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ROBOESL PROJECT

ROBOTICS-BASED LEARNING INTERVENTIONS FOR PREVENTING SCHOOL FAILURE AND EARLY SCHOOL LEAVING

Erasmus+ 2015-1-IT02-KA201-015141

Output 3: Validation of the impact of the learning activities

Lead Partner: LATVIJAS UNIVERSITATE (LV) Authors: Linda Daniela, Raimonds Strods,

Contributions: Dimitris Alimisis EDUMOTIVA, Greece; Michele Moro University of Padua, Italy

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Declaration

This intellectual output has been prepared in the context of the ROBOESL project. Where other published and unpublished source materials have been used, these have been acknowledged.

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Abstract

This document reports the Intellectual Output 3 - **Validation of the impact of the learning activities** in the context of the ERASMUS+ project ROBOESL. The output reports results of the Project and shows the impact of activities carried out during the Project. Results summarised in this report shows that planned and organised robotics based learning activities can reduce risks of Early School Leaving (ESL). There are given data acquired during the Project and conclusions which are made based on data

Output 3 - Validation of the impact of the learning activities

O3.1 A strategy for the validation of the impact of the learning activities on the selected students' achievements and attitudes and finally the prevention of school failure/ESL.

There was developed the strategy for the validation of impact of the learning activities on the selected students' achievements and attitudes and finally the prevention of school failure/ESL. This strategy was discussed with Project partners and teachers involved in Project activities.
Added as separate document with links to qustionnaires which were prepared on Google platform and used by Project partners.

O3.2 Evaluation tools for the learning activities

There were developed evaluation tools to assess robotics based learning activities to get information about impact of these activities for students who are at risk of ESL.

- Students' questionnaires which had to be filled before and after participation in Project activities about their attitude to robotic based learning activities and changes in their motivation
- ***Before*** participation in Project activities
    - Italian language https://docs.google.com/a/lu.lv/forms/d/12vA7cp9UHZi2BpshmobYo7RxfFG2mysdlRM8-frZlq4/viewform?c=0&w=1
    - Greek language https://docs.google.com/a/lu.lv/forms/d/1chBTDJwVsm2c6KsFEaOtUlTA8CQ4vrINzLQhfKN__1Y/viewform?c=0&w=1
    - Latvian language https://docs.google.com/a/lu.lv/forms/d/137CoyrWv-IwMffMNoRd3XCIhm-pMBqeqeHgQgUc6GAA/viewform?c=0&w=1
- *After* participation in Project activities
    - Italian language https://docs.google.com/a/lu.lv/forms/d/1bpi8Q6Wep_jQuqT33mLqA_5yog525GaKRkTBpAWpexo/viewform?c=0&w=1
    - Greek language https://docs.google.com/a/lu.lv/forms/d/1HjyZbQFx5qyj6BxMIborOynXMyOqs5D34G5o2RwGpxs/viewform?c=0&w=1
    - Latvian language https://docs.google.com/a/lu.lv/forms/d/1nCZeUJO58ZlC6mDdQvj6HW1SjBsJcBlO-D8_NLOUlmo/viewform?c=0&w=1
- Teachers' questionnaires which had to be filled before and after participation in Project activities about changes in students attitude and motivation

https://docs.google.com/a/lu.lv/forms/d/e/1FAIpQLSfmCNvhOelQIOdC49vt8AERNzfHNCHX2oDmiZcLHR5_zzQtyQ/viewform?c=0&w=1

1.1. Evaluation of motivation and attitude of students ***after***

https://docs.google.com/a/lu.lv/forms/d/e/1FAIpQLSeO9x-u_WH5eeoVXkWG9U0jkr6RQ8qa3p_uprl3v4meZ9EikA/viewform?c=0&w=1

- Evaluation of students' risks (special needs, learning problems, learning outcomes, social problems, etc.) which should be filled by teachers at the beginning of students involvement in Project activities and information about outcomes at the end of participation in Project activities
    - Evaluation of risks ***before***

https://docs.google.com/a/lu.lv/forms/d/e/1FAIpQLSeekmIVR_k8XP0o8bFcJ1NDuORN-Uvytliae6GdhCO4liqFIQ/viewform?c=0&w=1

    - Evaluation of risks ***after***

https://docs.google.com/a/lu.lv/forms/d/e/1FAIpQLSevuOwHzxaU_VuVJ5-E3DjQ9i9CAAhNAeqCpmleGIOpjLEIJw/viewform?c=0&w=1

Observation protocol where teachers should evaluate students attitude during participation in specific robotics projects/curicula. This material is added as separate document

O3.3 Collection of data coming from school activities

Collection of data was organised before and after participating in activities about students who were involved in activities. It was organised for 1st round and for the 2nd round. All the data is availble in excel format and availbale for Project partners. Data was analysed during the all Project.

O3.4 First Report with the statistical analysis of data coming from the learning activities of the 1st round of activities (spring semester 2015-16), first findings and conclusions.

