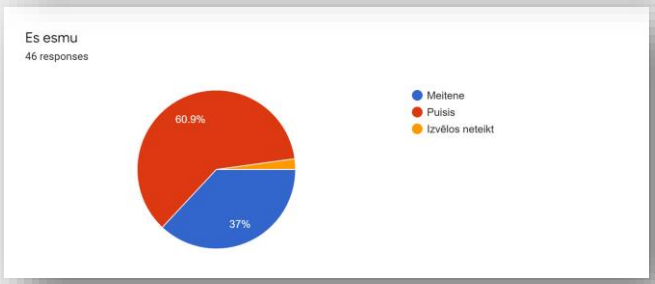
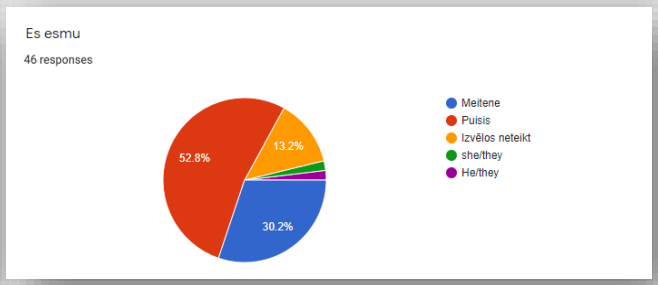
Poland		
Greece		
Latvia		

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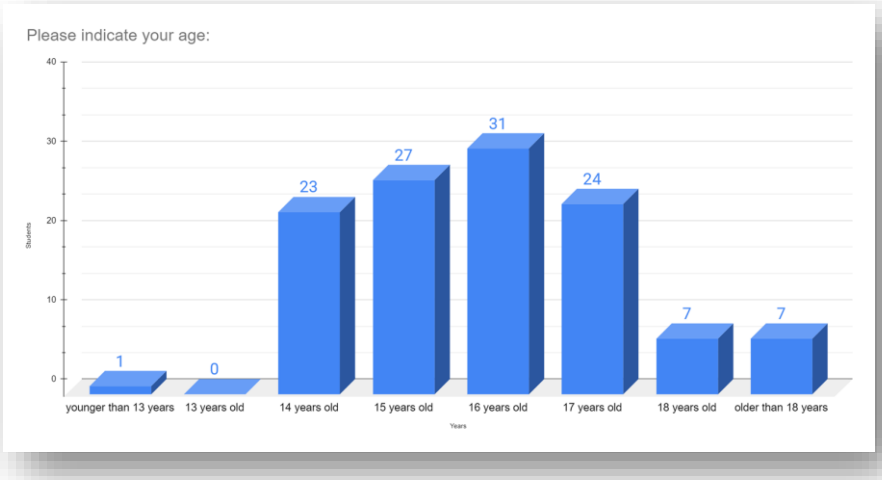
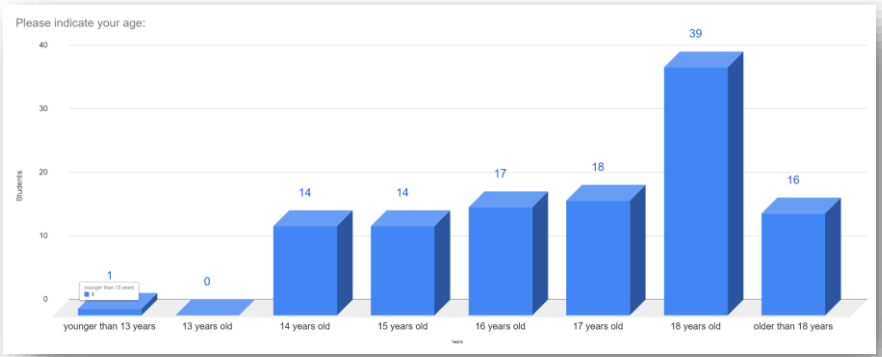
This chart shows the age of the students involved **at the beginning** of RoboScientists project activities.

A total of 120 students: Mostly 16-17 years old (55N), also younger 14-15 years old (50N), and 14 students were 18 or older than 18 years old.



This chart shows the age of the students involved at the end of RoboScientists project activities.

A total of 119 students: Mostly 18 years old (39N), students older than 18 years old (16N), also younger 15-17 years old (49N).



BEFORE

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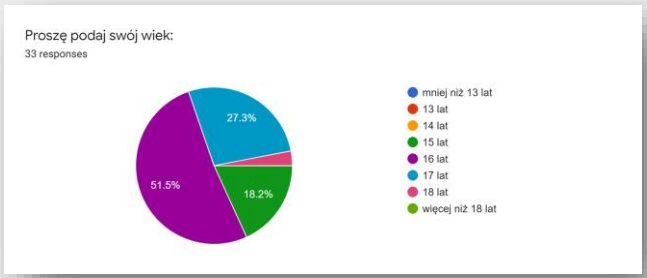

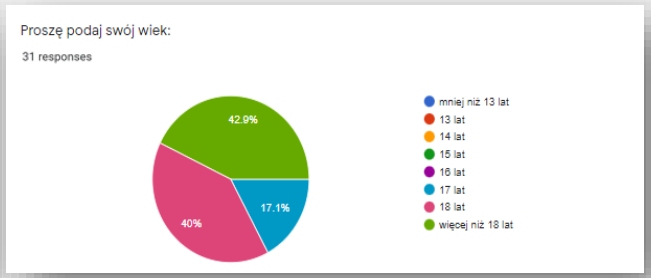

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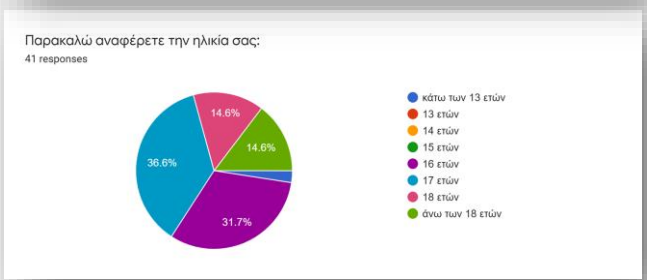
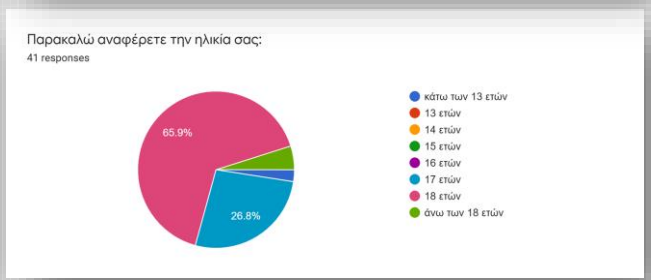
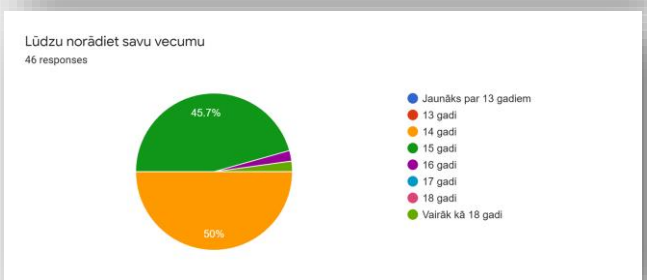
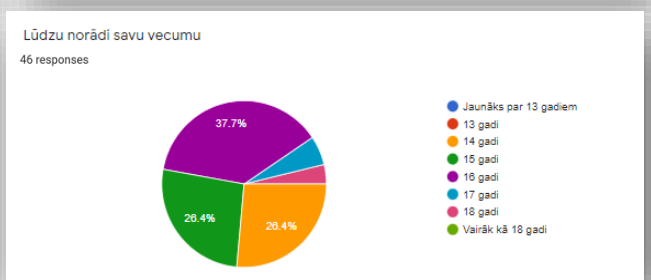




Latvia





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Covid-19

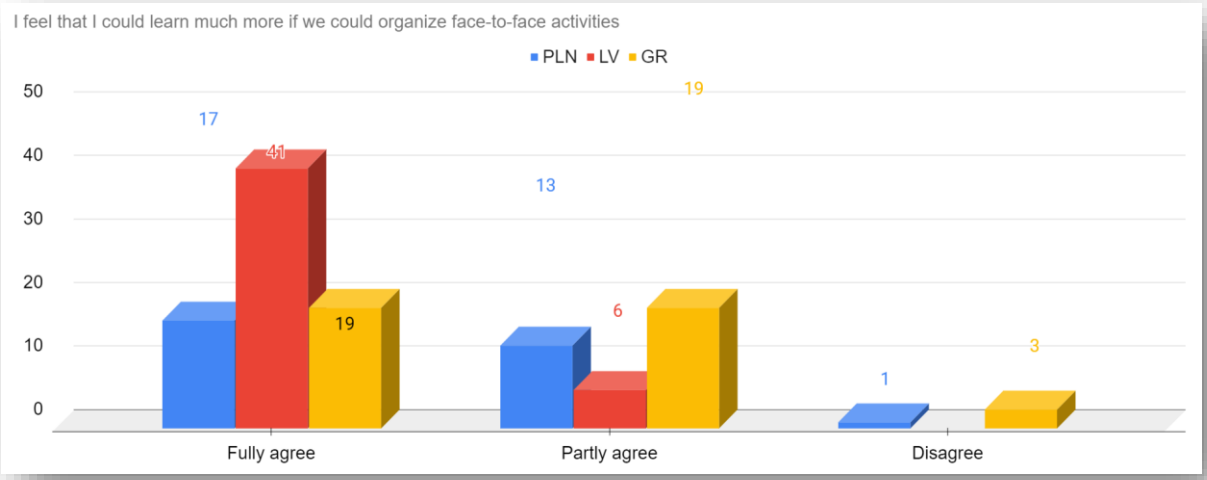
During Project implementation, the Covid-19 pandemics caused emergency situation in 2020 and 2021 and accordingly, face-to-face training was partially or permanently terminated in all project partners countries. An additional part to the student questionnaire in relation to this situation was included, in order to find out the students' opinion - whether the restrictions caused by Covid-19 have affected their performance and knowledge acquired during the project.

There were changes in project realization due to the restrictions caused by Covid-19. Please evaluate the statements mentioned below

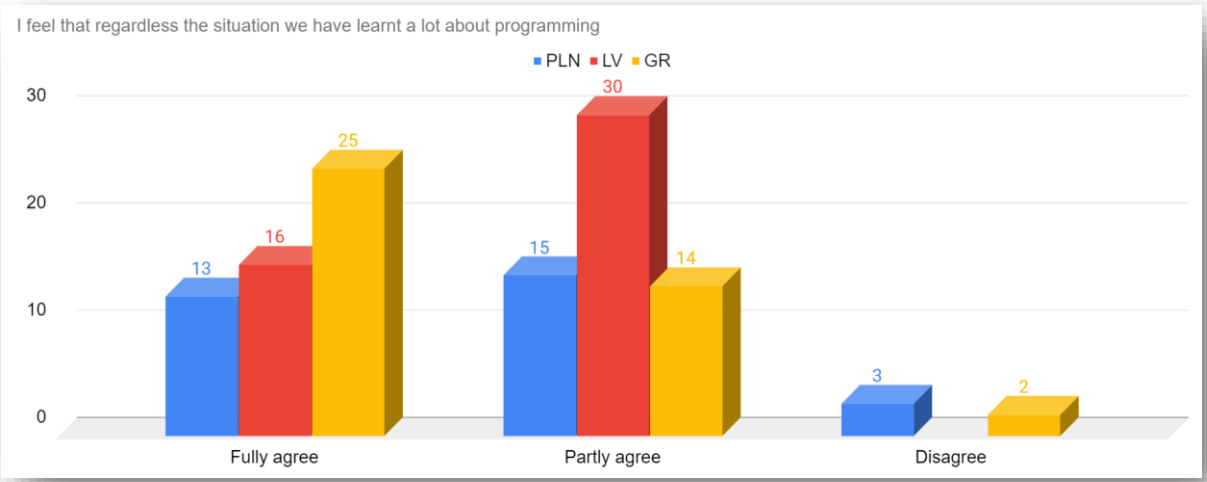
	Fully agree	***Partly agree***	***Disagree***
I feel that I could learn much more if we could organize face-to-face activities			
I feel that regardless the situation we have learnt a lot about programming			
I think that I have learn only few concepts about programming			
I think that I haven't learnt anything about programming			

The following is an assessment of the 4 most important issues related to the impact of Covid-19 on the implementation of the project from the students' perspective in relation to the acquisition of programming skills.

Covid-19 students' opinion



For the question of whether students would have learned much more if the activities had taken place in person without the Covid-19 restrictions "I feel that I could learn much more if we could organize face-to-face activities" most students answer in the affirmative (77 N), and a large proportion of students agree with this statement at least partly (38 N). We can conclude that young people also understand the practical part of robotics and the importance of being present for these activities. This is one of the most important questions, which also provides many answers to the overall results of the evaluation. Of course, no one foresaw remote learning when this project was planned, both teachers and students tried very hard and adapted to the circumstances, tried to learn robotics remotely, implement ideas, artifacts and learn topics, but unfortunately we can only conclude that students in face-to-face classes would have learned better and more new things about creating robotics artifacts.



Analyzing the question about students' self evaluation in relation to the acquired knowledge in programming "I feel that regardless of the situation we have learned a lot about programming", results show that their assessment is positive, with answers *fully agree* (54N) and *partly agree* (59N). We can evaluate it in different ways. First of all, programming is easier to learn in the remote learning process, because all the work takes place on a computer. Secondly, it could be related to their prior knowledge, because when starting the project a large number of students didn`t have experience and prior knowledge about programming, thus, the acquired knowledge in programming during the project can be evaluated as achievement and acquisition of new knowledge.

Covid-19 students' opinion

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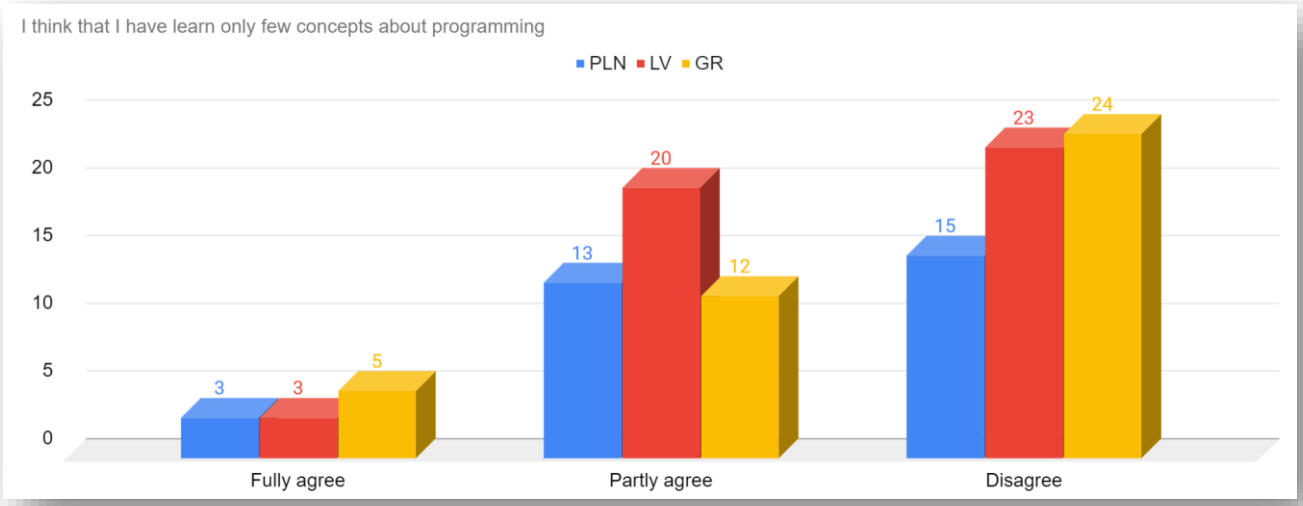
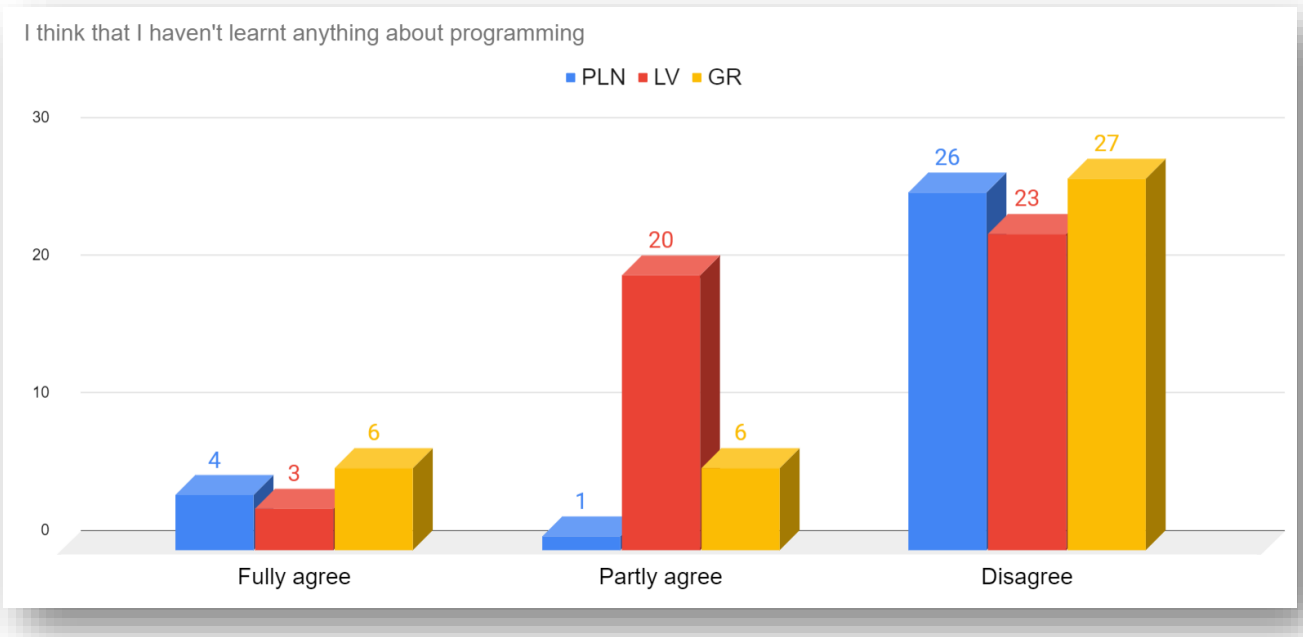


The next question with the following statement "I think I have learned only a few concepts about programming" correlates with the previous question, students answer mostly chose negative evaluation to the statement confirming that they did not learn much in programming during the project – *disagree* (62 N), as in the previous question, some students still consider this statement to be partialy true (45 N). It is possible to conclude that they are aware that they could have learned more, and perhaps this supports answers given in the first question and confirms the consequences of remote learning (Covid-19 restrictions).



The concluding question of additional «Covid-19 part» in questionnaire, due to the consequences of Covid-19 in the learning process during this project, is important, because it reflects the views of students for a statement such as "I think that I haven't learnt anything about programming". And we can appreciate the students' positive attitude, self-assessment and also the project evaluation - despite the situation,students do not agree that they did not learn anything during the project - most of them indicate that they do not agree with this statement (76N).