The project intended to explore how innovative technology-enhanced learning and teaching can address low achievement in basic skills and support schools to tackle ESL (early school leaving) problem. Project partners' experience in the development of robotics-based projects in schools has shown that educational robotics (ER), if deployed in a constructivist/constructionist learning environment and within a project-based learning methodology, can offer learning opportunities for children and support the development of basic and transversal skills such as creativity, teamwork, problem solving and more, and keep students interested and motivated with hands-on learning, learning by doing and other fun learning activities.
The main target group in the project are students who have a high ESL risk, the subordinate target group is also the teachers who, in the frame of the project, work with the developed materials during their training and later also other teachers who will be able to use the developed materials as open access resources, however the effect of projects' activities on the professional improvement of teachers is not analysed in details as it was not the direct aim of the project.
Early school leaving is often related to social exclusion risks which, in its turn, can be both connected with the social economic situation of the student's family and the

student's special needs as well as the problems in the educational process. When children and young people drop the education system early without obtaining the basic education or secondary education there exists a greater risk of not acquiring adequate education, profession, work, not earning enough means of subsistence which can lead to poverty, involvement into criminal groups and in general to social exclusion. The social exclusion is understood as a social multi-dimensional process of marginalization which possesses economic, social, cultural and political aspects and it is characterized by the inability of the individuals or the groups to join the society fully or partially, when they are denied the access or the access to such resources, services and activities that are vitally important for the person's development and that ensure a full-fledged functioning of the person in the society is encumbered. In education it is connected with insufficient possibilities to participate in the educational process, exclusion, unsatisfactory social integration and the inability to participate in the processes going on in the society in general. Social integration, in its turn, is defined as "a process in which everyone has the possibility to participate in the social, economic and political life based on the equality of rights, fairness and respect".

In order to check the possibilities of applying the learning modules of robotics for reducing the early school leaving risk (ESL) a set of criteria for selecting students who are at risk of ESL was developed. Part of the criteria allowed receiving the assessment only in the form of YES or NO, where YES meant receiving one point while NO meant no points. The variation of several points from 1 to 4 was possible in the other part of the criteria where 1 meant that such a feature was not observed, 2 – the feature is rarely observed, 3 – the feature is sometimes observed and 4 – the feature is always observed. In cases if there were more students than it was possible to involve in the project activities teachers were advised to give priority to those students whose risks were more serious. Thus, it was ensured that students who had shown early school leaving risks would participate in the approbation of the developed materials. However, it was, to a certain extent, also the project risk because working with robotics activities in a group of students who are at risk of ESL has not been widely used and thus positive results are predictable but not guaranteed, especially in such a short period of time (approx. 3 months) because the impact of different programs is observed with time displacement, which means that positive results more frequently are observed after a longer period of time. Another risk factor was the time of lessons, because the robotics activities were organized after class, thus making the day longer for students involved in the project, which is a big challenge for students with low learning motivation, who experience trouble concentrating for learning and who prefer to spend their time outside of the school.

Further in the text there are analysed obtained results after the first round of project activities. First the results obtained from the students are explained.

Students

Students filled in the evaluation survey about the changes in their attitude and knowledge before and after the participation in the project activities. All in all, 260 students from all three participating countries took part in the activities; the final evaluation questionnaire at the end of the first stage was filled in by 62 students; 44 or them were boys and 18 girls, their age being from 11 to such 19.

As seen in Table 1, students have evaluated the highest the option that learning creates fun when working in such a way (mean 4.13) and it is a stable basis that students will want to learn and acquire something new. Positive learning experience promotes the development of learning motivation and this, in its turn, decreases the early school leaving risks. Equally highly students have assessed the statements "I liked to work in groups to do assignments with robot" and "I liked that others helped me to solve problems with programming", for both of them the mean is 3.68 and this indicated the development of cooperation skills and their role in a positive teaching/learning process which ensures students' reciprocal learning and support in problem solving, which is a vitally important competence for students who in everyday life belong to social exclusion risk group which frequently leads to early school leaving.

Table 1. **STUDENTS' OPINION ABOUT THE BENEFITS FROM ROBOTICS ACTIVITIES**

Descriptive Statistics	N	Mean	Std. Deviation
Learning by using robots was fun	62	4,13	,914
I have learned how to program robots	62	3,52	1,036
I liked to work in groups to do assignments with robots	62	3,68	1,277
I liked to make calculations for programming	62	2,98	1,109
I can use this knowledge in other activities	62	2,97	1,086
I liked to solve problems with programming by myself	62	2,79	1,230
I liked that others helped me to solve problems with programming	62	3,68	1,238
I liked to look for extra information needed for using robots	62	2,77	1,247
Other outcome	62	1,24	,432
Valid N (listwise)	62		

Table 2, in its turn, presents summarized results which have been obtained by asking students what knowledge and skills they had improved when working with robotics activities and one of the most highly assessed is the improved cooperation skill with the classmates (mean 3.69) and teachers (mean 3.50), as well as students consider that their knowledge and understanding about using the ICT have improved (mean 3.66).

Table 2. **STUDENTS' OPINION ABOUT CHANGES IN THEIR KNOWLEDGE AND SKILLS AFTER ROBOTICS ACTIVITIES**

Descriptive Statistics	N	Mean	Std. Deviation
understanding of Math	62	2,81	1,171
understanding of Physics	62	2,55	1,224
understanding of Informatics and technologies	62	3,66	,940
attitude to learning	62	3,24	1,082
cooperation skills with my classmates	62	3,69	1,139
cooperation skills with teachers	62	3,50	1,211
Other outcome	62	1,32	,471
Valid N (listwise)	62		

Teachers

Teachers were asked to fill in several research tools and results obtained after summarizing teachers' answers after working with students about changes in their attitude, behaviour and other indicators that are indicative of the possible risk for early school leaving. Teachers gave their answers about changes that can be observed in

lessons of different school subjects. Teachers had to assess these changes using the principle of the Likert scale where 1 - no changes at all, 2 - some signs of improvement observed occasionally/rarely, 3 - some signs of improvement observed sometimes, 4 - signs of improvement observed in most situations, 5 - strong improvement observed in all situations. Thus, it allows concluding that the use of robotics learning activities in the out-of-class activities, promotion of students' interest in learning leads also to changes in students' attitude to learning in general. 203 questionnaires which were filled in about students who participated in robotics learning activities were useful for the analysis of the results. Table 3 summarizes the data about the teachers' opinion on changes that observe in students' attitude to learning and the obtained data allow concluding that teachers see the greatest change in the indicators *Cooperation with teachers in a positive way* (mean 3.07) and *Following of the behavioral rules in the classroom* (3.05), which indicate that positive changes are observed sometimes. These results after the first cycle of activities show positive trends and confirm the idea that fast improvement in such a short period of time is not possible. However, more serious changes are observed in relation to features of behaviour which is one of the most illustrative variables in the evaluation of the pedagogical process confirming the changes in the students' attitude. The improvements in other indicators are more evaluated as "some signs of improvement observed occasionally/rarely".

Table 3. **TEACHERS' OPINION ABOUT CHANGES IN STUDENTS' ATTITUDE TO THE TEACHING/LEARNING PROCESS**

Descriptive Statistics	N	Mean	Std. Deviation
Preparation of homeworks	203	2,70	1,231
Cooperation with teachers in a positive way	203	3,07	1,167
Cooperation with classmates during lessons in a positive way	203	2,96	1,127
Readiness for work in lessons	203	2,76	1,191
Understanding of the connection between learning and achievements	203	2,85	1,178
Readiness to do extra assignments to improve achievements	203	2,74	1,224
Following of the behavioral rules in the classroom	203	3,05	1,242
Readiness to join out of class/school activities together with other classmates	203	2,82	1,109
Readiness to join activities led by other classmates	203	2,77	1,148
Readiness to reach learning aims	203	2,87	1,242
Valid N (listwise)	203		

Table 4 summarizes the results about changes in students' motivation and it is seen that teachers observe these changes only in rare cases and the lowest assessment concerns the statement "Readiness to work hard to achieve the aim", which, on the one hand, indicates that students' motivation has not significantly changed and, on the other hand, confirms also C. Migdley and T.Urdan's (2001), T.Urdan et.al. (1998)) views about the students' aims when the driving force of motivation is the willingness to shirk in order not to show one's incompetence, as authors call it *self-handicaping*. Taking into consideration that students have assessed the benefits from robotics learning activities more positively than teachers it can be concluded that students have liked such lessons but this positive attitude has been based more on the interest in the learning process that has been organized differently, the possibility not to be afraid to

be incompetent; still students' achievement motivation to improve their academic achievement also in other school subjects has not yet consolidated.

Table 4. **TEACHERS' OPINION ABOUT CHANGES IN STUDENTS' MOTIVATION**

Descriptive Statistics	N	Mean	Std. Deviation
Motivation to learn the subject you teach	203	2,86	1,278
Motivation to understand his/her mistakes to correct them	203	2,90	1,286
Motivation to improve achievements	203	2,80	1,286
Motivation to overcome difficulties in learning	203	2,81	1,285
Readiness to works hard to achieve the aim	203	2,70	1,271
Valid N (listwise)	203		

Table 5 presents the summarized results about the changes in the expressions of problematic behaviour that had been observed by teachers and the mean average concerning different expressions of problematic behaviour serves as evidence that students who belong to the risk group of early school leaving have not significantly changed their behaviour. This can have several explanations where one can be that the teaching/learning process during the lessons does not correspond to the special needs of students who are in the risk group and the specifics of their problems but teachers do not change anything in the process therefore students express their attitude through their behaviour. The second possible reason can be the teachers' negative attitude to children who are in the social exclusion risk group therefore they are unable to see objectively students' positive changes and accept them, for they continue considering that the expressions of students' behaviour are not connected with what is happening in the class and school. Thus the responsibility about what is happening is put on the students without the analysis of what could be changed in the educational process so that everyone is involved and that everyone could feel positive self-efficacy.

Table 5. **TEACHERS' OPINION ABOUT CHANGES IN STUDENTS' PROBLEMATIC BEHAVIOUR**

Descriptive Statistics	N	Mean	Std. Deviation
Beeing late for the beginning of lessons	203	2,25	1,103
Problematic behaviour during recess (break)	203	2,22	1,141
Aggressiveness to other students	203	2,28	1,174
Aggressiveness to teachers	203	2,26	1,237
Using rude language with classmates	203	2,19	1,225
Using rude language with teachers	203	2,18	1,226
Rejection to do assignments during the lessons	203	2,26	1,140
Aggressive reaction in situation of conflict	203	2,30	1,183
Valid N (listwise)	203		

Table 6 summarizes the results about the changes in students' problem solving skills and the obtained results allow concluding that teachers see the most improvement in the indicator "Solves the conflicts in a calm way" (mean 3.37), which confirms that the positive cooperation experience which was gained during the robotics learning activities when students learned to mutually interact with each other, with teachers and to search for different possibilities of solving the problem has also helped to

develop, though slightly, the conflict solution skills that can be useful in everyday life situations.