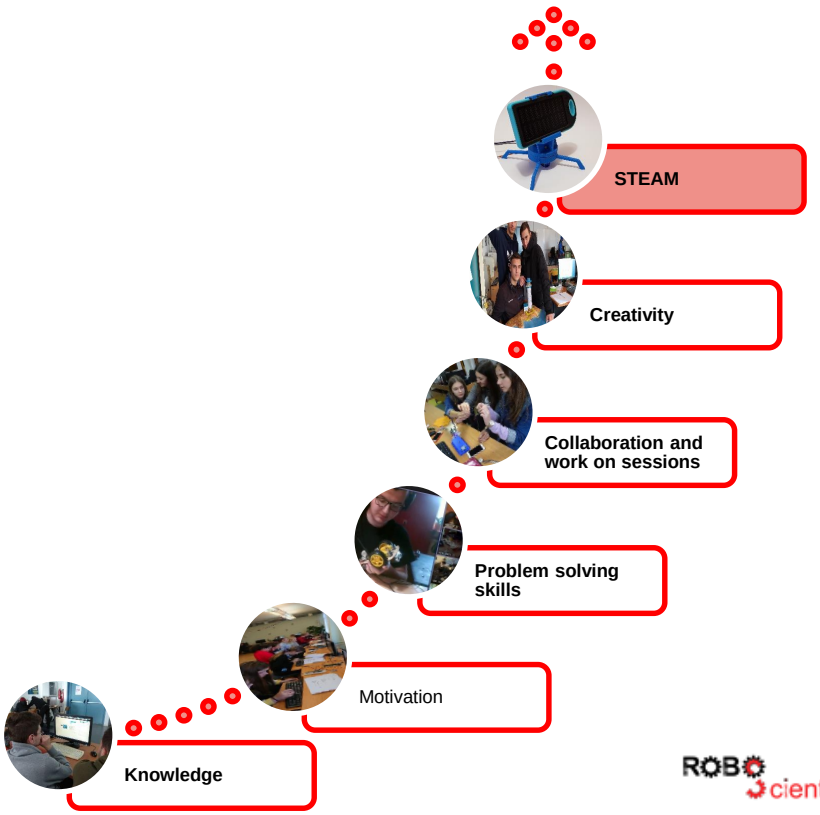
Data analysis, methodology and research results

Firstly, all questionnaires were developed in English, discussed with the partners and approved, then translated into all national languages of the project partners (Polish, Greek, Latvian). They are designed to provide answers and an assessment of the qualitative and quantitative indicators of the project. At the end of the project activities, the data were combined by transferring the students' answers from Polish, Greek and Latvian, using the Excel coding method (replace) and preparing the data for work with SPPS. Statistical software platform *IBM® SPSS® Statistics* were used for data analysis and descriptive method was chosen to reflect the results.

The evaluation report continues with an overview and analysis of data on student questionnaire results, as mentioned before, student questionnaire consists of 6 parts:

Knowledge
Motivation
Problem solving skills
Collaboration and work on sessions
Creativity
STEAM

The validation report on RoboScientists project includes the most important results, data, their analysis, full evaluation in the context of project implementation achievements and quality indicators.

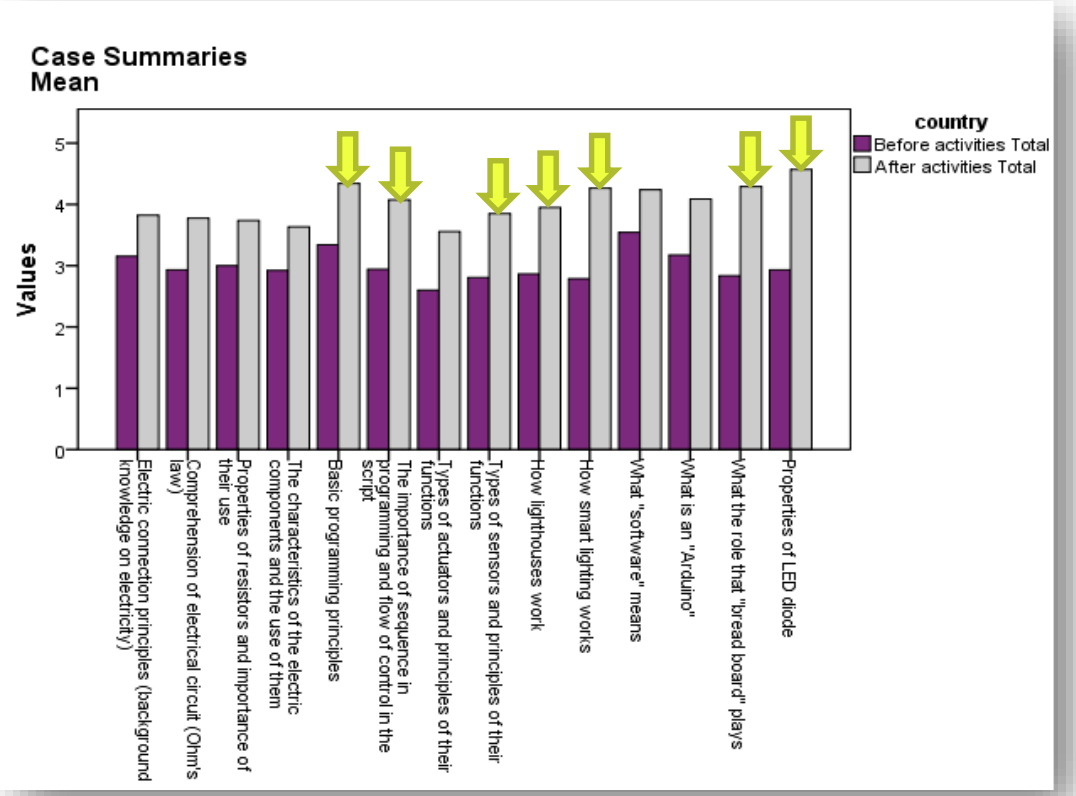


Knowledge

Please evaluate statements about different knowledge by choosing the answer that describes your opinion about the level of knowledge on particular topics:

	I fully understand it and can use it in my activity	*I know the meaning, but I don't know how it works. I would like to learn*	*I know the meaning, but I do not understand how it works*	*I don't know anything about this topic, but I wish to learn*	*I don't know anything about this topic. Not interested to learn*
Electric connection principles (background knowledge on electricity)					
Comprehension of electrical circuit (Ohm's law)					
Properties of resistors and importance of their use					
The characteristics of the electric components and the use of them					
Basic programming principles					
The importance of sequence in programming and flow of control in the script					
Types of actuators and principles of their functions					
Types of sensors and principles of their functions					
How lighthouses work					
How smart lighting works					
What "software" means					
What is an"Arduino"					
What the role that "bread board" plays					
Properties of LED diode					

Knowledge



In order to ascertain the level of knowledge gained by the students during the project, they not only filled in worksheets from the developed curriculum but also conducted a self-assessment within the framework of this questionnaire.

Students were asked to rate their knowledge of various STEAM topics with the following options:

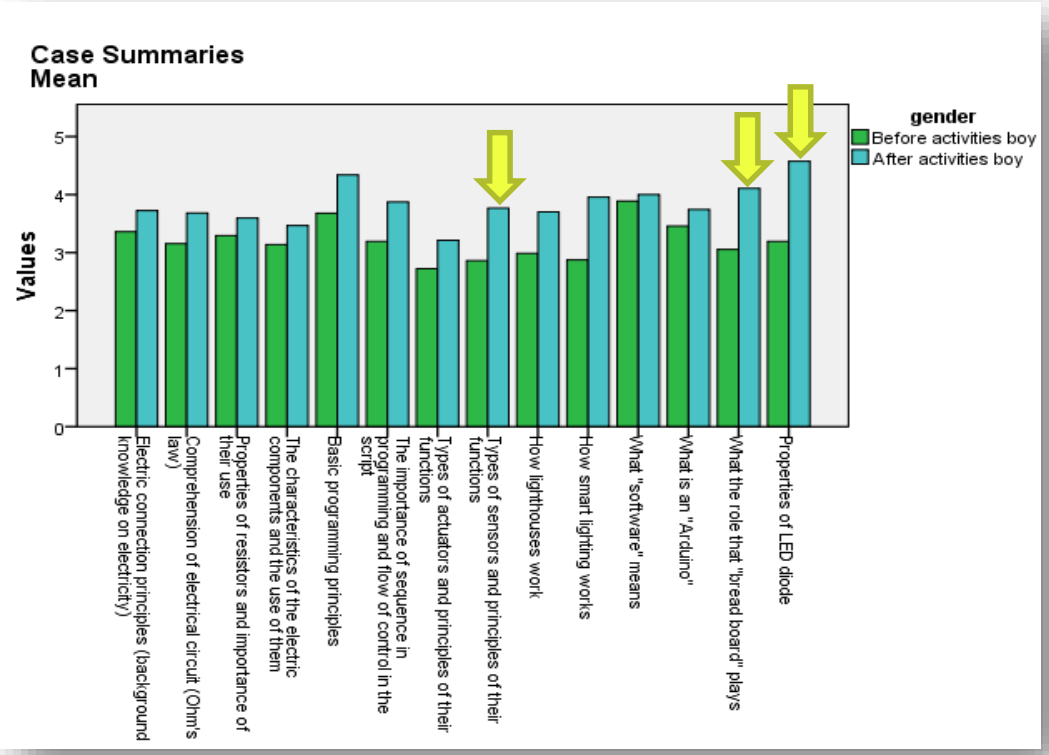
1. *I fully understand it and can use it in my activity*
2. *I know the meaning, but I don't know how it works. I would like to learn*
3. *I know the meaning, but I do not understand how it works*
4. *I don't know anything about this topic, but I wish to learn*
5. *I don't know anything about this topic. Not interested to learn*

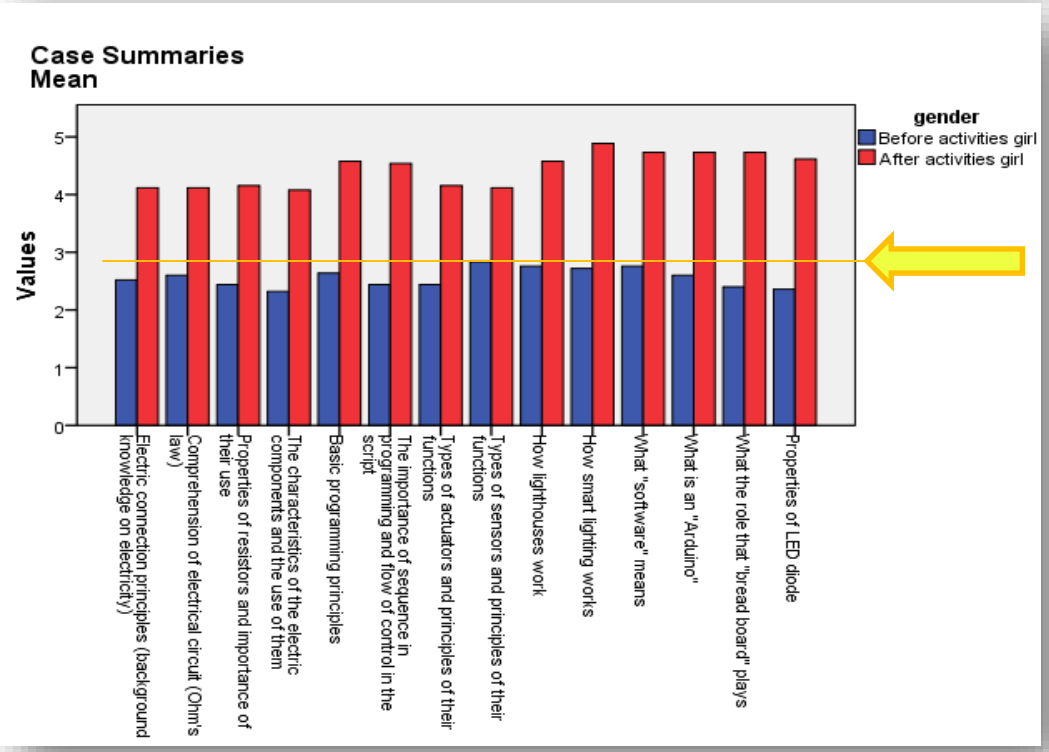
As can be seen in the diagram, there is a significant increase in the level of knowledge and understanding of several topics according to student opinion. The increase in the level of knowledge in the following topics stands out:

- How smart lighting works
- What the role that "breadboard" plays
- Properties of LED diode
- Basic programming principles
- The importance of sequence in programming and flow of control in the script
- Types of sensors and principles of their functions
- How lighthouses work

It is definitely important to mention that knowledge has grown in all of the chosen topics.

Knowledge





Comparing the increase of knowledge in the selected topics by gender, we can clearly observe that the girls who participated in the activities of the RoboScientists project evaluate the increase of their knowledge much higher in practically all topics (POST project questionnaire). What we can see clearly in the chart where results are summarised. We can conclude that it is possible that many girls have learned such knowledge for the first time, and during the RoboScientists project, girls' understanding and knowledge of all STEAM topics has grown significantly.

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Country results

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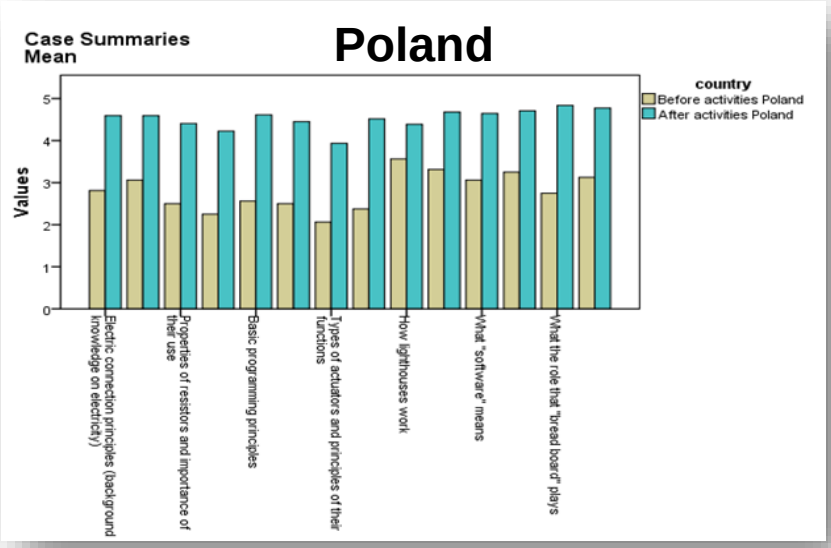
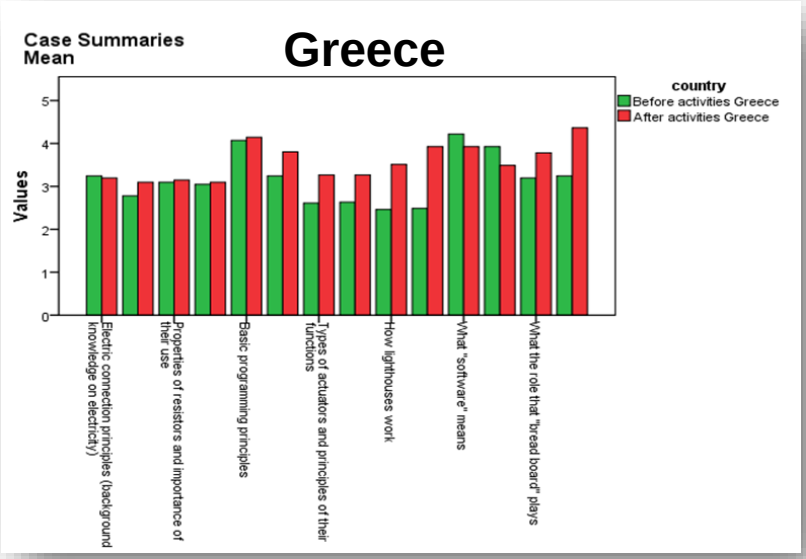
Knowledge

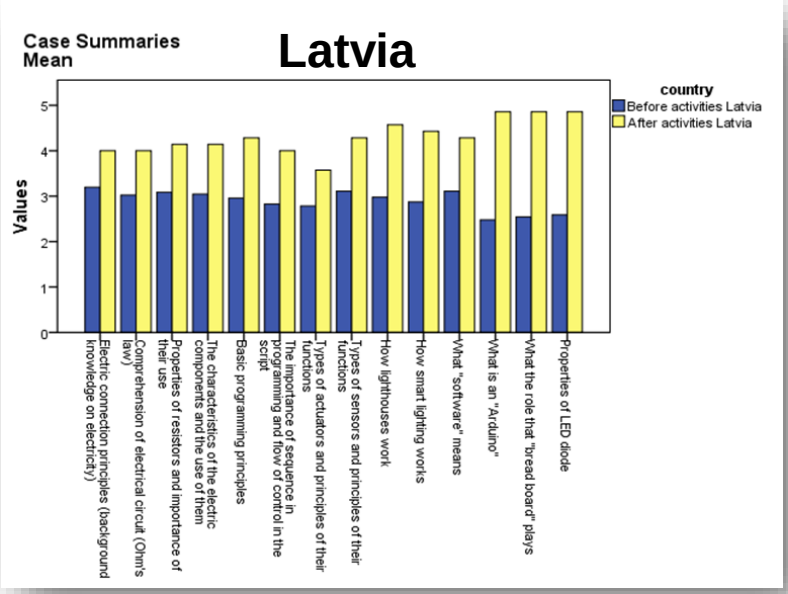
Poland

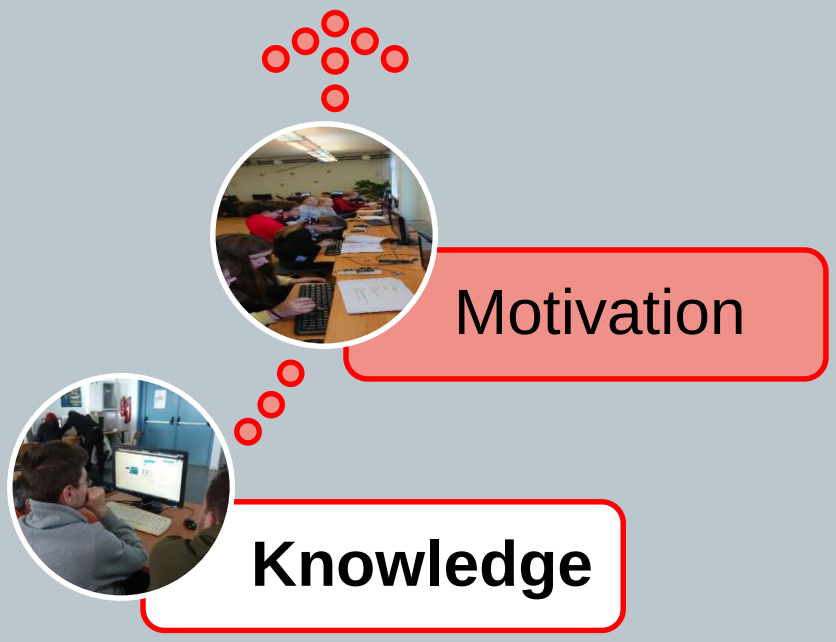


Greece



Latvia





Please evaluate the statements below on the factors which motivates you to learn NEW knowledge

	Strongly agree	***Agree***	***Neutral***	***Disagree***	***Strongly disagree***
I clearly understand the task					
I can achieve the learning aims					
My classmates' achievements and success in reaching learning aims					
Teacher believes in my success					
The feedback given by teacher on the progress of the task					
I start to understand concepts which were not clear to me previously					
The support from teachers during learning process					
The support from my peers during learning process					
The robot/program works					
I can feel fun during the learning					
I can create something by myself					

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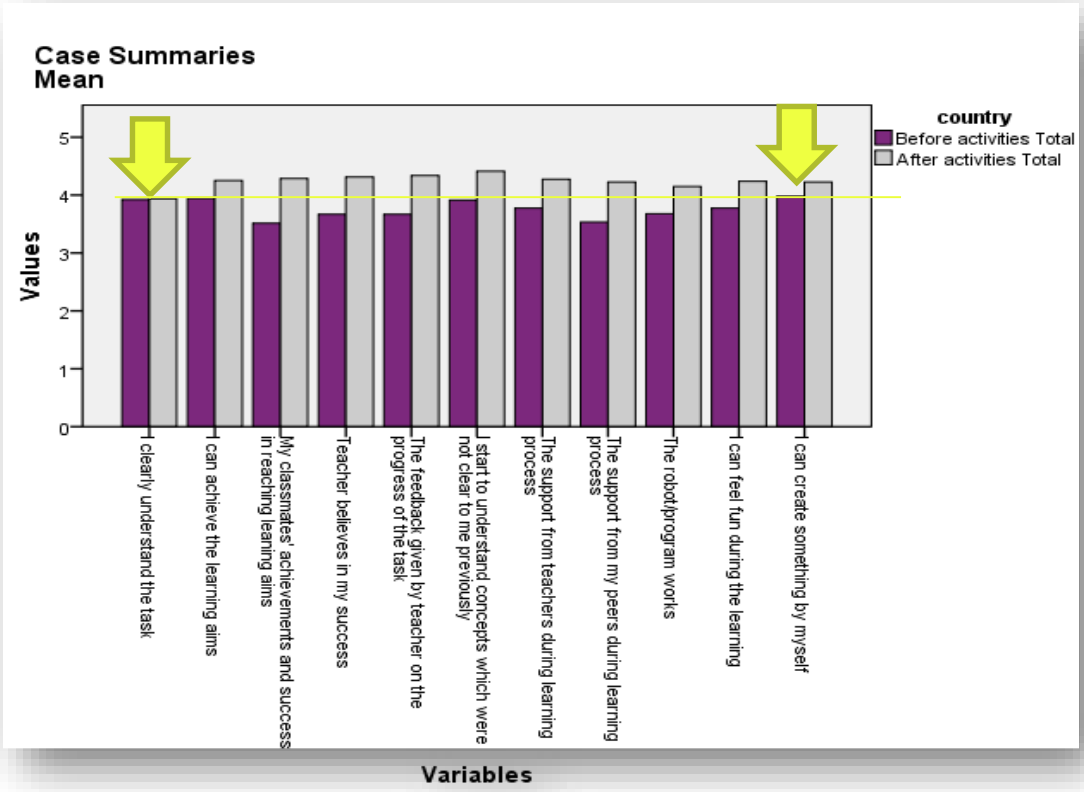
Motivation



Many different criteria were set to assess students' motivation to learn STEAM, robotics, creativity, and collaboration in general. Increasing motivation is one of the main goals of the RoboScientists project. Mostly, the criteria are designed to find out what exactly motivates the student - internal motivation, own success, or different kinds of external sources of motivation - recognition, praise, support, etc.

There are two important factors in the motivation of students, both before and after the implementation of the RoboScientists project. The constant importance factors are following ones - firstly, it is important for students to have clear requirements, rules and to know what needs to be done *(I clearly understand the task),* in some ways we can conclude that also knowledge is an important factor in motivation, as understanding "what needs to be done" to some extent, is also based on the student's knowledge and understanding of the subject in general. *S*econdly, the ability to create something on one's own is almost invariably important *(I can create something by myself).* Also, before the project activities, one of the three most valued motivational factors for students is the achievement of learning goals, of course.

However, when analyzing the results after RoboScientist's activities, the main factors of motivation appear to be:

- *I start to understand concepts which were not clear to me previously*
- *Teacher believes in my success*
- *The feedback given by teacher on the progress of the task*

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Motivation

Country results

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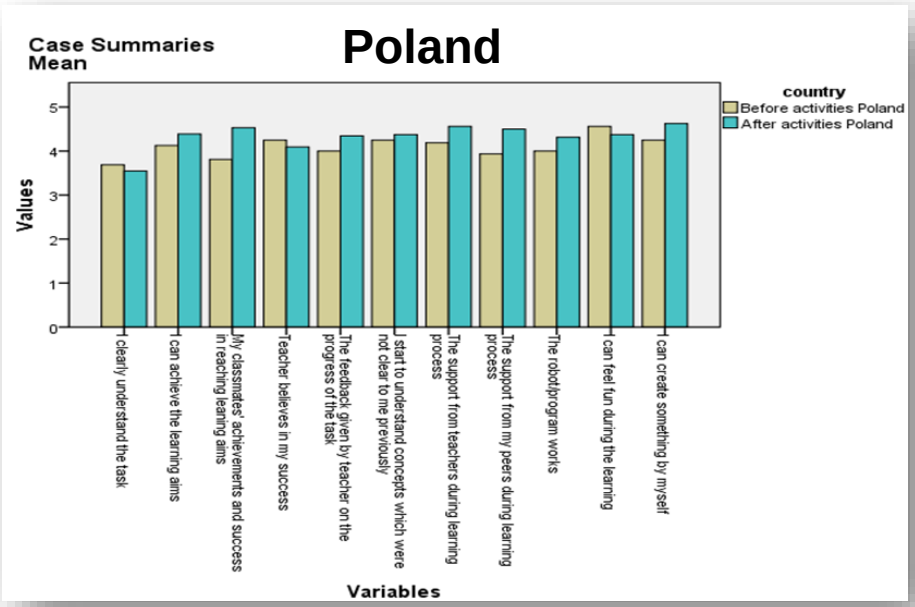
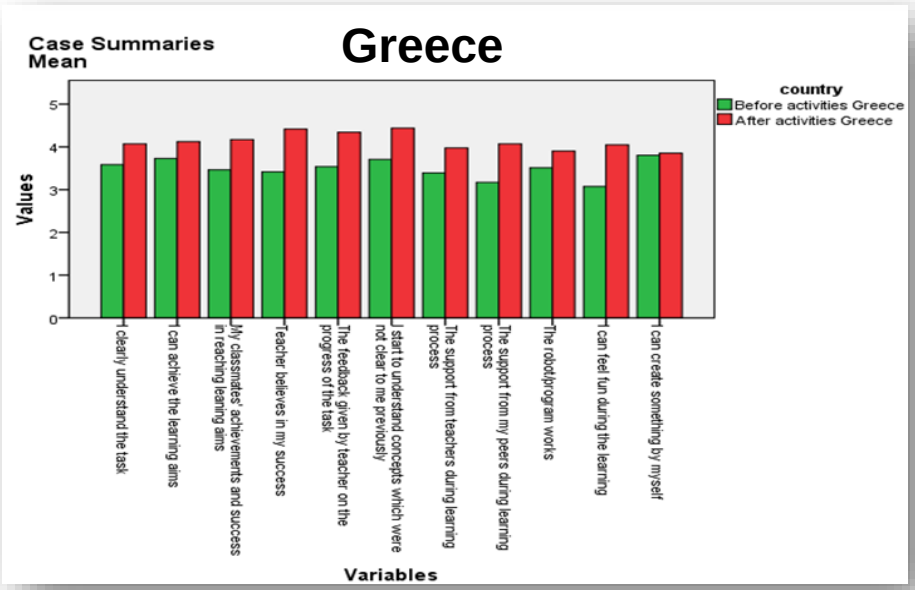
Poland



Greece



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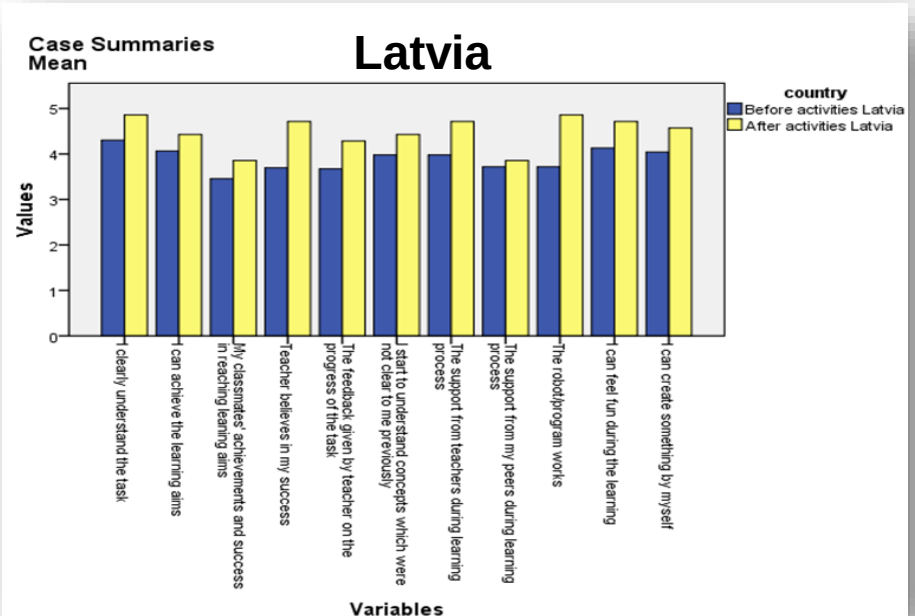

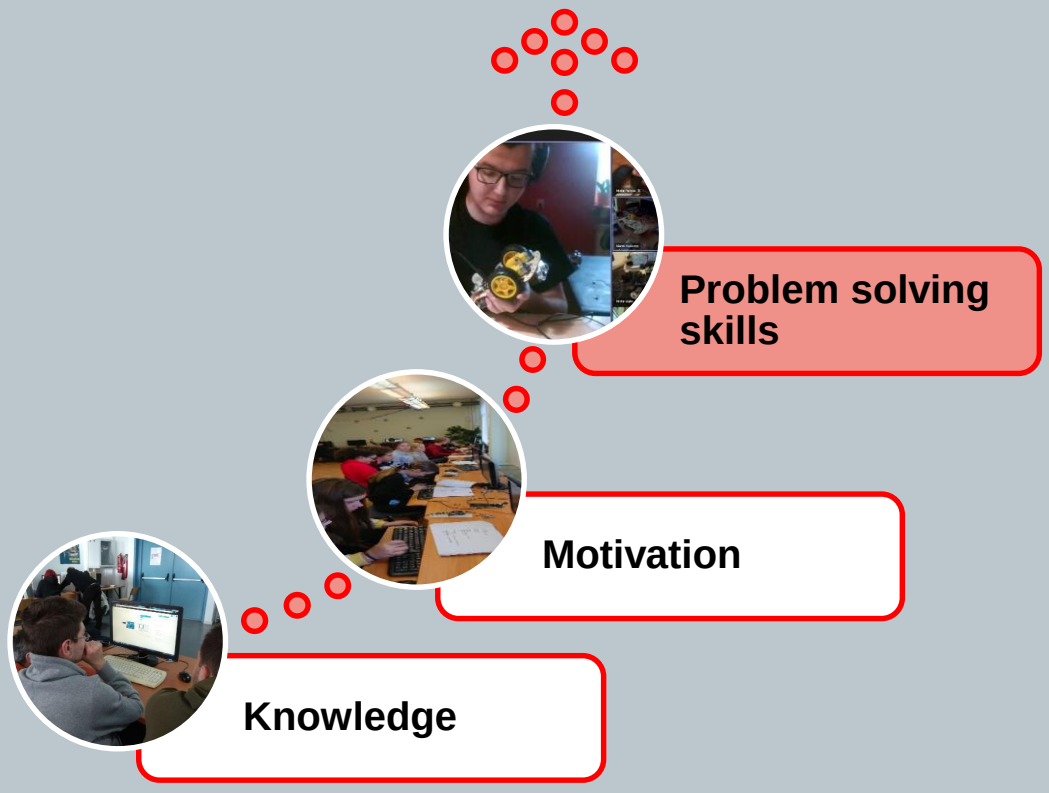

Please evaluate how you deal with a difficult situation in learning process

	Strongly agree	***Agree***	***Neutral***	***Disagree***	***Strongly disagree***
I solve learning problems by myself					
I think that teacher should help me solving problems					
I look for extra information needed for learning					
I look for information on the internet to resolve the situation					
I ask for support of my classmates					
I ask for support of the teacher					
I search for the information in the learning materials provided					

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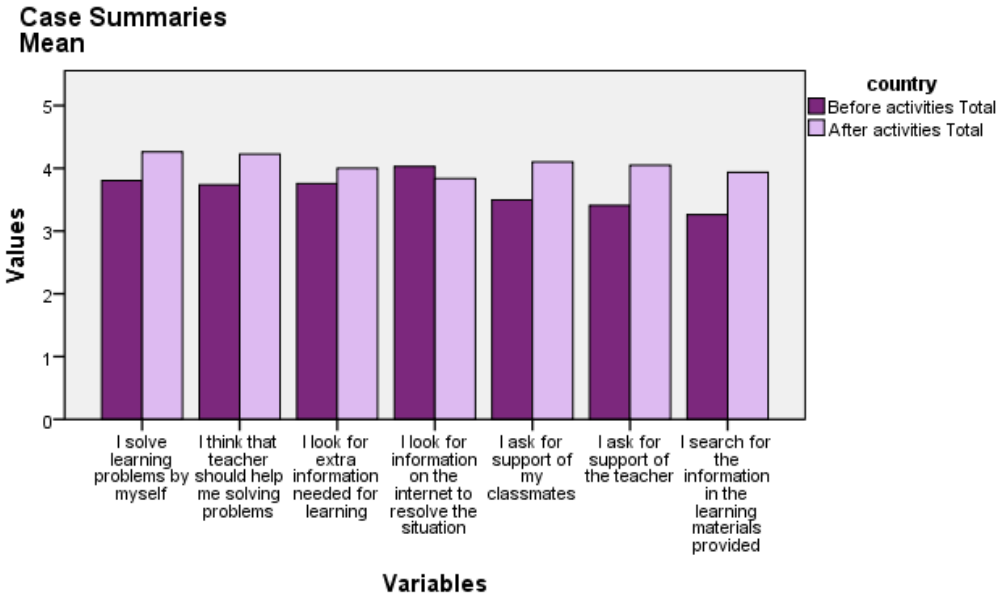
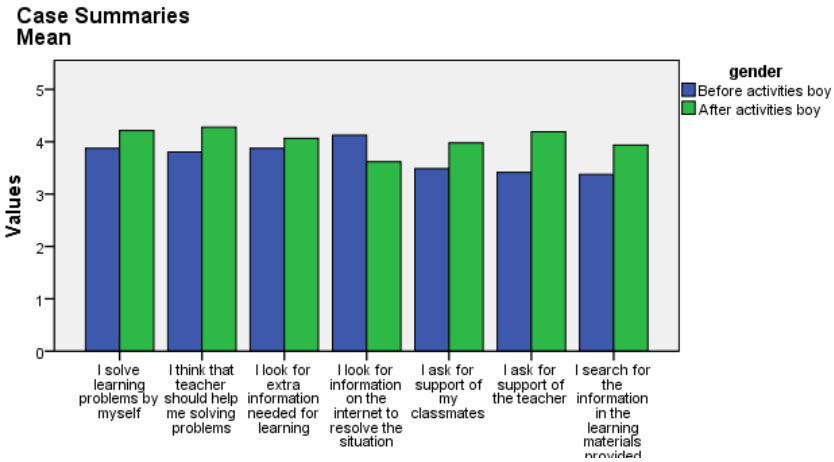
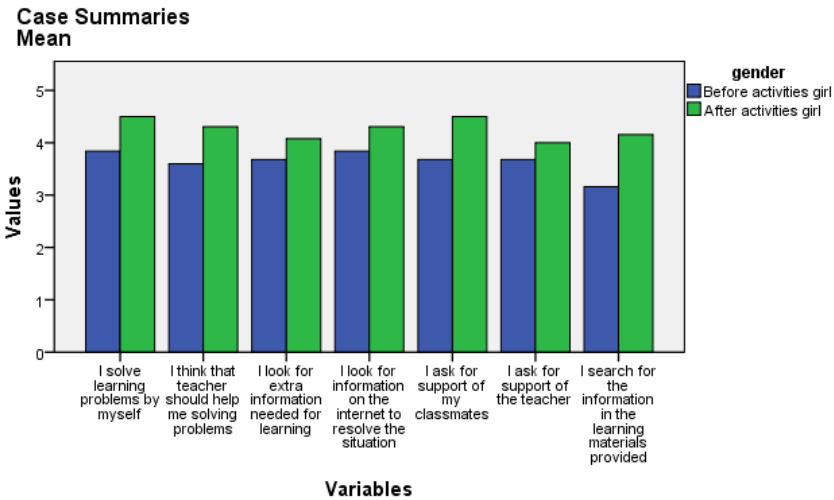
Problem solving skills



Analyzing indicators of problem solving, there are differences in answers given before and after the project activities, such as, before, they indicate *searching for information on the Internet* as the main way of problem solving, but two other most important indicators are:

- *I solve learning problems by myself*
- *I think that teacher should help me in solving problems*





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Please evaluate the statements how would you describe your favourite learning process

	Strongly agree	***Agree***	***Neutral***	***Disagree***	***Strongly disagree***
I like to cooperate with my classmates in preparing projects					
I like to work individually on preparing the projects					
I would like to do more work towards robot construction					
I like when there are different activities during the robotic projects (theory, work with electrical components, programming, artistic activities - crafting, etc.)					
I like when I can do something active in robotics session					
I like when I can make something creative					
I like when there are particular instructions on every learning step					
I like to search for the information by myself					
I like when teacher helps me to find the information					

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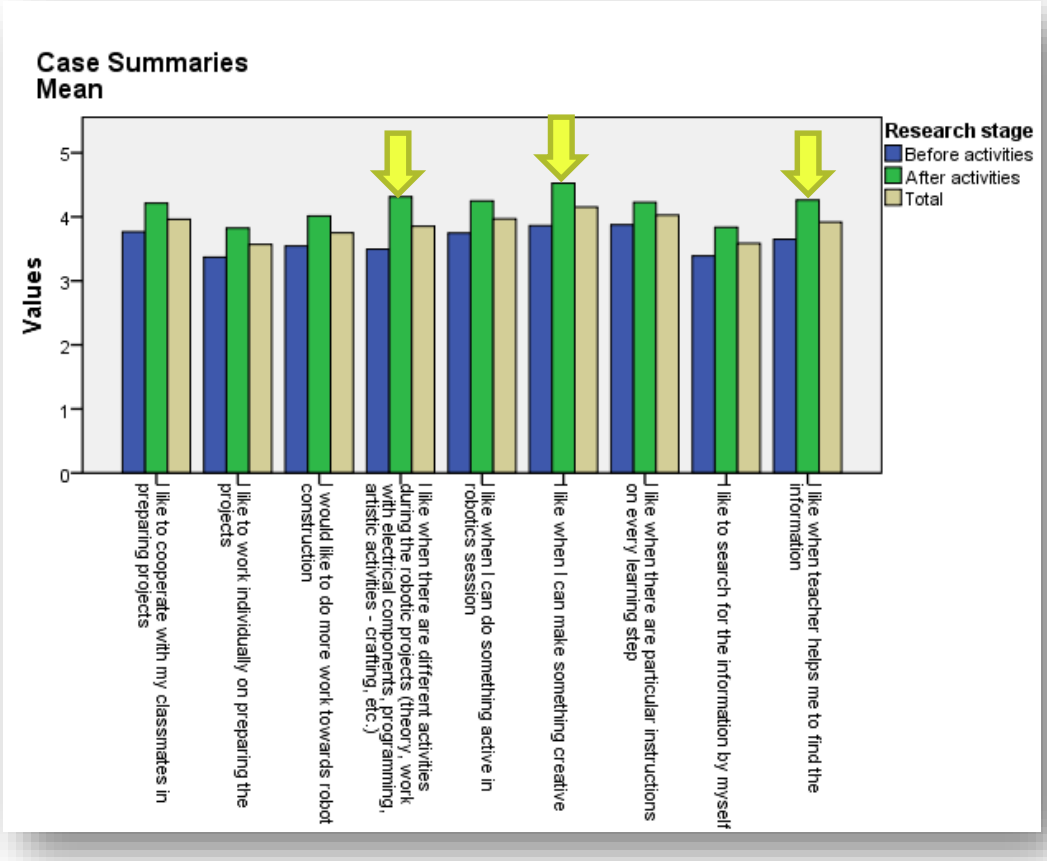
Collaboration and work on sessions