Table 6. **TEACHERS' OPINION ABOUT CHANGES IN STUDENTS' PROBLEM SOLVING SKILLS**

Descriptive Statistics	N	Mean	Std. Deviation
Solves the learning problems by himself/herself	203	2,93	1,124
Asks for help from teachers	203	2,87	1,002
Solves the conflicts in a calm way	203	3,37	1,210
Valid N (listwise)	203		

The results as a whole indicate positive trends in the changes concerning students' attitude to learning that allows predicting that in a longer period of time these results will become more stable and thus the early school leaving risks will be decreased.
Differences are observed in the opinions expressed by teachers and students about positive changes after working with robotics activities when students' opinion about the changes on average exceeds 3 (partly agree), while teachers have assessed the changes in students' attitude and motivation between 2 and 3, which more corresponds "some signs of improvement observed occasionally/rarely". This can have several reasons:

- Students in ESL risk group cooperate better with other students and teachers in situations where the learning process is less formal and they need not to be afraid of appearing to be incompetent;
- Teachers who assess changes in students' attitude, motivation and problematic behaviour have established their own opinion about students belonging to the ESL risk group and are not ready to change it because they do not notice the slight improvements in students' behaviour and attitude although they are and on the bases of them it is possible to facilitate the development of students' motivation;
- The formal education process having standardized requirements does not correspond to students who have specific health problems, specific family situation and other social exclusion risks and without changing it and without introducing other learning strategies it will be difficult to do away with or to decrease these ESL risks.

OSERVATION RESULTS

Teachers were asked to fill prepared observation protocols to document processes during activities with educational robotics.

> **Indicators:** 0 – can't be observed; 1 – low level ; 2 – can be observed almost in all situations; 3 – can be observed during all Project; 4 – does more than expected

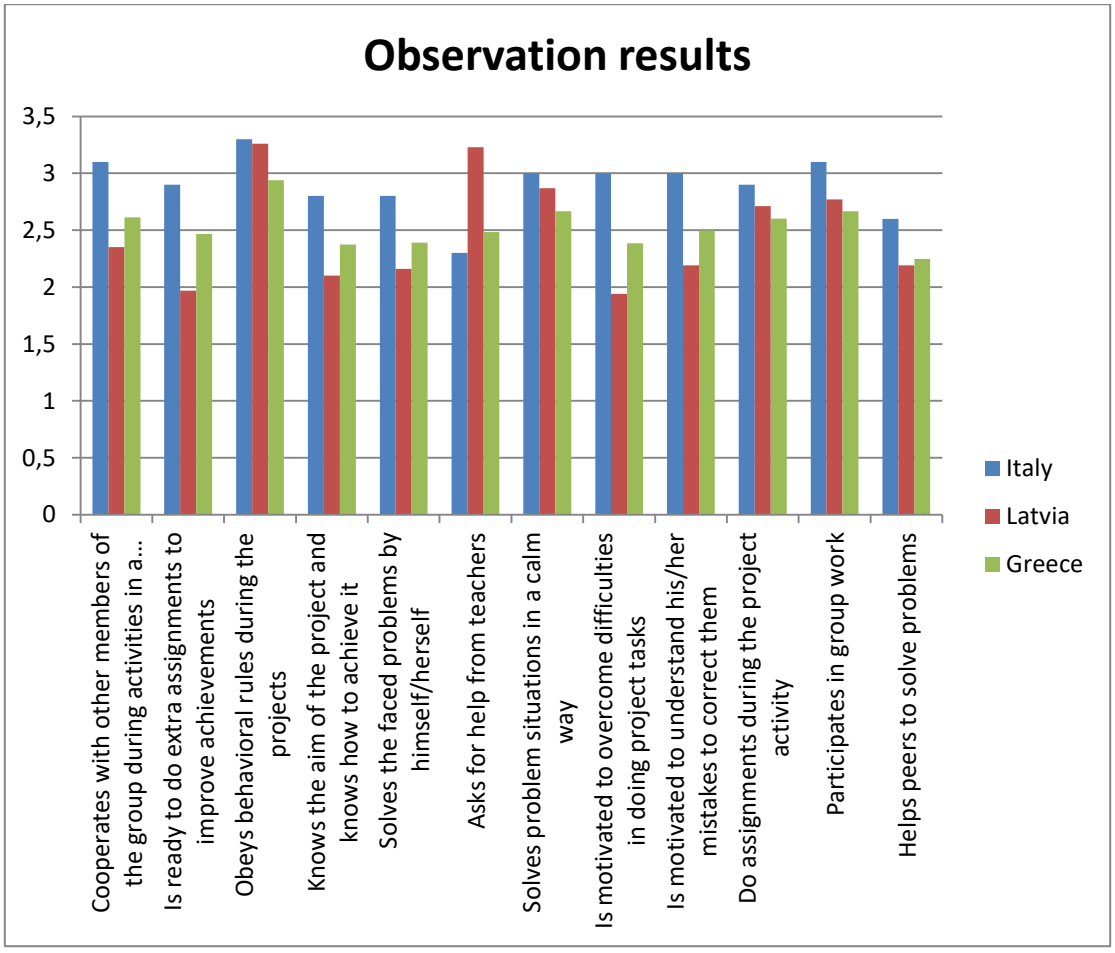

Fig.1. **OBSERVATION RESULTS (Country comparison)**

Results are summarised by countries, but it is done just for information, because the Project didn't have specific tasks for different countries and it's aim wasn't to make comparision between countries. All the results must be analysed taking into account the context of the school, country and legislative basis of the country.