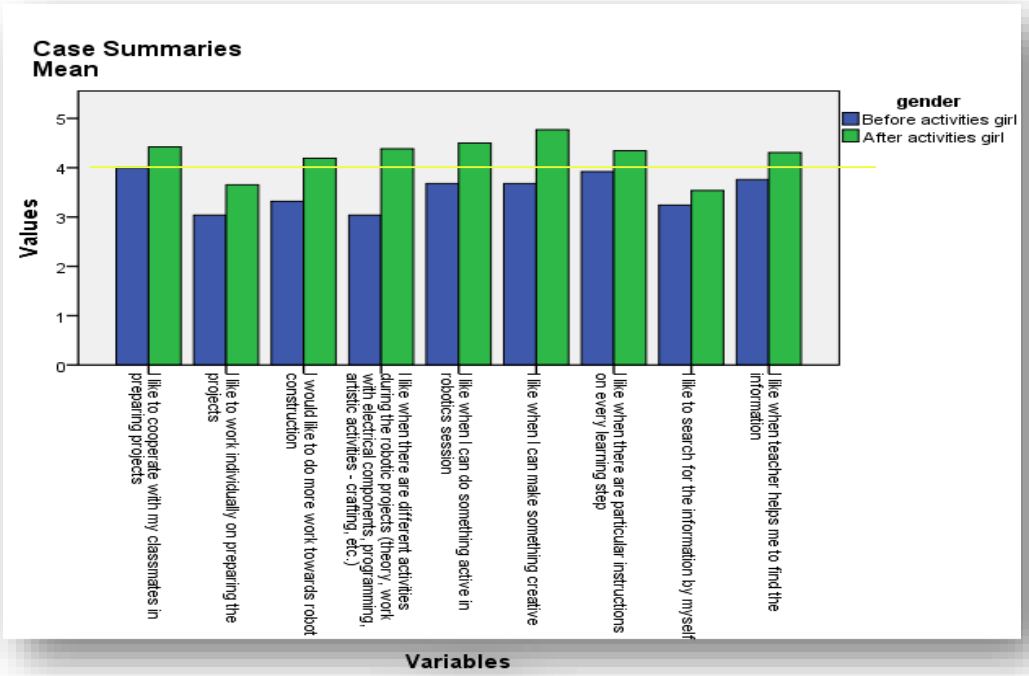


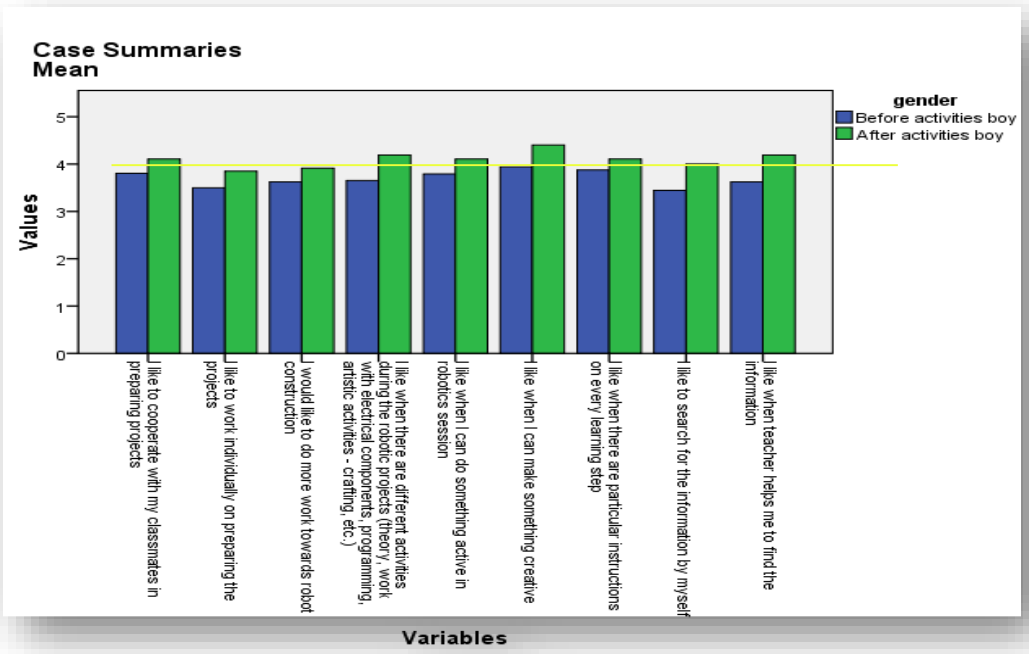
Analyzing the results of students' self-assessment in their cooperation and class work, we can conclude that the opinion of most students has changed in three cooperation criteria, comparing data for the indicators of before and after activities about their favourite learning process:

- *I like when I can make something creative*
- *I like when teacher helps me to find the information*
- *I like when there are different activities during the robotic projects (theory, work with electrical components, programming, artistic activities - crafting, etc.)*

Thus, it can be concluded that the students' experience in the RoboScientists project has changed their attitude towards work in the classroom, which confirms that the teacher's help and presence in robotics classes is very important. They also acknowledge that they now value the ability to work in practice, incorporating and changing a variety of activities during a lesson, rather than just learning theory. Consequently, creative expressions are also more important than before.

Collaboration and work on sessions





Examining the assessment of boys and girls about their favorite learning process, it can be concluded that the opinion of boys has changed much more significantly than that of girls. It is possible that the activities of the RoboScientists project showed them other options and learning methods that have significantly changed students' attitude towards this issue.

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Collaboration and work on sessions

Country results

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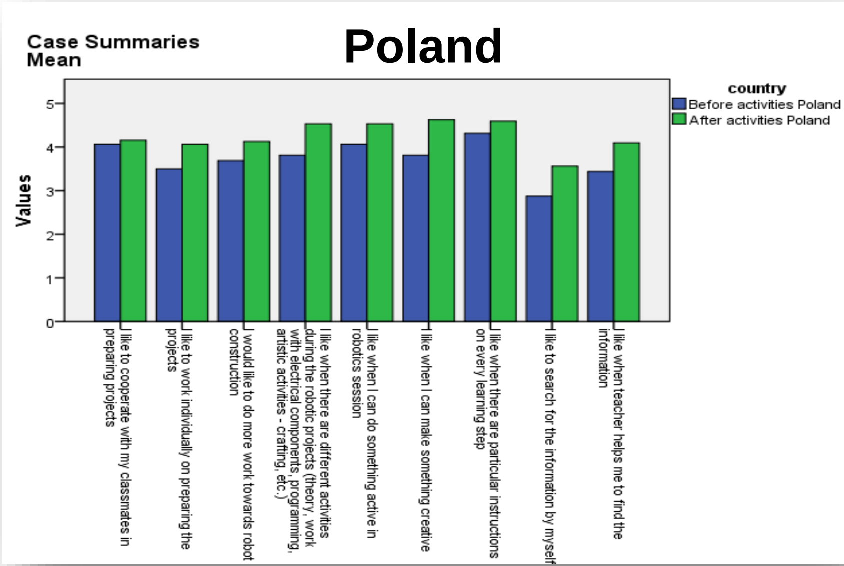

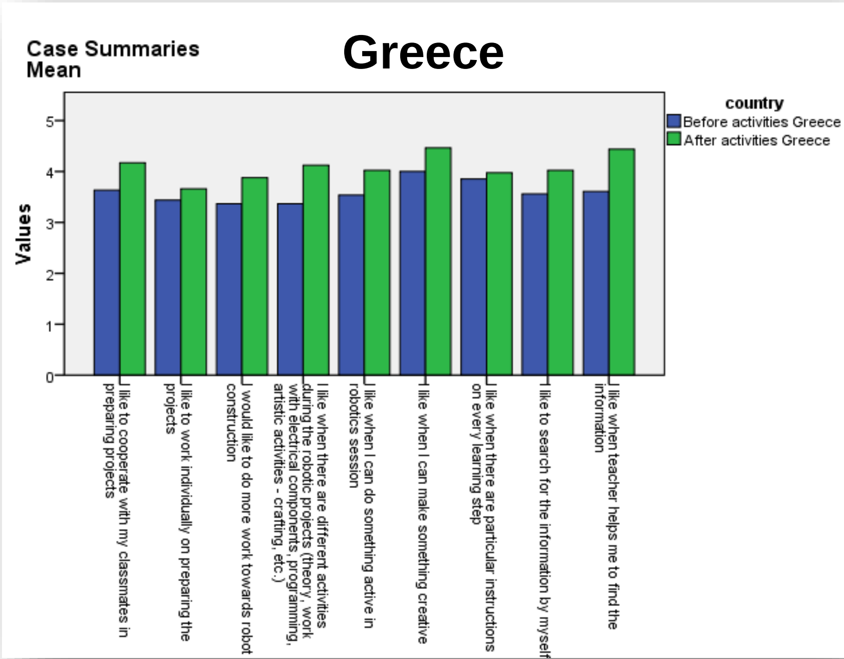

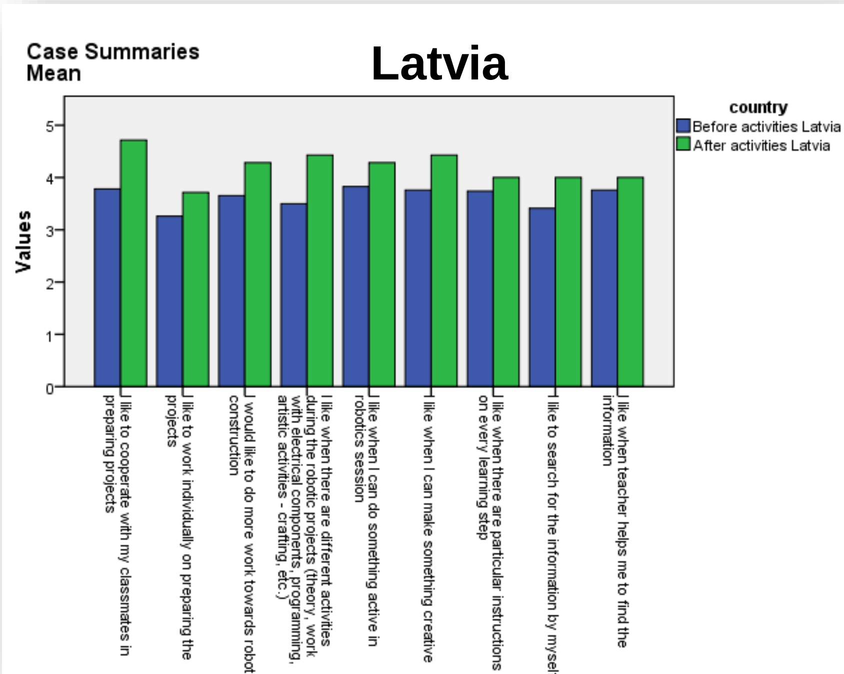

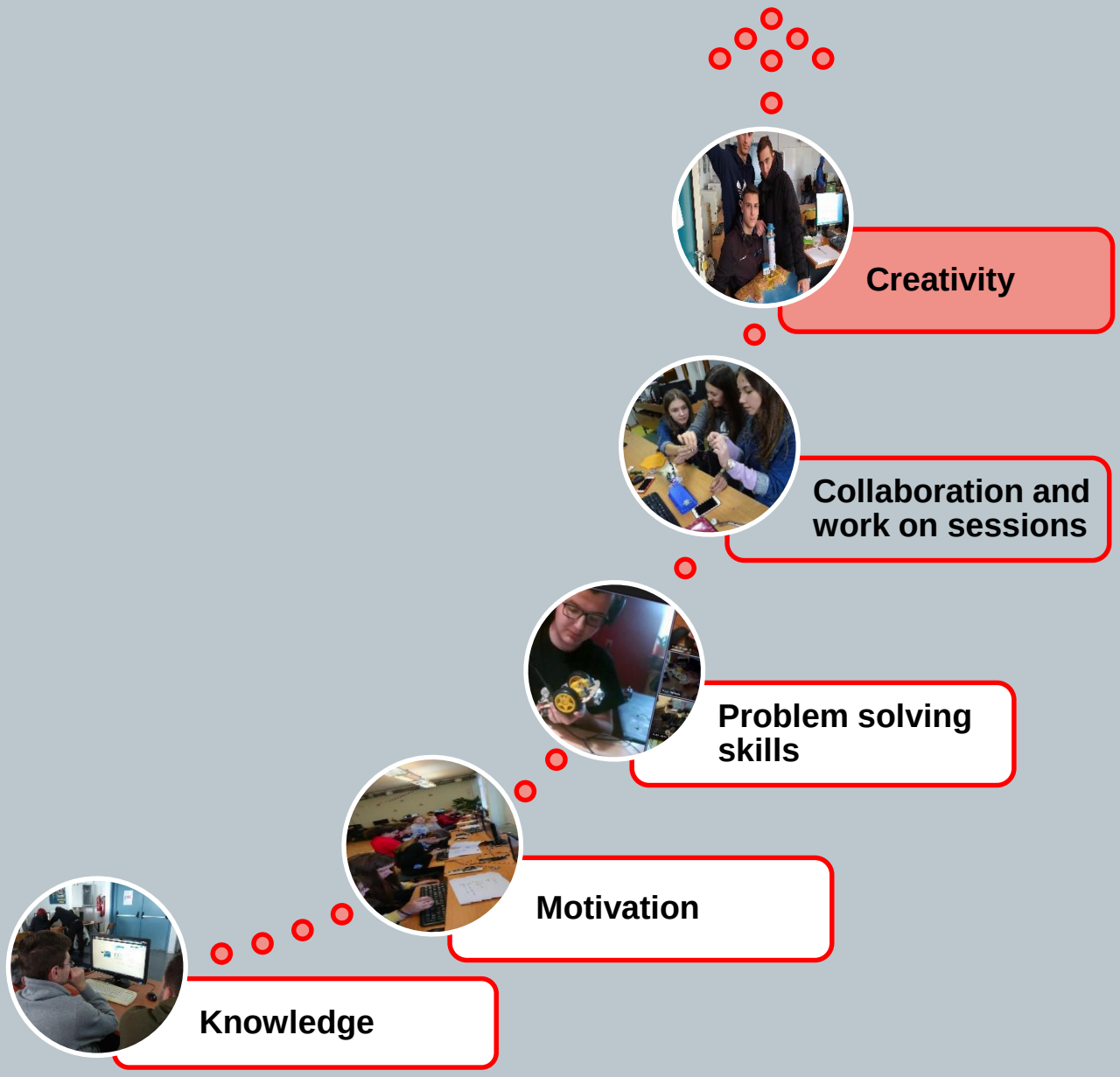

Please evaluate statements how would you describe your creativity?

	Strongly agree	*Agree*	*Neutral*	*Disagree*	*Strongly disagree*
I can come up with some creative solutions in developing robotics					
I like when my peers make creative solutions for robotics but I do not like to do it by myself					
I think that I can come up with some creative solutions in finding the ways how to decorate developed robots					

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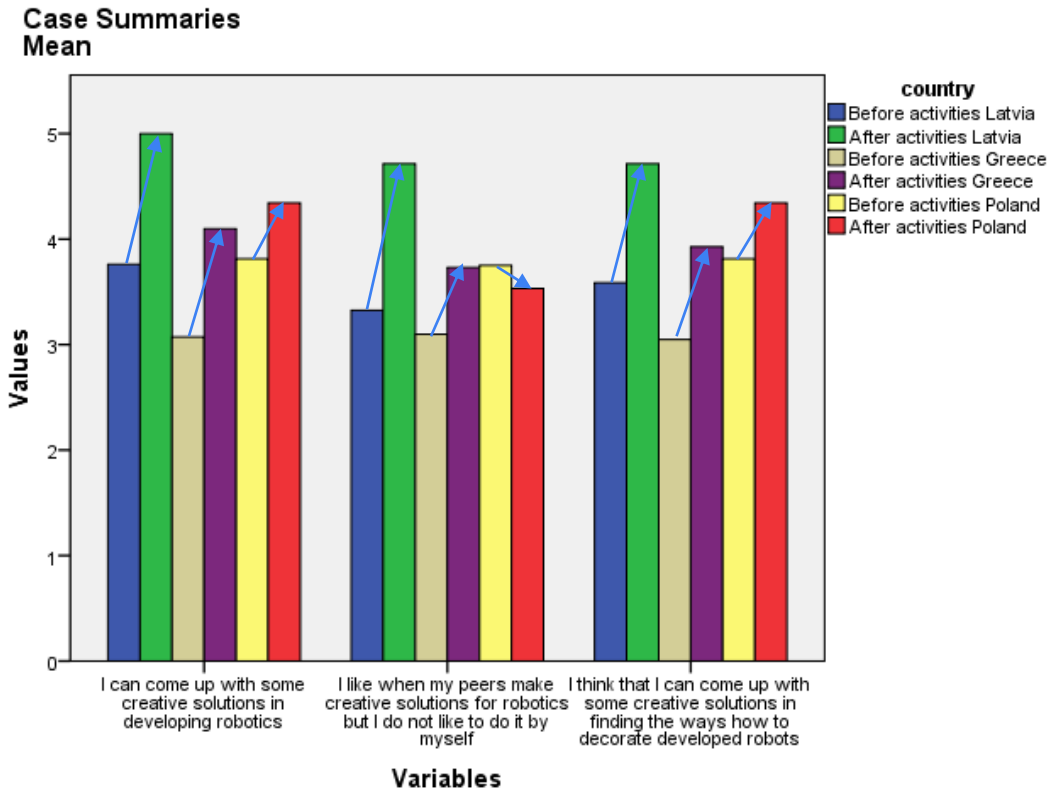
Creativity



Evaluating the results in relation to the assessment of students' creativity, it can be stated with complete conviction that after the activities of the RoboScientists project, all students value their creative abilities higher than it was before.