O3.5 Final Report with the presentation and statistical analysis of data including this coming from the learning activities of the 2nd round of activities (Autumn semester 2015-16), final findings and conclusions.

The early school leaving risk is one of the problem issues the solution of which has been tackled by many countries in the world because a low level of education exerts impact not only on the competitiveness of the country in the world due to the lost human capital which does not contribute to the national economy but also in view of social considerations when a poorly educated person is unable to secure oneself financially thus becoming a burden for the economy because such people need social support, they can create threats to other people's security, etc.
The early school leaving risk in the project partner countries is relatively high. Although the Eurostat data show that all three project participant countries have achieved the aim set in 2016 and early school leaving is below 10 per cent; however,

in Greece the indicator is still 6.2%, in Italy – 13.8% and in Latvia 10% (Eurostat, 2016).

The reasons for early school leaving are often complex and they mutually combine. They can be risks in the student's family when he/she does not receive sufficient social and/or emotional support. These can be problems in the learning process that are related both to the student's special needs (health issues, learning difficulties, etc.) and the feeling of oneself in the school, the lack of emotional bonding to the school, feeling excluded, failing to receive the teachers' support in solving the problems. ESL risks can also be connected with the students' motivation to learn and overcome the difficulties as well as with the problems in organizing the teaching/learning process when students' individual needs are neglected, the teaching/learning process is uninteresting and students do not see the connection between the knowledge that is acquired and and the real life needs. There are also many outside-the-school factors that can cause ESL because the easily accessible information, the possibility to participate in different activities can give the impression that the time spent at school is lost time.

The project participants in their activities tried to take into consideration both the necessity for interesting and exciting teaching/learning process and the necessity to acquire new knowledge so that learners developed a link between exciting activities of robotics and other kinds of knowledge that are acquired in the compulsory teaching/learning process in order to make the learning process more interesting and to show learners that it is possible to learn in a different way and to acquire knowledge through hands-on activities. LEGO Mindstorm robots were chosen as a tool for attaining the set aim. Thus, both the hands-on learning principles and the e-learning principles, to a certain extent, were used because the LEGO software had to be employed for programming of robots. The use of LEGO Mindstorm robots allowed introducing such pedagogical principles in practice as: peer learning and collaborative learning when students worked in groups in order "to teach" the robot to do something; active learning strategies because students themselves programmed the robots and checked whether their programme worked; blended learning strategies because students had to use the e-environment and the teacher's support and help was still needed.

The following aspects have to be taken into consideration when evaluating the project outcomes:

- teachers of different school subjects (e.g., informatics, philosophy, literature, physics, home economics, etc.) who showed the willingness to learn how to work with robots so that afterwards they could work with the students of the project target group participated in the project.
- project experts (M. Moro, D. Alimisis, E. Micheli) worked out 10 curricula specifically for the needs of the project which the involved teachers approbated in their training sessions to use later in their work with the students exposed to the ESL risk.
- teachers had a possibility to consult the developers of the curricula as well as colleagues from other partner countries in the on-line forum thus ensuring a continuous exchange of experience and reciprocal learning.

Taking into consideration the above mentioned it can be considered that technologies, in this case Lego Minsdstorm robots can be used meaningfully as agents in the learning process in order to reduce the social exclusion risks.

The results that were obtained during the second round in which students from the three Project partner countries participated without singling out the results of individual countries. All teachers who work every day with the students selected for the project were asked to give their assessment of the students who participated in the project activities.

Table 7 summarises the data about some of the questions included in the questionnaire that describe the students' attitude to learning, their motivation and problem solving skills before and after the participation in the project activities. As described above the formulation of questions were modified trying to include in them a similar thought so that the results were mutually comparable. In the table the questions that were asked before the participation in the activities are given in the upper line and under it is the question that was asked after the participation in the project activities. Although there is no statistically significant improvement of the results in some parameters still there is improvement. For example, in the question about learning as an exciting process the mean has changed from 3.32 to 4.40, which proves that changing the traditional learning forms to activities in which the student is an active participant of the study process using learning agents (Lego robots) as intermediaries it is ensured that students regard the teaching/learning process as exciting. The mean in the question about searching for the additional information that is necessary for the learning process has changed from 2.88 to 3.48. Also these changes are relevant enough to conclude that students' enthusiasm and interest in robotics activities serve as a drive for students to seek additional information and take the responsibility for constructing their knowledge. It is especially important in the context of students with a low learning motivation and confirms the role of robots as agents of the learning process. The obtained results show that students have a desire to find out and learn something more thus it is possible to assume that students will develop new neural connections that will help them also in other learning contexts. It also relates to the opinion expressed by students about the statement "I can use the gained knowledge in other activities", in which the mean is 3.72.