Country results

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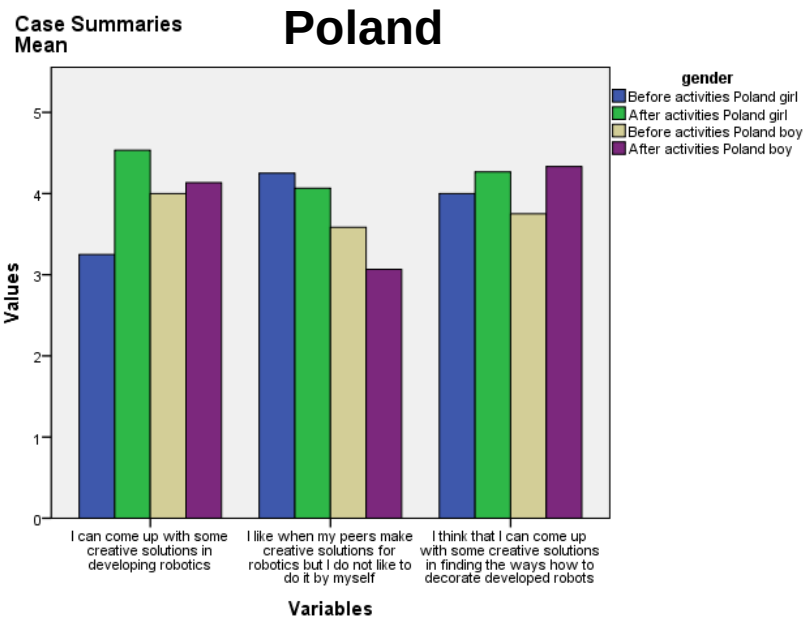
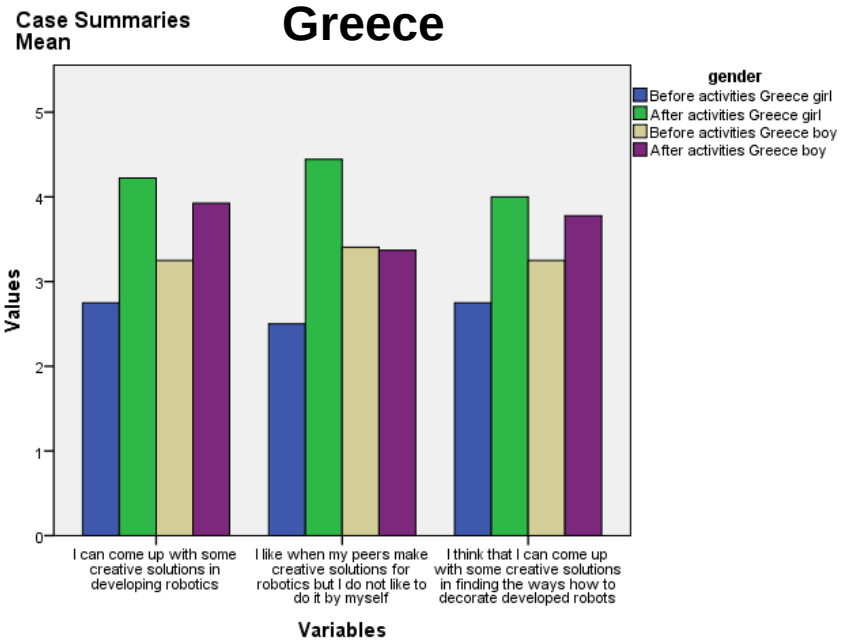
Creativity

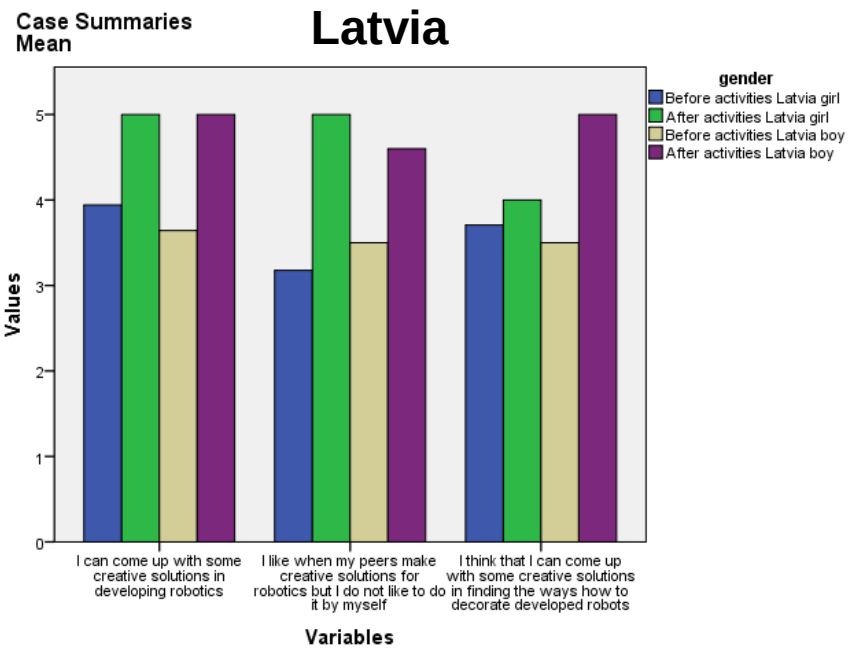
Poland



Greece



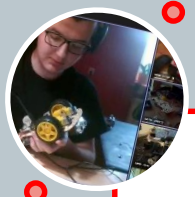
Latvia



STEAM

Creativity

Collaboration and work on sessions



Problem solving skills

Motivation

Knowledge

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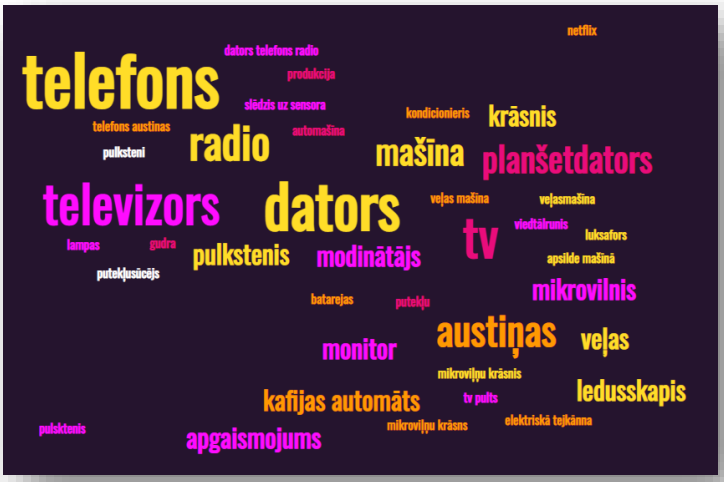
Answers to open-ended question

students were asked to list at least **five products they use every day which are programmed**, the most popular answers were:

1. **komputer** 21 times
2. **Telefon** 16 times
3. **Telewizor** 15 times
4. **Smartfon** 14 times
5. **Tablet** 10 times

1. **Telefons** 16 times
2. **Dators** 11 times
3. **Televizors** 7 times
4. **TV** 7 times
5. **Radio** 5 times



1. **Κινητο** 15 times
2. **Υπολογιστης** 10 times
3. **Τηλεοραση** 10 times
4. **Κινητό** 9 times
5. **Τηλεόραση** 7 times

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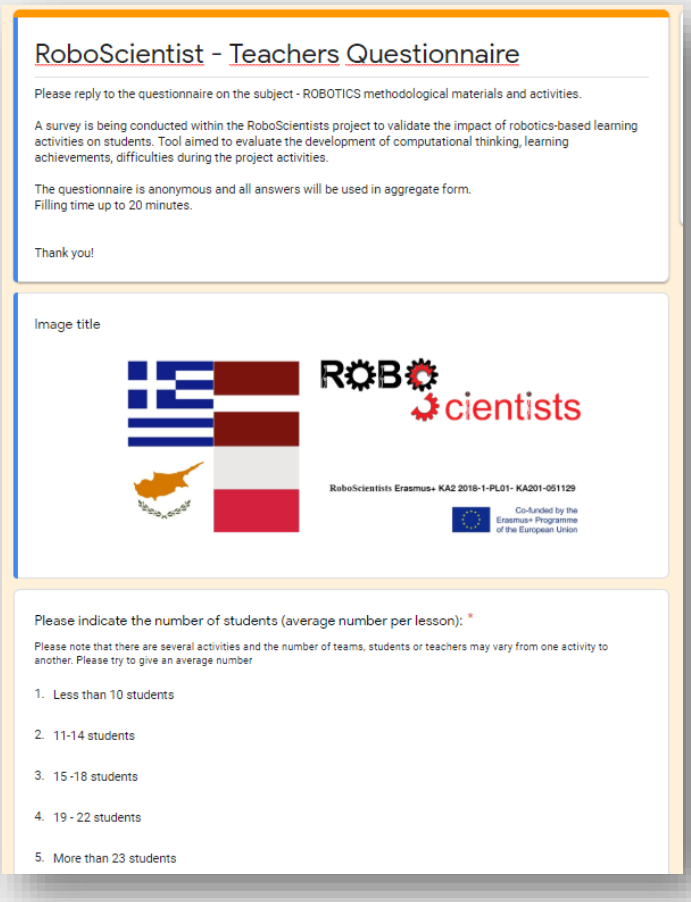
Teacher Questionnaires

The teachers involved in the RoboScientists learning activity provided feedback through questionnaire:

The impact to their teaching/professional development

How the whole intervention was perceived by them

Focus on their students' learning, motivation towards STEM, difficulties and challenges



RoboScientist - Teachers Questionnaire

Please reply to the questionnaire on the subject - ROBOTICS methodological materials and activities.

A survey is being conducted within the RoboScientists project to validate the impact of robotics-based learning activities on students. Tool aimed to evaluate the development of computational thinking, learning achievements, difficulties during the project activities.

The questionnaire is anonymous and all answers will be used in aggregate form.
Filling time up to 20 minutes.

Thank you!

Image title

RoboScientists Erasmus+ KA2 2018-1-PL01- KA201-051129

Co-funded by the Erasmus+ Programme of the European Union

Please indicate the number of students (average number per lesson): *

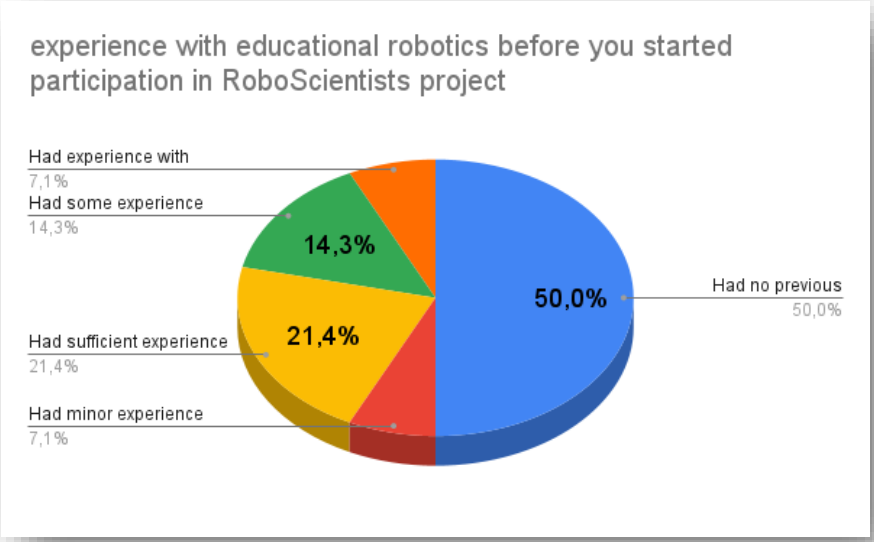
Please note that there are several activities and the number of teams, students or teachers may vary from one activity to another. Please try to give an average number

1. Less than 10 students
2. 11-14 students
3. 15 -18 students
4. 19 - 22 students
5. More than 23 students

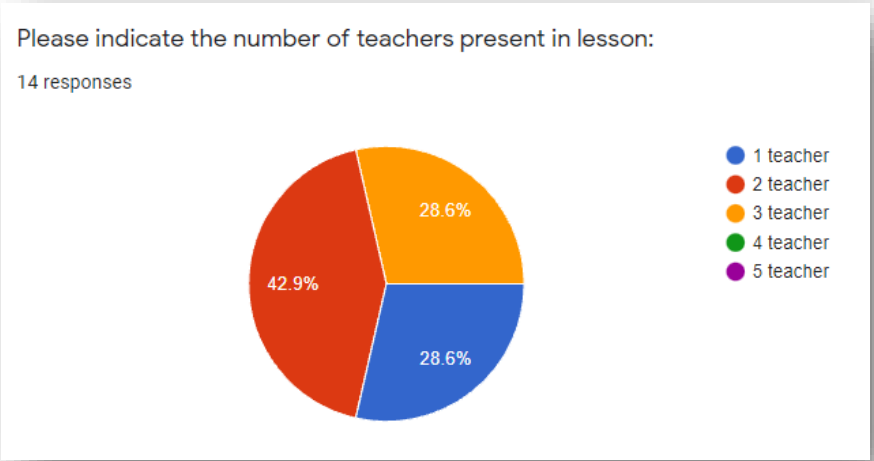
Teacher Questionnaires

First of all, when analyzing statistical information about teachers, the following conclusions can be drawn:

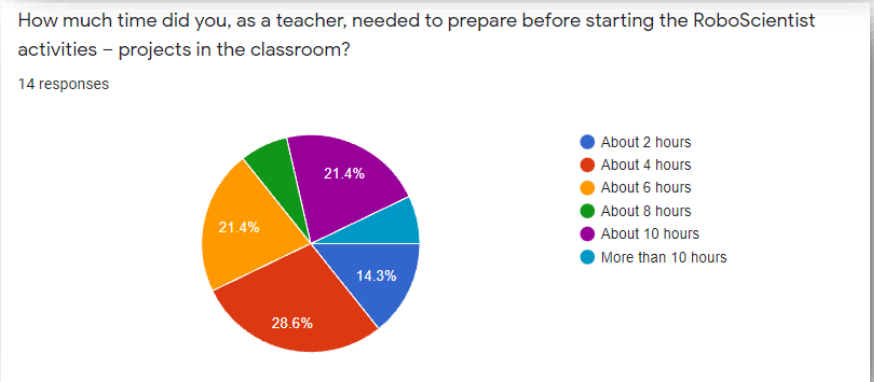
Half of the teachers (50%) did not have previous experience in teaching educational robotics and 7 % had minor experience before participating in the RoboScientists project.



When organizing the work in the robotics lessons during the implementation of the project activities, most of the class work was led and participated by 2 teachers (42%). As well as 1 teacher in 28% of casses and 3 teachers were involved in 28 % casses.



Looking at the data on how much time teachers needed to prepare for the work before the lessons, we can conclude that most of the teachers devoted 4 hours (28%) for it. But a significant percentage of teachers also devoted 6 hours (21%) and even 10 hours (21%) for this work.



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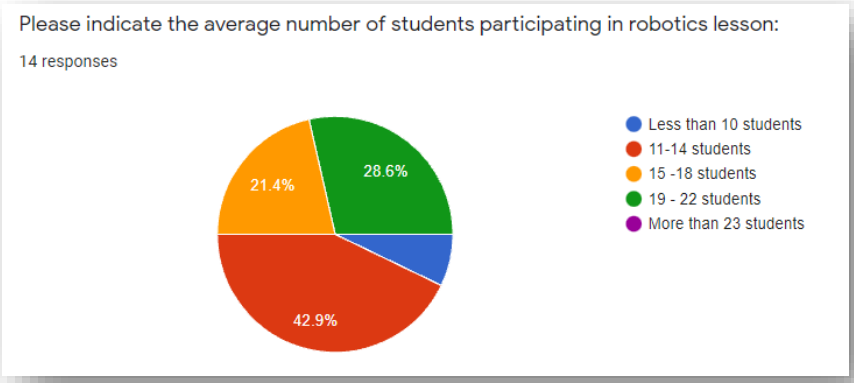
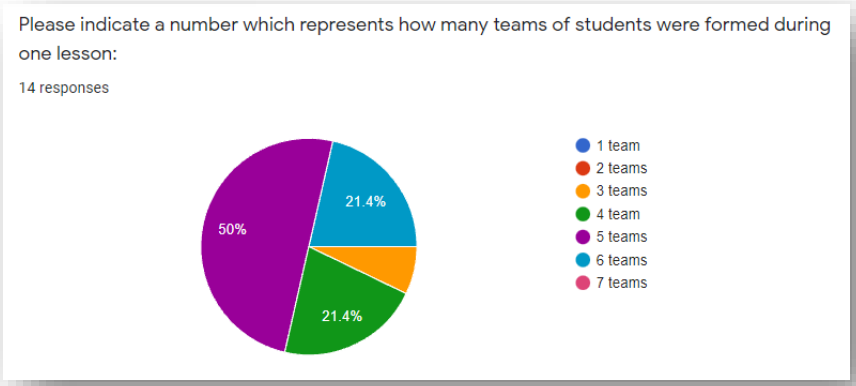
Continuing to analyze the data on the organization of students' work from the perspective of teachers, the following conclusions follow:

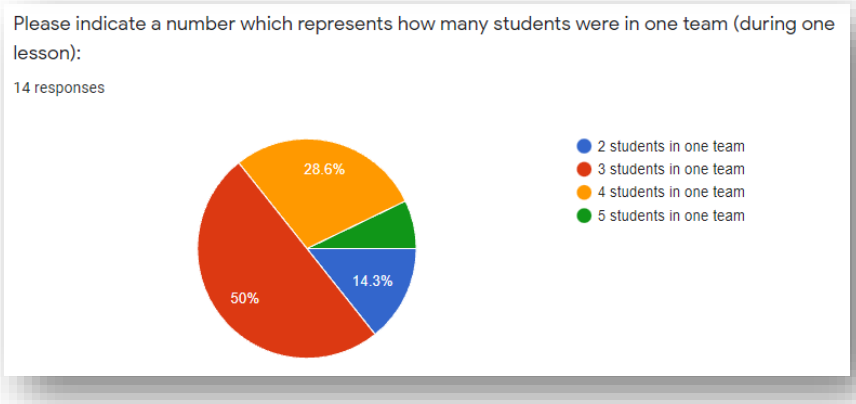


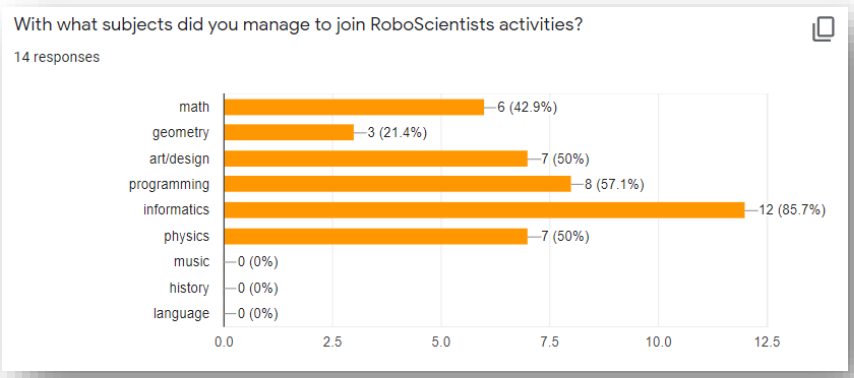
The work was planned and organized in groups where the number of students was mostly 11-14 (42%), but there is also a considerable number of casses when class work is organized with larger groups of 19-22 (28%) students.

By analyzing this chart we can conclude that the teachers have taken into account the recommendations from project partners (curriculum developers) and have not organized the work in large student groups / teams. When dividing the students into teams at least 5 teams per class in 50% of cases, as well as into 4 (21%) and 6 (21%) teams.



As evidenced by the following diagram, in which teachers indicate that students worked in groups of 3 (50%) and 4 (28%) participants. Moslty because of creating smaller ones (3-4 students in one team), students have the opportunity to get involved and work in practice.





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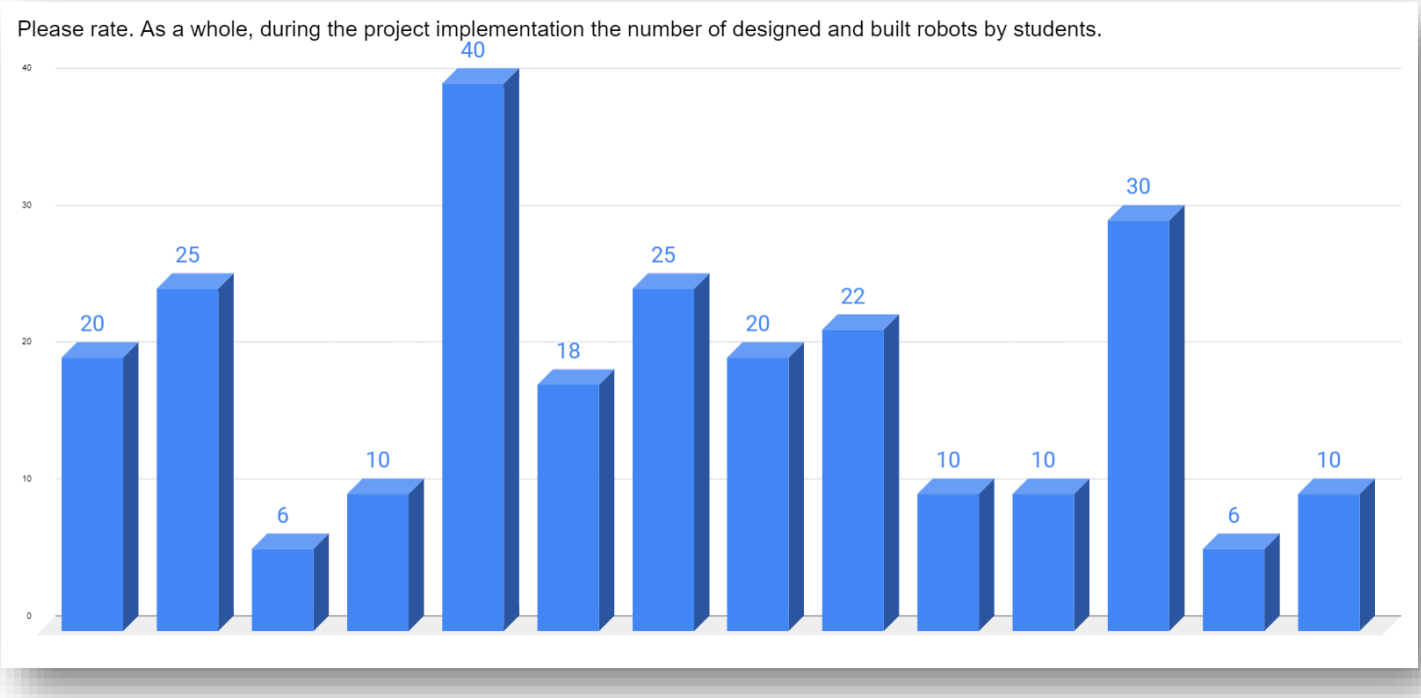
Quantitative indicators

Quantitative indicator #1

Number of designed and built robots by students

During the RoboScientists project, 252 robot designs and models have been created in various activities in all four partner countries. Taking into account all the previously mentioned restrictions and learning process conditions caused because of the global pandemic - remote learning, so the number of implemented artifacts is sufficient.



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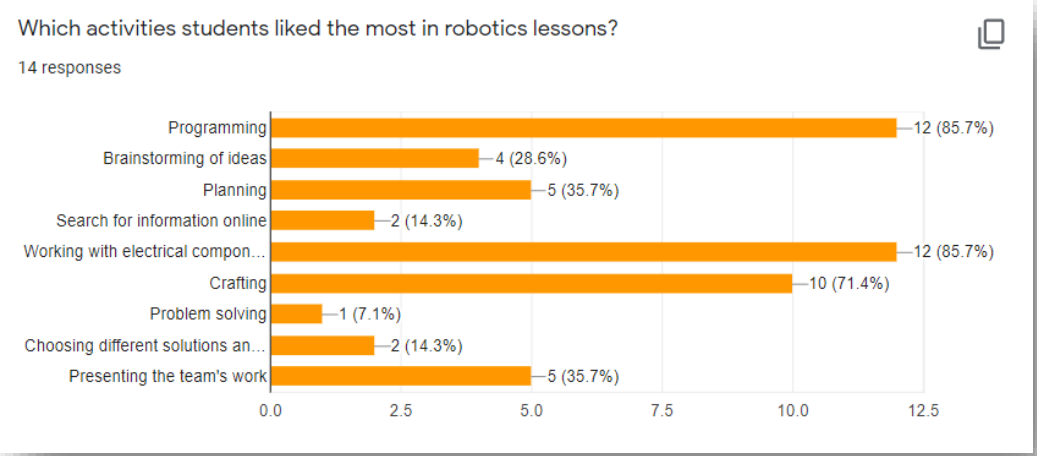
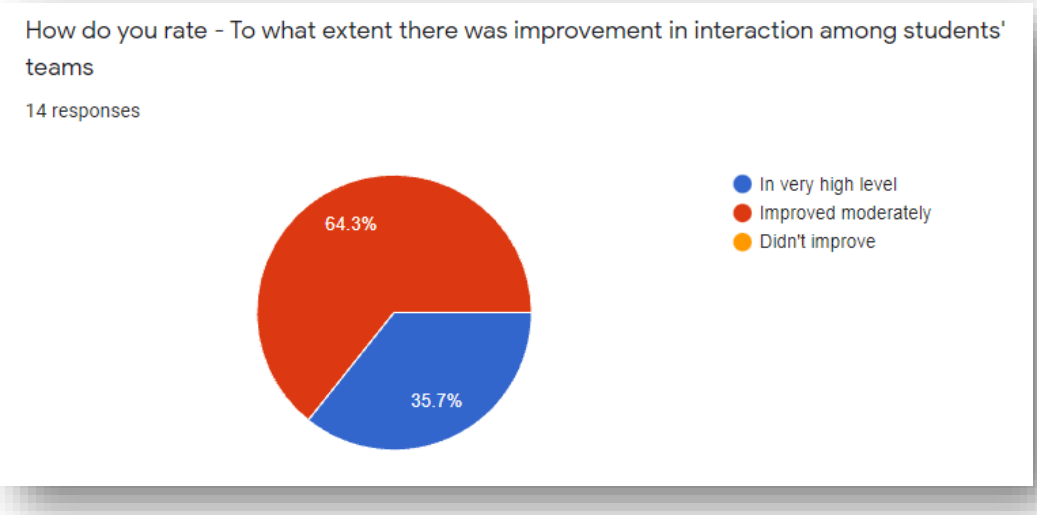
Quantitative indicator #2

Percentage of participant students that expressed more positive attitudes towards STEM related disciplines



When teachers evaluate the activities that students liked most during the RoboScientists project, the activities related to programming, working with electronic components and crafting clearly stand as most important. Activities such as problem solving and search for information have received the lowest ratings, but important factor that the highest rated activities such as programming also does require problem solving skills - they are simply acquired without noticing the exciting process.

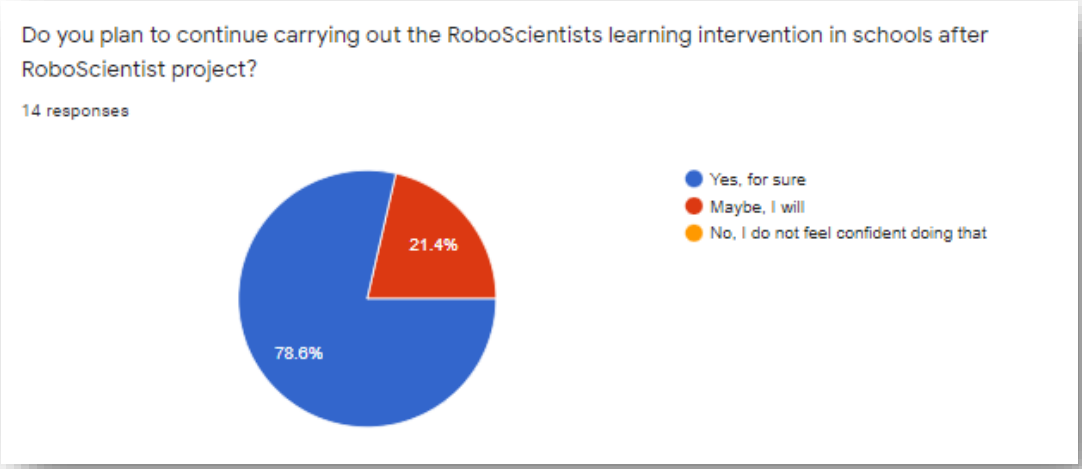


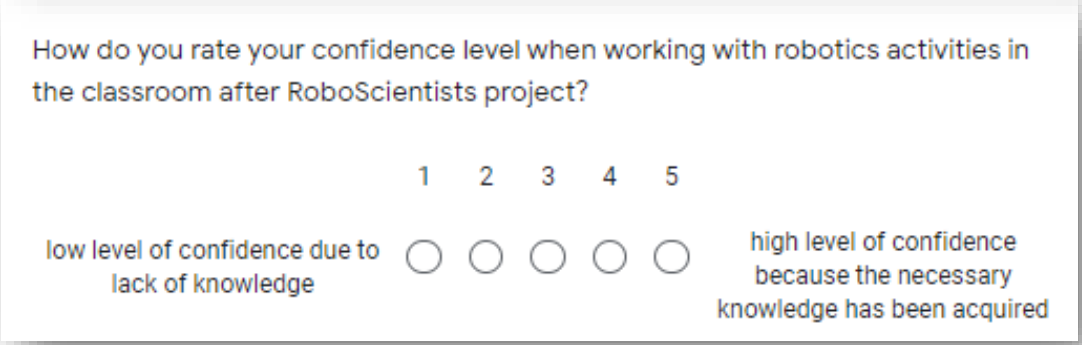
There are strong indicators of improvement in interaction among students' teams. Most teachers point out that it improved moderately 64%, and 35% showed improved result in a very high level. It is important to note that absolutely no teacher indicated that there would be any improvement.

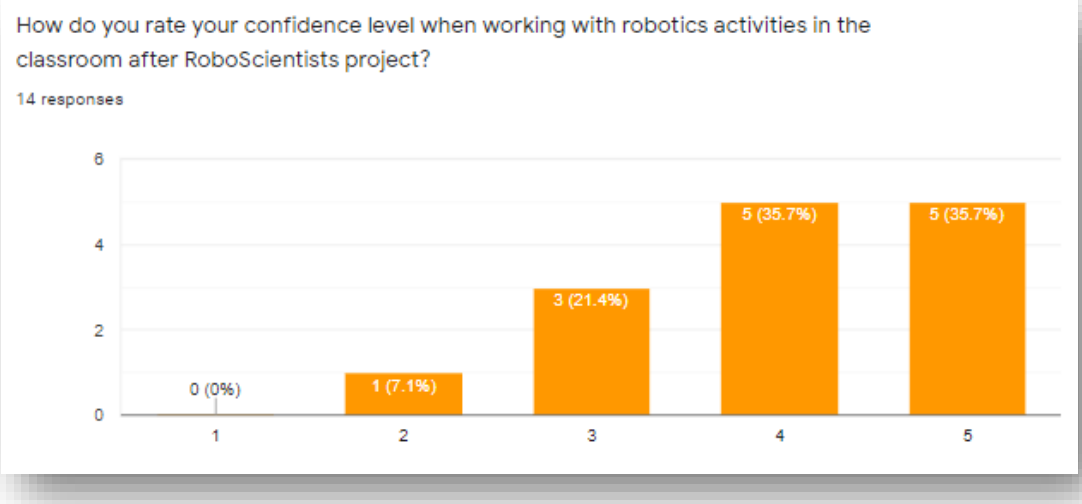
Quantitative indicator #3

Percentage of teachers in a position to continue carrying out the RoboScientists learning intervention in schools (Confidence level)

Most respondents' teachers' 78,6% plan to continue carrying out the RoboScientists learning intervention in schools after the RoboScientists project, which is also in line with the teachers' confidence level assessment responses – not all teachers evaluate their confidence levels as high, but most of them do.



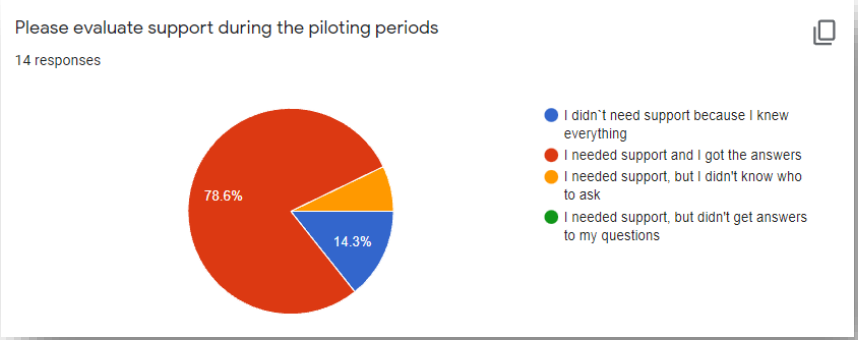




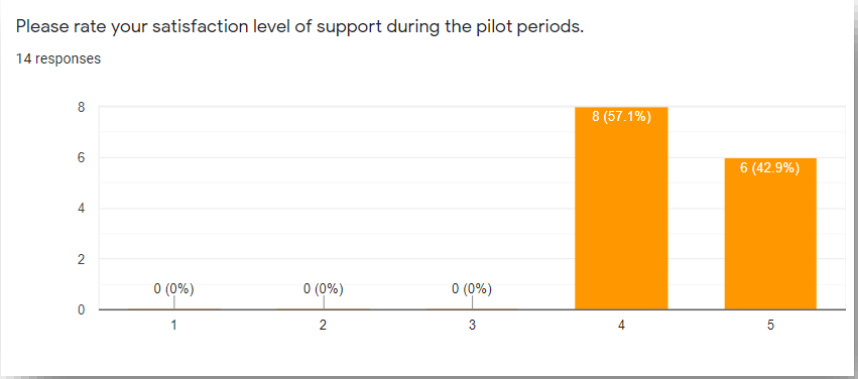
Quantitative indicator #4

Teacher's satisfaction level from the training offered (C1, C2, C3 and C4) and support during the pilot periods

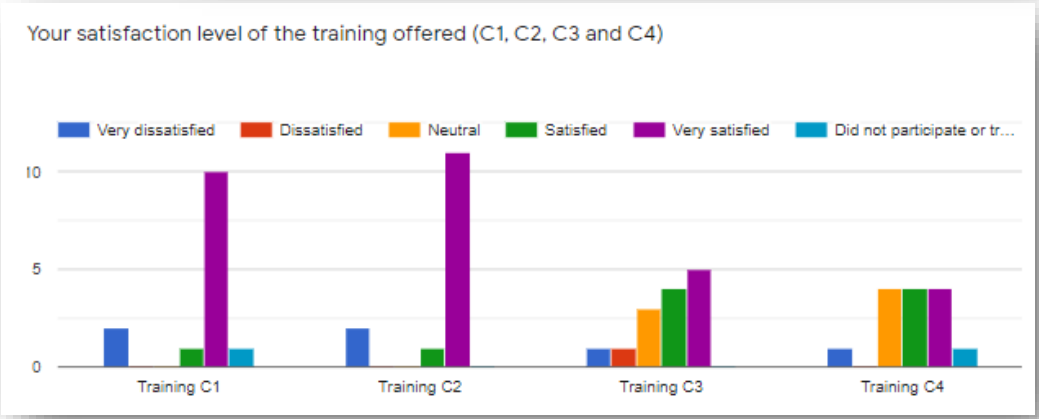
Data on teacher satisfaction during pilots received support show that most teachers (78%) had questions and needed help, but they received the support and answers needed. Also, some teachers (14%) point out that they did not need support at all, because they knew everything by themselves.



The fact that the necessary help has been received is also confirmed by the following diagram, where teachers positively evaluate the support received during the pilot.



Assessing the teachers' satisfaction level with the training activities organized during the project, the data shows that teachers were mostly satisfied with the face-to-face training process in Poland and Greece (before COVID-19). But online training satisfaction level can be considered as partially satisfactory.



What do you consider to be the main strength of training meetings?

- Difference activities, levels, video
- Presentations and construction
- Knowledge gained
- Practical exercise
- The trainers were very well prepared, the training materials helped to understand the problems
- Face to face
- A lot of time was devoted to practical robotics classes
- Video
- Practical lessons
- Joint meetings and exchange of experience

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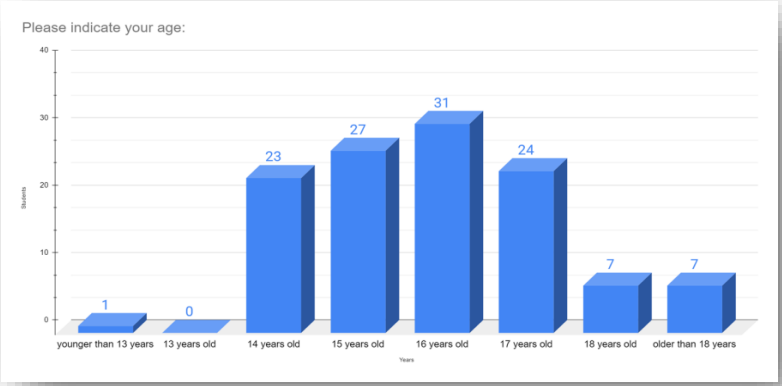
Quantitative indicator #5

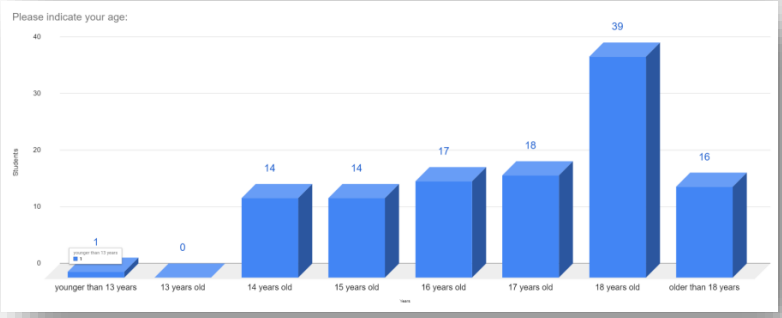
Participation of students in the pilot stages | Target >= 40 in each country

Number of students starting project activities 120. Number of students completing project activities 119.

This chart shows the age of the students involved at the beginning of RoboScientists project activities and also indicates the student amount - A total of 120 students.



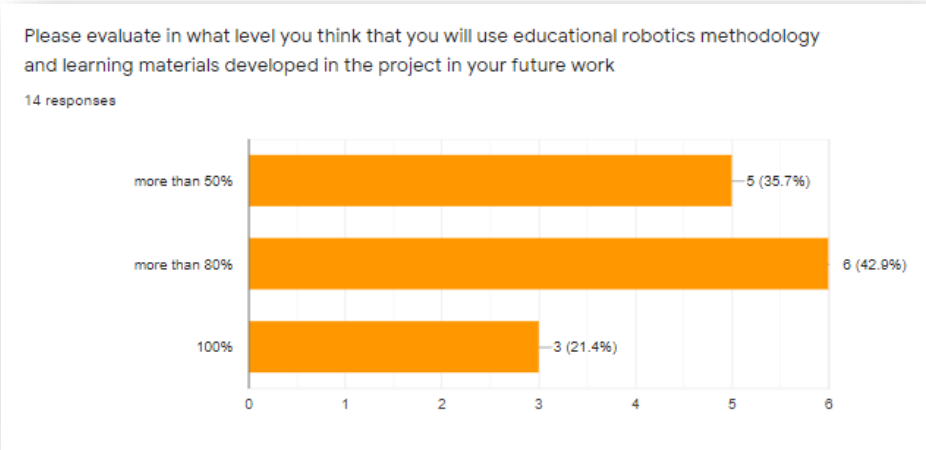
This chart shows the age of the students involved at the end of RoboScientists project activities and also indicates the student amount - A total of 119 students.



Quantitative indicator #6

Final acceptance rate of the RoboScientists methodology and pedagogical framework by the teachers | Target> 80%

Final acceptance rate of the RoboScientists methodology and pedagogical framework by the teachers. The results of the questionnaire show that more than 80% are marked by 6 respondents and 100% acceptance rate are given by 3 respondents. Given that only 14 teachers were interviewed (all who participated in the project activities), these results can be considered very good, as more than half of the teachers indicate the highest indicators.