The mean, in its turn, in the question about solving the learning problems at the beginning was 2.91 but after the participation in the project was 3.44 because of the use of the robots. The obtained results confirm that the positive role of the chosen strategy using robots as the agents of learning. Students who are exposed to the ESL risk often have acquired the avoidance motivation strategies; they avoid solving different problems, including the solution of the learning problems. If the involved students consider that this skill has developed as a result of the project activities then it allows hoping that this skill will be used also in other contexts and will help to reduce the ESL risks.

Analysing the questions about the mutual cooperation with classmates the improvements are rather small (at the beginning the mean is 3.94, at the end of the project 4.10). Students at the beginning of the project were not asked to evaluate the cooperation with teachers (those who led the robotics classes). Such a question was asked only at the end of the project and the obtained result – the mean 4.25 proves the necessity for the teachers' support and individual attention that was possible in the activities organized in the particular way and that was specifically taught to teachers during the training. This result is also compulsory for the evaluation of the teaching/learning context because it confirms that changing the teachers' attitude to students, organizing an interesting teaching/learning process, allowing students

themselves to be active participants of the teaching/learning process, engaging robots as agents of the learning process and balancing the mutual student/teacher relations, reducing the division of the hierarchic relations students perceive teachers more as the cooperation partners.

Table 7. **STUDENTS' OPINION ABOUT THE CHANGES AFTER ROBOTICS ACTIVITIES**

Descriptive Statistics:	**Mean (before)**	**Mean (after)**	**Std. Deviation (before)**	**Std. Deviation (after)**
Learning is fun	3.32	4.40	.999	.836
Learning by using robots was exciting				
I like to cooperate with my classmates in lessons	3.94	4.34	.988	1.030
I liked to work in groups during the robotic activities				
I like to look for extra information needed for learning	2.88	3.48	1.202	1.158
I liked to look for additional information to improve my knowledge about robotics				
I like to solve learning problems by myself				
I liked to solve problems during coding process by myself	2.91	3.44	1.050	1.101
I like to colaborate with my classmates in lessons	3.94	4.10	.988	.989
Collaboration skills with classmates				
Collaboration skills with teachers'	-	4.25		.788
I can use the gained knowledge in other activities	-	3.72	-	1.201

Questions that were asked only after the participation in the project activities, for example, whether students learned to program the robots do not have the comparison in the *before and after* aspect (see Table 8). The questions in the questionnaire were formulated in the following way: ***Activities with robots helped me to improve my:*** here students had to evaluate the offered versions using the principles of the Likert scale from 1-completely disagree to 5-completely agree. The obtained results confirm that students assess very positively both the improvement of knowledge in mathematics (mean 3.21) and physics (mean 3.05), but the highest assessment goes for "skills to program robots" (mean 3.89) and "Knowledge of information technologies" (mean 4.06). These results, too, serve as indicators allowing to draw the conclusions that the use of robots as agents of learning in the work with students exposed to the ESL risk brings results despite the rather short period of time when these activities were organised.

Table 8. **STUDENTS' OPINION ABOUT THE CHANGES AFTER ROBOTICS ACTIVITIES**

Robotic activities helped to improve:	**Mean**	**Std. Deviation**	**Variance**
Knowledge in math	3.21	1.166	1.359
Knowledge in physics	3.05	1.311	1.719
Knowledge of information technologies	4.06	.946	.895
Skills to program robots	3.89	.842	.709

Analysing the teachers' opinion about the changes that they see in students who had participated in the project activities allows concluding that there are no significant changes in teachers' opinions about differences in students' attitude to learning, their cooperation skills with other students and teachers. The mean has changed by 0.15 points (see Table 9). On the one hand, these results can be treated as negative because the changes are not significant but it also makes the researchers draw the conclusions which take into account the context in which the data were collected. Firstly, it has to be taken into account that the questionnaires were filled in by all teachers who worked with students exposed to the ESL risk but who themselves were not involved in the project activities. Secondly, it has to be remembered that activities with robots were organised in the extra-curricular format without introducing changes in the compulsory study process. Thirdly, the students' involvement in the project activities was rather short (3 months) and this is a very short period of time, especially if one has to work with students who are in the ESL risk group. Fourthly, students exposed to the ESL risk often have already developed a negative attitude to the compulsory teaching/learning process which is also expressed in their learning, attitude and behaviour during the lessons thus it does not allow teachers assess positively the changes in students because they are not so evident. Fifthly, it has to be remembered that all activities that are performed in the pedagogical process and especially in work with students who need a special support have a time-shift which means that they can appear after a longer period of time after performing these activities.

However, these results that cannot be assessed as significantly positive allow the researchers concluding that it is necessary to make radical changes in the compulsory study process so that encountering the ESL risks they are not worsened and therefore including more practical activities in which students themselves can be active and be responsible for their academic achievement because as students' answers show that working with robots they wanted to seek additional information thus becoming active participants of the learning process. It is necessary to give teachers additional pedagogical knowledge how to work with students who have low learning motivation, how to promote their interest to develop the achievement motivation. The results of teachers' surveys allow assuming that the use of non-human agents (Lego Mindstorm

robots in the frame of the project) gives results because students do not perceive them as teachers to whom they probably have developed a negative attitude.