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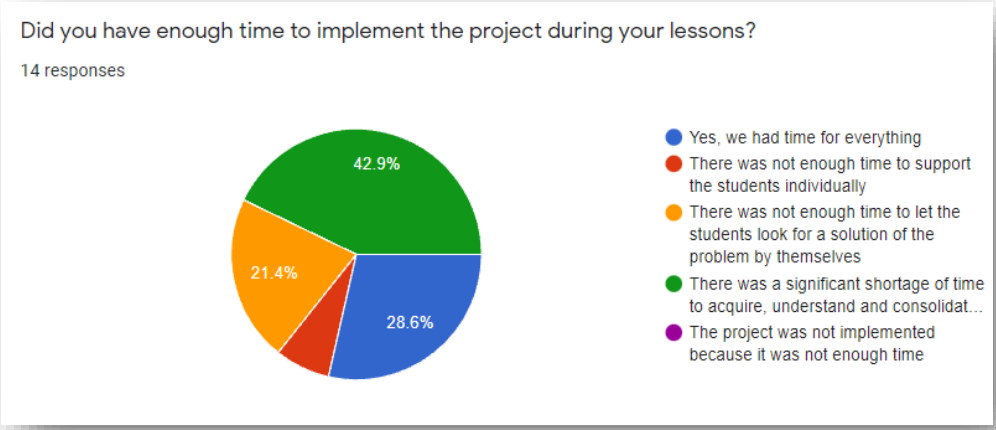
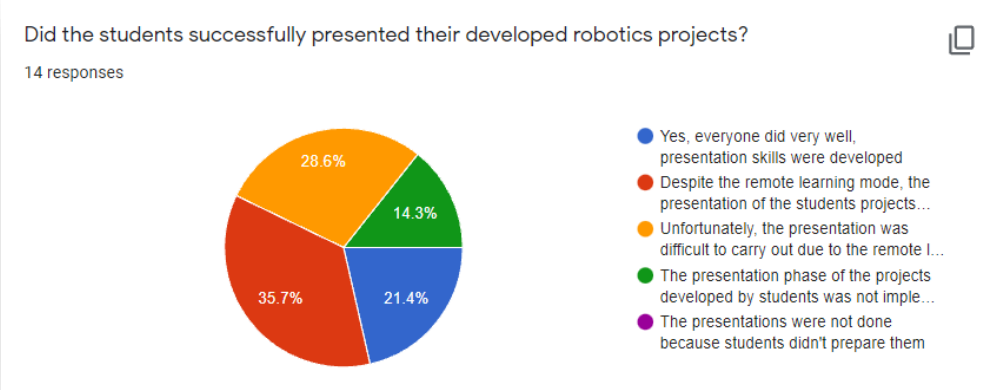
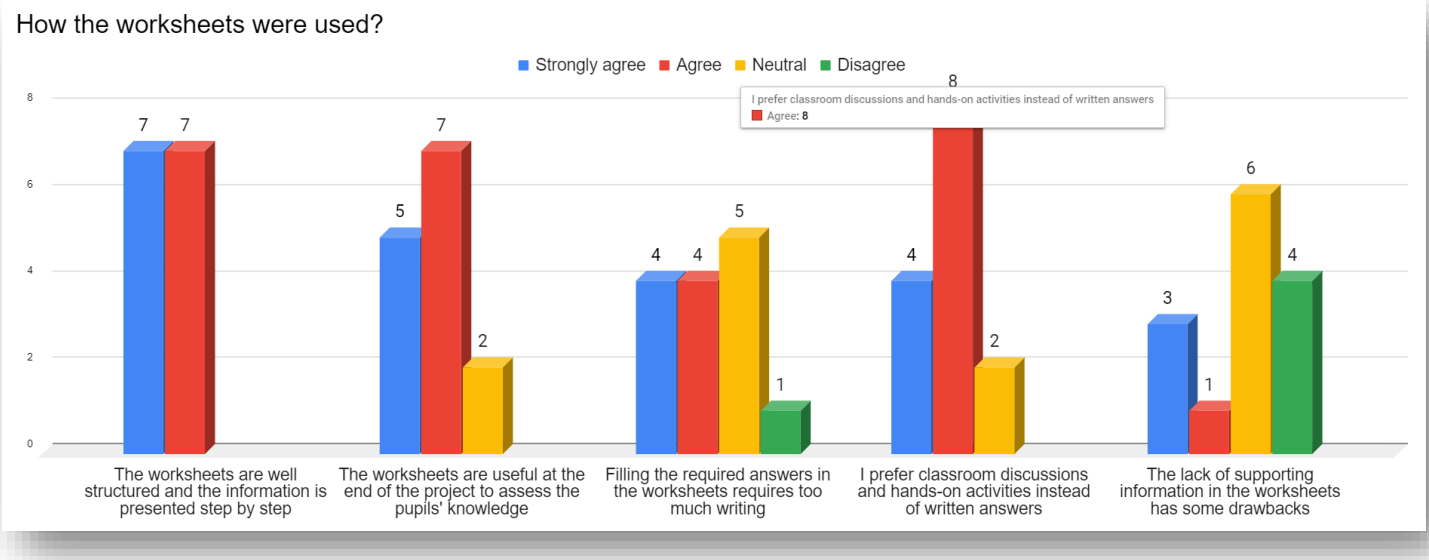
Quantitative indicator #7

To what extent educational resources for teachers and students were completed successfully.

Most teachers (42%) in question *Did you have enough time to implement the project during your lessons?* admits that there was a significant shortage of time to acquire, understand and consolidate knowledge. Some teachers (21%) say there wasn't enough time to let students look for a solution to the problem by themselves, but 28% say that students,had time for everything.







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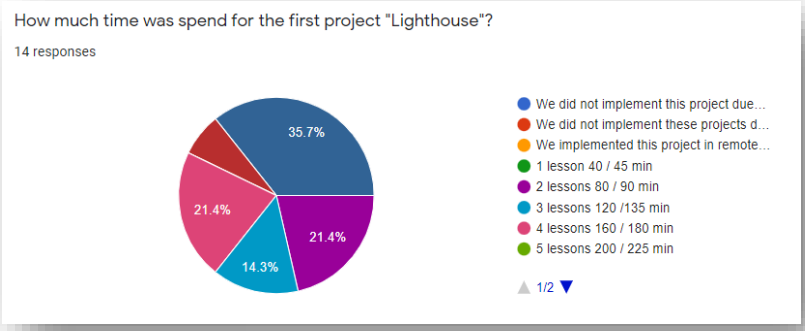
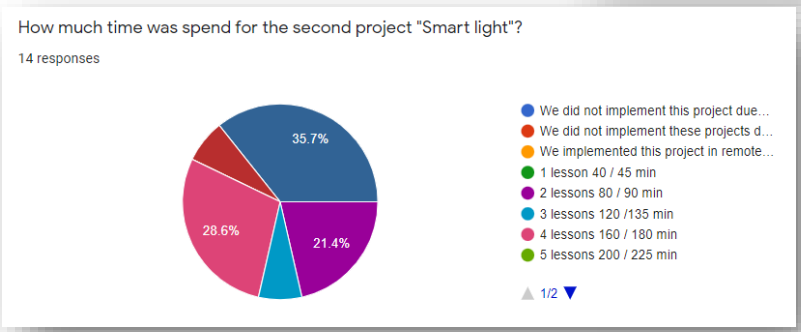
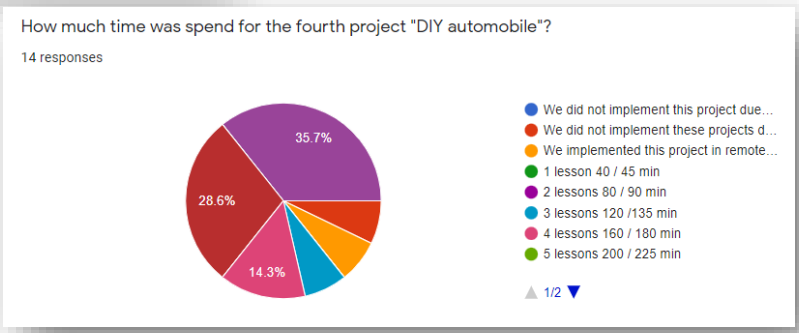
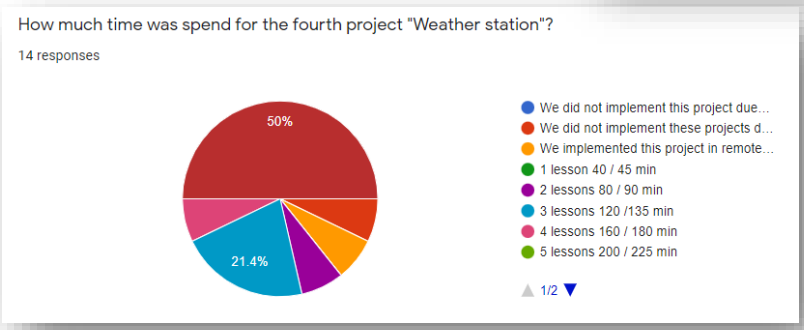
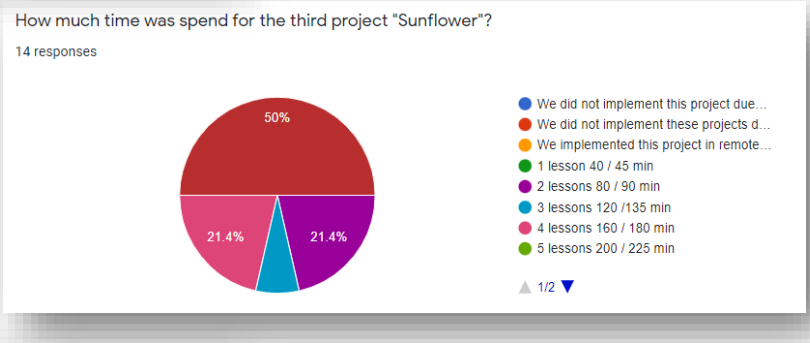
How much time was spent on the six project implementation in class

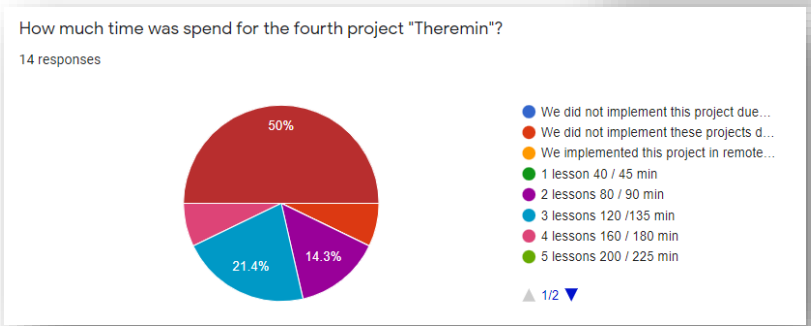












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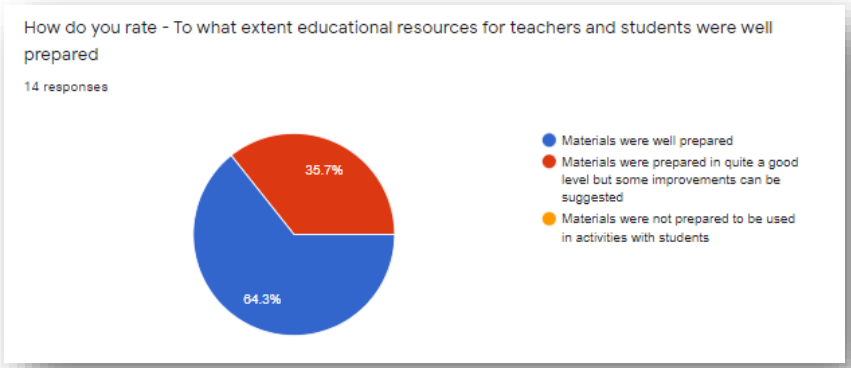
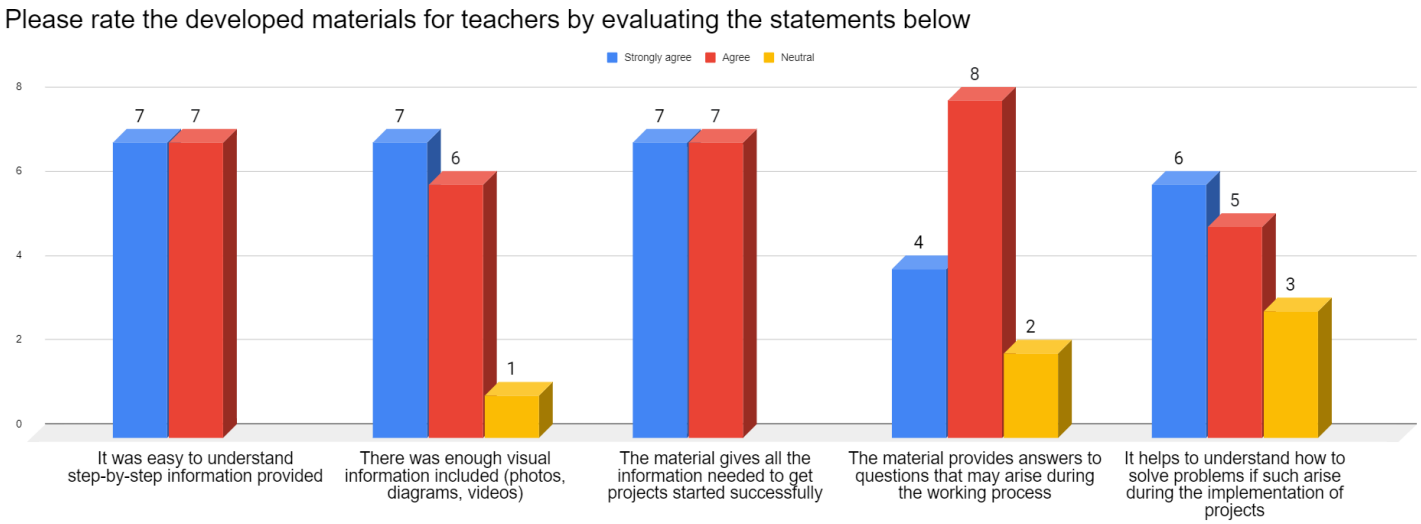
Qualitative indicators

Qualitative indicator #1

Teachers' perceptions on the value of the RoboScientists curriculum and resources for enhancing students' interest in STEM education

Although the methodology and pedagogical framework were rated relatively high, it should be noted that more teachers mention that the *Materials were prepared at quite a good level but some improvements can be suggested.* The materials were not particularly digitized, only available electronically. But without the interactivity - these were not online tests and tasks and that could have made difficulties at the learning process during remote learning period. 35% of respondents stated that *Materials were well prepared.*





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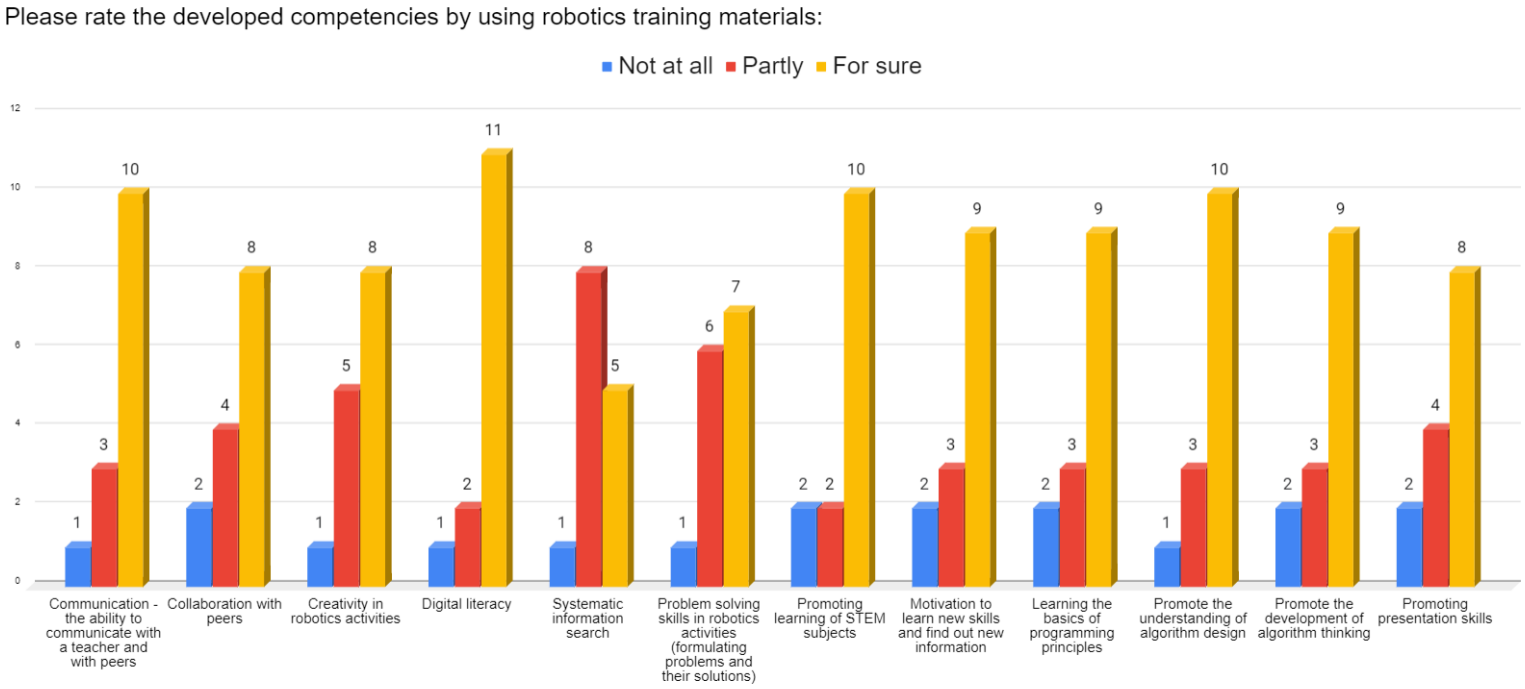
Qualitative indicator #2

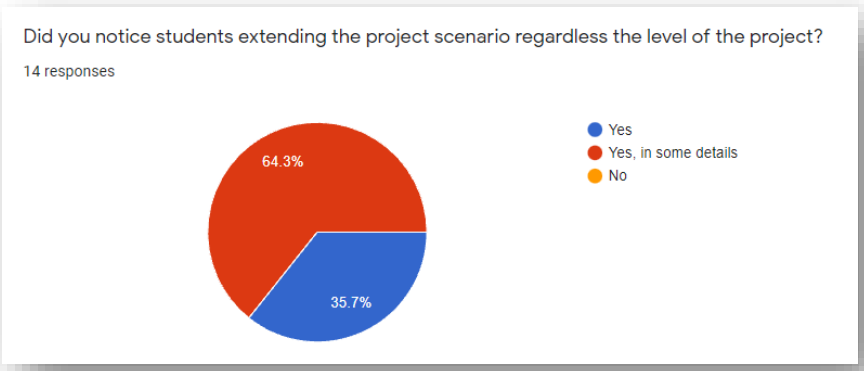
Students' perceptions on the RoboScientists activities



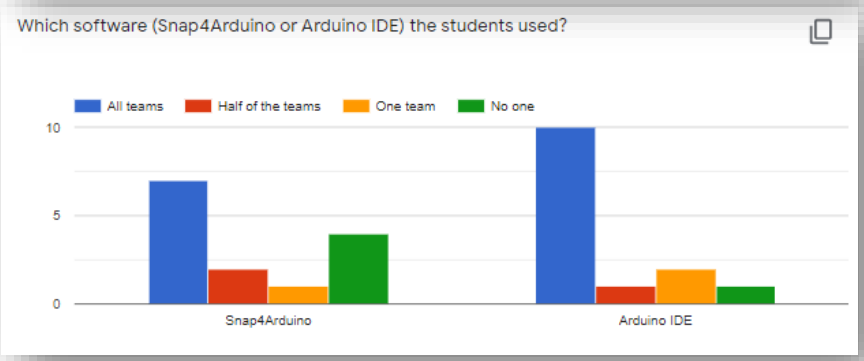
The diagram perfectly shows the competencies most developed in the students during the RoboScientists project as demonstrated by the teacher questionnaire, such as:

- *Communication - the ability to communicate with a teacher and with peers*
- *Understanding of algorithm design*
- *Digital literacy*
- *Promoting learning of STEM Promote the development of algorithm thinking subjects*

In addition, teachers have observed competencies such as compromise and specific creativity.



64% of students extended the project artifacts scenario regardless of the level of the project.