Table 3. **TEACHERS' POINT OF VIEW OF CHANGES IN STUDENTS' ATTITUDE BEFORE AND AFTER ROBOTICS ACTIVITIES**

Descriptive Statistics:	Mean (before)	Mean (after)	Std. Deviation (before)	Std. Deviation (after)
Cooperates with classmates during lessons in a positive way	**3.54**	**3.71**	1.027	1.066
Is ready to join out of class/school activities together with other classmates	3.65	3.79	.979	.890
Is ready for work in lessons	3.58	3.68	1.056	1.140
Asks for help from teachers	3.14	3.30	1.032	1.028
Solves the learning problems by himself/herself	**3.30**	**3.50**	1.143	1.142
Solves conflicts in a calm way	**3.94**	**4.20**	1.072	.921

It is clear that a low socio-economic status, low learning achievements, grade retention, low learning motivation are all contributing factors to the risks of ESL, however, research on school leaving indicates that gender is one of the risk factors. Among early school leavers, men outnumber women by three to two. This is not surprising, given, on the one hand, the disproportionate concentration of boys among low-achieving students.

By using the methodology of ESL risk assessment criteria, to choose students that could take part in the projects' activities, on average 52, 5% more male students were involved in the project. It confirms the fact that has been proven in several previous studies, that boys are more exposed to risks of social exclusion. It poses a topical question, one that should be analysed in a wider context, in order to evaluate educational processes and how well are they suited for each gender.

Table 9. **STUDENTS OPINION ABOUT PARTICIPATION IN PROJECT ACTIVITIES**
(gender aspect)

	Gender of the student:		Learning process by using robots was exciting	I learned how to program the robots	I liked to work in groups during the robotic activities	Knowledge gained in the robotic activities can use in other subjects	Attitude to learning	Skills to collaborate with classmates	Skills to collaborate with teachers'
After robotic activities	**Girl**	Mean	4,47	4,11	4,42	4,26	4,00	4,21	4,42
		Std. Deviation	,612	,567	1,261	,733	1,000	1,084	,692
		Variance	,374	,322	1,591	,538	1,000	1,175	,480
	Boy	Mean	4,38	3,82	4,31	3,56	3,56	4,07	4,20
		Std. Deviation	,897	,904	,958	1,272	1,088	,964	,813
		Variance	,805	,817	,918	1,617	1,184	,929	,661

By analysing students' replies (see Table No 9), where they stated their opinion after their involvement in the projects' activities, it is evident that in all of the analysed parameters there are differences between male and female students answers. Regardless that the differences are minute, they attest that altogether female students' attitude towards learning is more positive than that of male students. The results approve that female students have a more positive attitude towards education. However let us not forget, that students involved in the activities are exposed to school leaving risk, which is why the lowest parameter for both genders was regarding the statement "Attitude to learning" (mean for girls 4, 00; boys 3, 56), which, in turn, can be explained by the fact that the activities were organized after compulsory classes, thus the students' attitude towards the learning process altogether is showing the least improvement. This comes to show that revision of compulsory learning is needed to make it more interactive and exploiting the possibilities of active learning approaches, for example, learning by doing. Early education leaving risks can be diminished by several aspects that were revealed in the course of this study. Risk group students often characterize the learning process as boring; on the other hand, they characterize learning by using robotics as exciting, which certainly can have a positive effect on students' willingness to continue their education. Another aspect that could promote the wish to continue learning is cooperation and sense of

attachment, belonging. This statement is proved by the results as both boys and girls were positive about cooperation in group projects (mean for girls 4, 42; boys 4, 31) and improvement of cooperation skills among students (mean for girls 4, 21; boys 4, 07). Results of this study indicate that a positive and encouraging learning process improves the girls' attitude towards programming, which, in turn, can influence their will to pursue IT in their future, which still is a largely gender disproportionate field. The most essential difference was shown at the statement "Knowledge gained in robotic activities can be used in other subjects" (mean for girls 4, 26, boys 3, 56), which attests to the concept stated in other studies, that boys have more difficulties to abstract the acquired knowledge in order to used it in a different context. The acquired results indicate a necessity for teachers to differentiate their learning methods, to utilize active learning approaches, to organize hands-on activities, in order to aid the boys to develop their ability to abstract and utilize the acquired knowledge in different learning situations, thus developing their meta-cognitive thinking.