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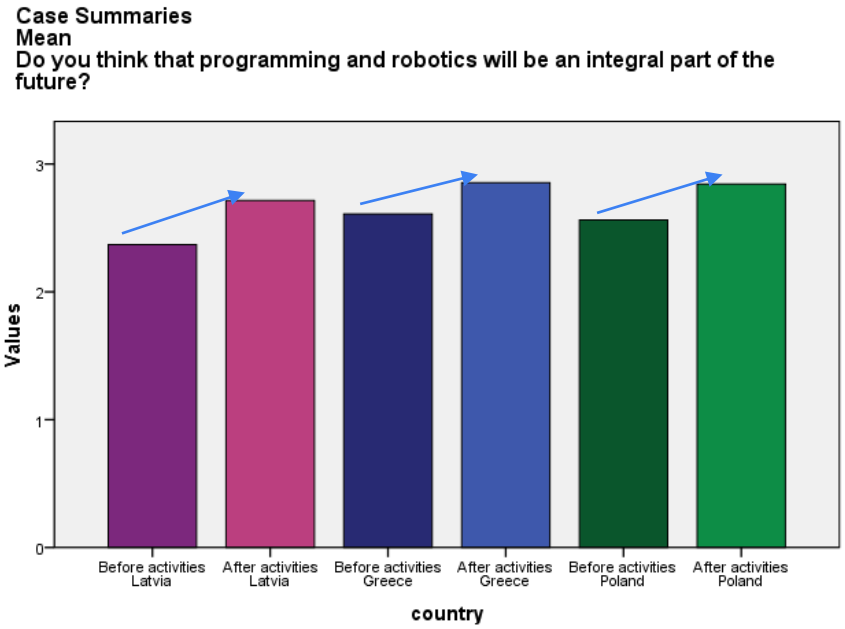
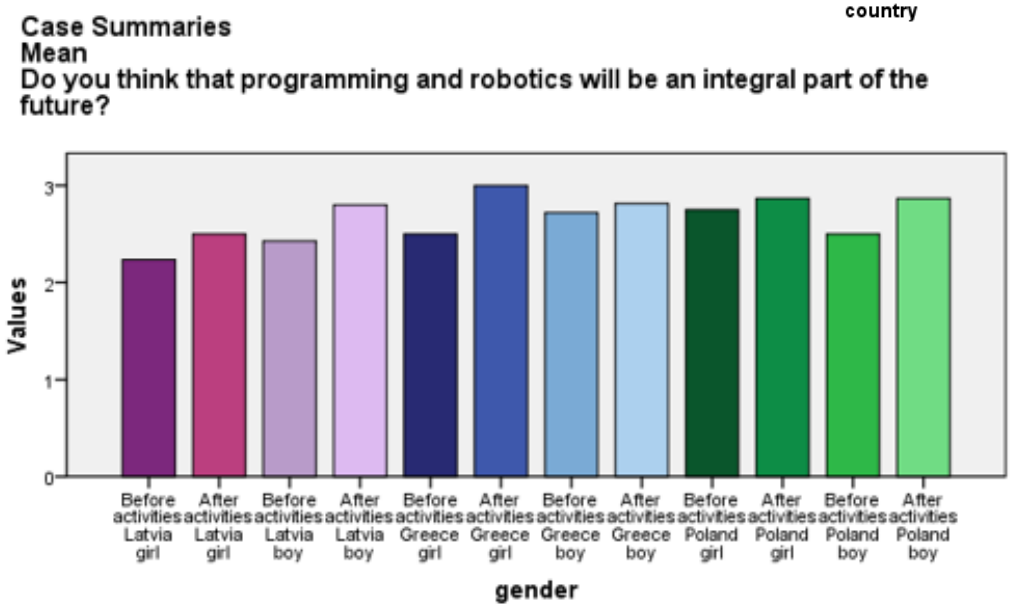
Qualitative indicator #3

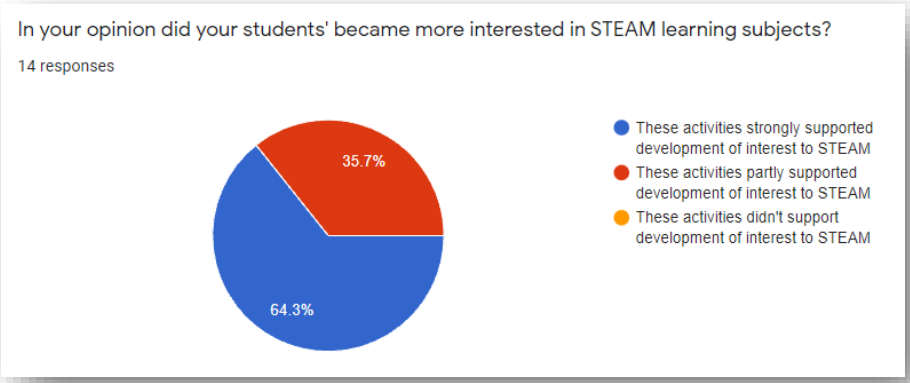
Students' perceptions related to the value of STEM subiects

Giving opinion on question *"Do you think that programming and robotics will be an integral part of the future?"* after the project activities, choosing the answer option *"yes, I am sure that will be so"*, we can conclude that the pupil's opinion has slightly improved in all the partner countries of the RoboScientists project and it means that students understand the importance of programming and robotics in the future and their belief that these two areas will be an integral part of the future.





64% of teachers in the questionnaire state that RoboScientists activities strongly support the development of interest in STEAM, while 37% state that these activities partly supported development of interest to STEAM.



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Qualitative indicator #4

Students' motivation towards STEM related careers and educational paths

Answers provided by students

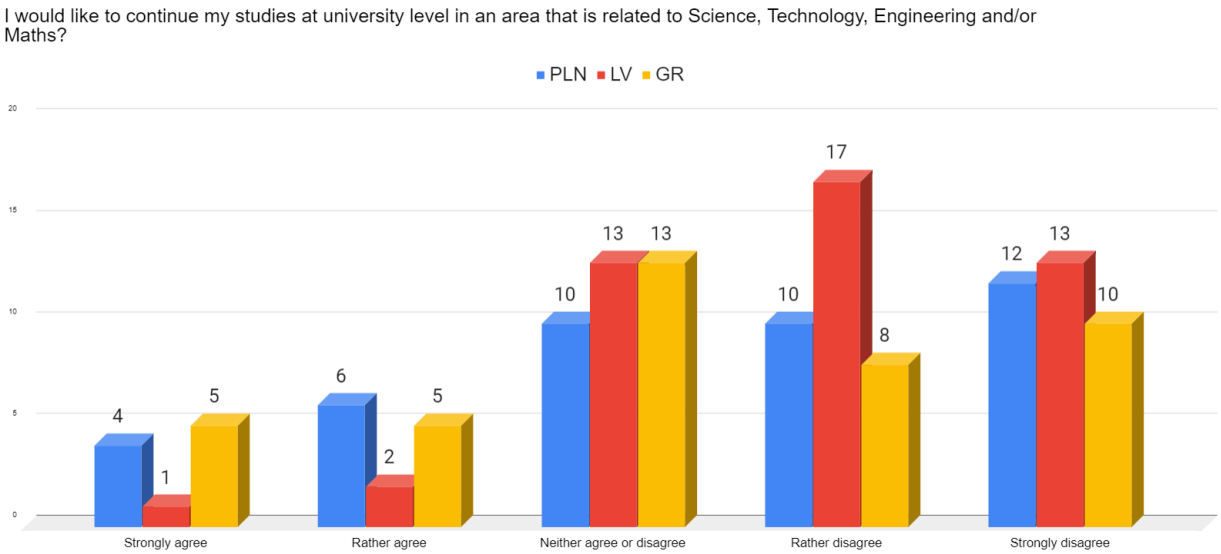
Evaluating one of the most important questions answered by students from all partner countries who participated in the RoboScientists project activities, **related towards STEAM careers and educational path**.

We can clearly observe that the students' opinion has changed a lot after the activities of this project, because mostly in the beginning the students answered these question ***I would like to continue my studies at university level in an area that is related to Science, Technology, Engineering and/or Maths?*** as strongly disagree (35N), disagree (35N) or neutral (33N).

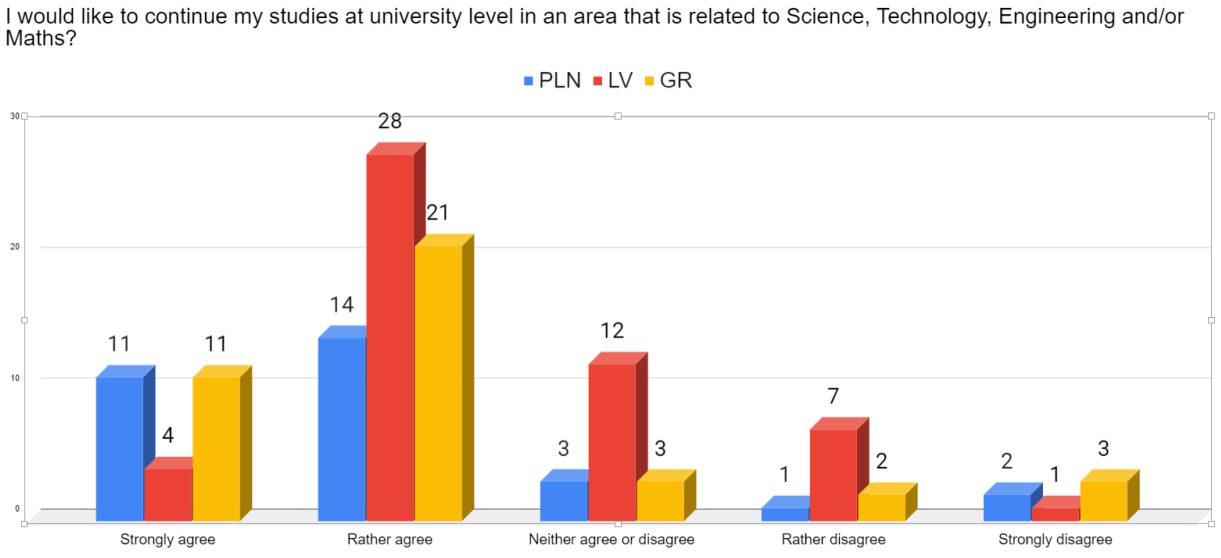
However, after the project activities, there is a significant increase among those students who are considering continuing their studies in the field of STEAM, indicating the answers - strongly agree (26N) or agree (63N).

First of all, it is perfectly normal that not all students have changed their minds, because not all people like electronics, programming and science as such. The goal is not to make every student in the world a programmer. **However, this project and the activities carried out during it strongly develop students creativity, motivation and interest in STEAM knowledge, and it has been shown that it can even change students' views on linking the future educational path to STEAM sciences.**

BEFORE project activities



AFTER project activities



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Qualitative indicator #4

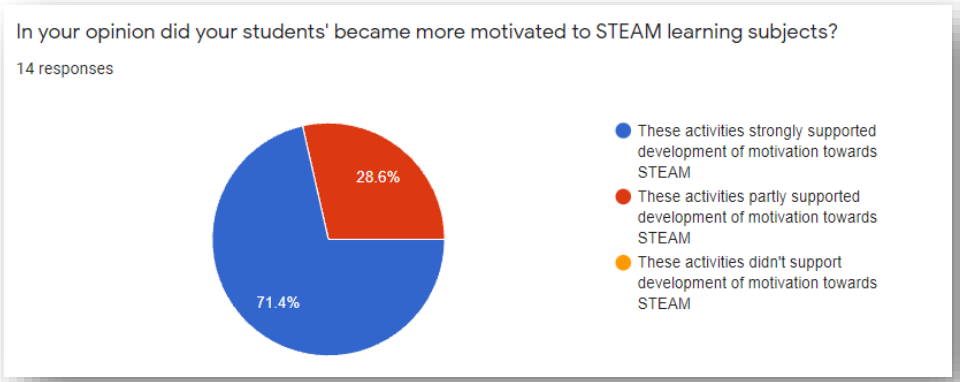
Students' motivation towards STEM related careers and educational paths

Answers provided by teachers

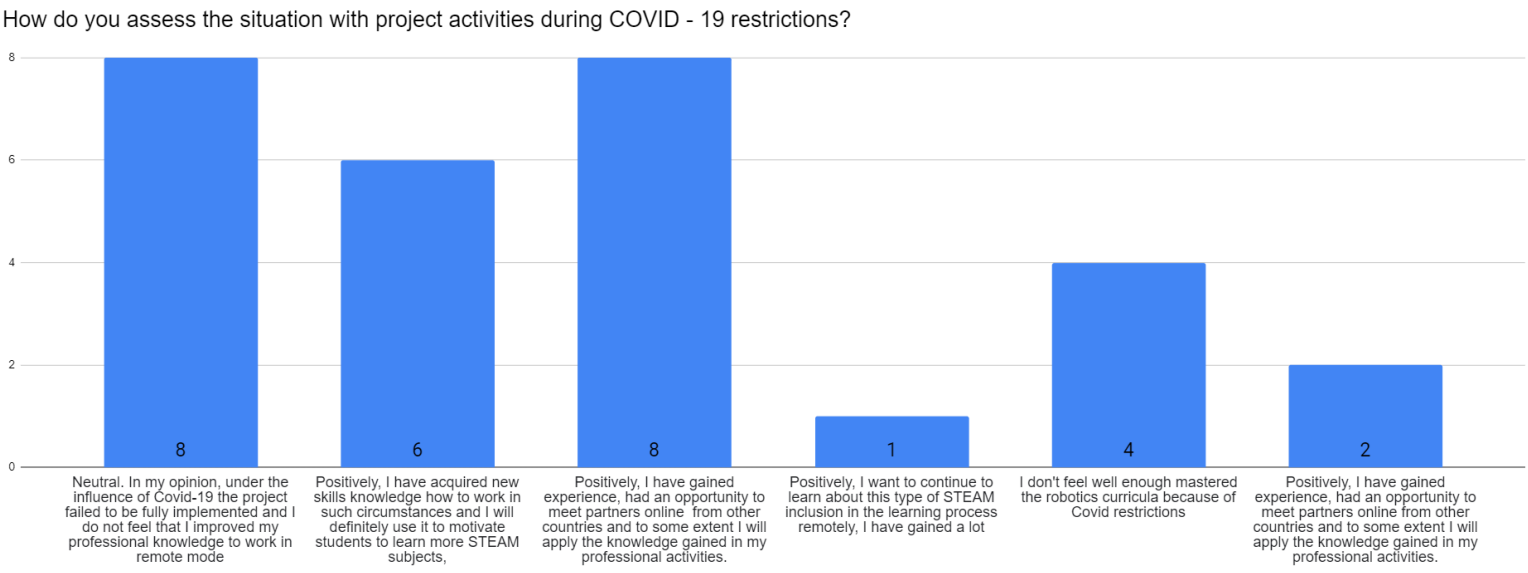
71% of teachers in the questionnaire indicate that RoboScientists activities strongly supported the development of motivation towards STEAM, while 28% indicate that these activities partly supported the development of motivation towards STEAM.

Also, by submitting answers to an open ended question *Did you observe some aspects which showed that students' motivation to learn raised during the project? What kind of aspects can you name?* teachers discover that students motivation is raised in such aspects:

- Interest in electronics
- Increase in understanding of algorithms and the ways in which program code translates into concrete action.
- Looking for additional information
- Programming
- Involvement
- Increased interest
- Constructions



Covid-19



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Teachers' suggestions and answers to open-ended questions

Regarding problems, improvements and aspects that may not have been included in the evaluation questionnaire. The data is not analyzed but included in the report for information and consideration.

- If you faced other difficulties which are not mentioned in the previous question, please describe them here:
  - Preparing the components for individual classes (divided into individual groups), and then cleaning and arranging all the elements after class, required a lot of time. This resulted in "breaking" lessons with other classes that were not involved in the project.
  - Time and money.
  - Students had difficulty deciding whether the problems were due to errors in the program code or incorrect electronic connections.
  - Lack of time.

- Do you have any other comments regarding the progress of the project implementation and the impact of Covid-19 on the success of the project?
  - Teaching specific robotics skills is very difficult remotely. Only the basics can be taught from a distance in this way, e.g. on the TinkerCad platform. More difficult classes are also possible, but only with students who already have a lot of knowledge in this topic. The teacher has a lot of difficulties with solving students' technical problems at a distance. Students are afraid that they may damage school's equipment at home, they have problems with self-diagnosis in situations when they create something completely new (e.g. a car or a weather station). It takes a long time for the teacher to find out at a distance why something is not working for the student at home.

- If you think that something more should be mentioned about the worksheets, please use the space below:
  - It would be a good idea to add links to additional knowledge pages for students at the end.

- Do you have any suggestions about, how could we develop and improve the curriculum of the teacher training course?
  - Providing teachers with starter kits with electronic elements so that they can develop.

- If you think that something more should be mentioned about the material, please use the space below:
  - There were not enough printed or electronic manuals for the hands-on exercises.

- Were there any weak points in training activities?
  - Lack of time / We did not have enough time / Not enough time.
  - COVID-19.
  - There are no precise instructions in paper or electronic form for the exercises performed. Issue of remote meetings.
  - Presentations (PowerPoint).
  - Level differences.

- Do you have any suggestions, how could we develop and improve the curriculum of the teacher training course?
  - Starter kits with electronic components for teachers from the very first training.
  - More exercises and more half-baked solutions.

Conclusions

The indicators used to measure the quality of project results fall into **2 categories**:

Quantitative indicators

#1 Number of designed and built robots by students.
During the RoboScientists project, 252 robot designs and models have been created in various activities in all four partner countries.

#2 Percentage of participant students that expressed more positive attitudes towards STEM-related disciplines
Can be found in post students questionnaires wherein all indicator students' results are increased.

#3 Percentage of teachers in a position to continue carrying out the RoboScientists learning intervention in schools (Confidence level)
Most respondents' teachers 78,6% plan to continue carrying out the RoboScientists learning intervention in schools.

#4 Teacher's satisfaction level from the training offered (C1, C2, C3, and C4) and support during the pilot periods.
Assessing the teachers' satisfaction level with the training activities organized during the project, the data shows that teachers were mostly satisfied with the face-to-face training process in Poland and Greece (before COVID-19). But online training satisfaction level can be considered as partially satisfactory.

#5 Participation of students in the pilot stages | Target >= 40 in each country.
A number of students starting project activities 120. A number of students completed project activities 119.

#6 Final acceptance rate of the RoboScientists methodology and pedagogical framework by the teachers | Target> 80%.
The results of the questionnaire show that more than 80% are indicated by 6 respondents and a 100% acceptance rate is indicated by 3 respondents.

#7 To what extent educational resources for teachers and students were completed successfully.
Most teachers mention that the Materials were prepared at quite a good level but some improvements can be suggested.

#8 Percentage of active teachers in the online class | Target > 15 per country

Qualitative indicators

#1 Teachers' perceptions on the value of the RoboScientists curriculum and resources for enhancing students' interest in STEM education.
Although the methodology and pedagogical framework were rated relatively high, it should be noted that more teachers mention that the Materials were prepared at quite a good level but some improvements can be suggested. 35% of respondents stated that Materials were well prepared.

#2 Students' perceptions of the RoboScientists activities.
64% of students extended the project artifacts scenario regardless of the level of the project.

#3 Students' perceptions related to the value of STEM subjects.
Can conclude that the student's opinion has slightly improved in all the partner countries of the RoboScientists project and it means that students understand the importance of programming and robotics in the future and their belief that these two areas will be an integral part of the future.

#4 Students' motivation towards STEM-related careers and educational paths.
71% of teachers in the questionnaire state that RoboScientist's activities strongly supported the development of motivation towards STEAM, while 28% state that these activities partly supported the development of motivation towards STEAM.

#5 Feedback generated through threads in the forum of the online class related to the teaching practice with RoboScientists resources

Content of the annexes

Annex 1 – Students PRE Questionnaire (before project activities)

Annex 2 – Students POST Questionnaire (after all project activities)

Annex 3 – Teachers POST Questionnaire (after all project activities)

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ROBOSCIENTISTS PROJECT
Motivating secondary school students towards STEM careers through robotic artefact making

Erasmus+ KA2 2018-1PL01-KA201-051129

Creators
Linda Daniela *(University of Latvia)*
Arta Rūdolfa *(University of Latvia)*

Declaration
This report has been prepared in the context of the ROBOSCIENTISTS project. Where other published and unpublished source materials have been used, these have been acknowledged.

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This project has been funded with support from the European Commission. This communication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.