Table No 10. **TEACHER OPINION ABOUT STUDENTS BEFORE AND AFTER PARTICIPATION IN PROJECT ACTIVITIES (gender aspect)**

	Gender of the student:		Solves the learning problems by himself/herself	Asks for help from teachers	Cooperates with classmates during lessons in a positive way	Is ready for work in lessons	Is ready to join out of class/school activities together with other classmates	Is involved in sport/art activities not connected with learning at school	Average
Before robotic activities	**Girl**	Mean	3,96	3,56	4,08	4,19	4,04	3,27	3.85
		Std. Deviation	1,110	,823	,647	,790	,824	1,216	
		Variance	1,232	,677	,418	,624	,679	1,478	
	Boy	Mean	3,14	3,03	3,40	3,43	3,56	3,37	3.32
		Std. Deviation	1,095	1,053	1,059	1,062	,992	1,224	
		Variance	1,198	1,108	1,122	1,128	,984	1,497	
After	**Girl**	Mean	4,00	3,81	4,10	4,24	4,05	3,39	3.93

robotic activities		Std. Deviation	,975	,846	,863	,900	,734	1,164	
		Variance	,951	,716	,745	,809	,539	1,356	
	Boy	Mean	3,35	3,16	3,60	3,52	3,72	3,46	3.46
		Std. Deviation	1,148	1,031	1,095	1,153	,918	1,149	
		Variance	1,317	1,063	1,199	1,330	,843	1,320	

The only parameter where girls show a lower result than boys, both before and after involvement in the projects' activities is "Is involved in sport/art activities not connected with learning in school", which altogether proves that boys wish for more activities where it is possible to get involved not only mentally, but physically as well. This aspect, regardless that it is not analysed in depth in the project, is highly informative. It enables us to pose a conclusion that the traditional learning process where the teacher is the main actor and the students are merely a passive audience is less suitable for male students.

During the first stage the average female student advantage (in teachers' assessment) is in five out of six parameters chosen for analysis, where female students' grades were 0, 64 points higher. During the second stage, after involvement in the project, the difference had reduced to 0, 57 points; however it cannot be regarded as a significant difference to pose assumptions regarding gender differences in the learning process using robotics activities working with ESL risk group students.

Students' answers illustrate gender differences in evaluating their attitude towards learning, working with robots, learning motivation and cooperation, because the results attest that male students tend to evaluate themselves more negatively than female students, which corresponds with evaluations done by teachers analysing them in a gender context.

The acquired data indicates that teachers tend to value female students' involvement in learning activities more positively, in problem solving, in cooperation with other students and teachers by asking them for help if it is needed, in willingness to get involved in learning. Regardless that there are no significant changes in students' average results, the fact, that in both the students' self-assessment and the teachers' opinions there is a difference between parameters characterizing the involvement of male and female students in the learning process, indicates a significance to devote special attention to this problem. It allows for an assumption to be made that girls are able to have a positive communication with the teachers, in turn, they get more positive feedback and/or grades and *vice versa*, teachers having a more positive attitude towards female students enables them to have a more positive self-assessment, which in turn diminishes the risks of ESL. To some extent, this proves the

assumption that teachers and their attitude can serve as a "push" factor and slowly repel male students from the educational system, especially male students exposed to risks of ESL.

Considering that male students are more exposed to risks of ESL, it is plausible that their risks were more evident or there was a combination of several risks that accumulated mutually, which is why it takes longer to overcome these risks than it does for the female students. Even though the results were acquired during a brief period of time and should be verified by carrying out a longitudinal research, they indicate to several potential problems, such as:

- It is plausible that there are significant problems in the pedagogical process – teachers have a gender-differentiated attitude towards students, which may be caused both by a lack of understanding of children and teenager development differences in gender context, or by problems in organization of the learning process, which is more suitable for female cognitive process organization peculiarities. The validity of the statement is proved by the fact that male students have a higher parameter of "is involved in sport/art activities not connected with learning in school", which indicates that male students have a need for active involvement, hands-on activities, which should be taken into consideration organizing the compulsory learning process.
- Teachers have no grasp of ESL risks and their impact on learning, in turn, they are unable to distinguish the, firstly minute, changes in the students' attitude and motivation. If students were positively encouraged for their efforts during compulsory learning activities, it would promote the development of their achievement motivation, thus diminishing the role of ESL risks.
- An assumption can be made, based on the results, that by utilizing positive motivation strategies in the robot programming process, girls also illustrate an attitude improvement towards programming.

Another aspect worthy of additional attention in future studies is social stereotypes, which may be one of the factors when evaluating students with a low socio-economic status, with special needs and/or with behavioural problems.

It should be emphasized that students involved in the project were chosen based on ESL risks, it means that the results could have been different if students, who are motivated to acquire new knowledge, with no learning problems and with a positive attitude towards the learning process, would have been involved in robotics activities. Taking this aspect into consideration the project group wish to emphasize that these results cannot be generalized and attributed to all students. To comprehend the special needs of ESL risk groups and how to differentiate the pedagogical process to diminish these risks, further, thorough projects and studies must be carried out.

The answers given by students about the participation in the project activities in the 1st and 2nd rounds were summarized and compared and the results are summarized in Table 11. The changes of the mean in the positive direction are observed in all the criteria included in the questionnaire. The mean in the 1st round was 3.28 (closer to the indicator 3, which meant "somehow agree"), but in the 2nd round the mean was 3.8 (closer to the indicator 4, which meant "mostly agree") that point to the conclusively positive results of the project activities. It is evident that the most significant changes are in the indicators: "I can use this knowledge in other activities", where the mean

change comes to 0.75 points, "cooperation skills with teachers", where the mean change is by 0.75 points, "I liked to look for extra information needed for using robots", where the mean change is by 0.71 point and "I liked to work in groups to do assignments with robots", where the mean change is by 0.66 points. All these changes cannot be considered statistically significant; however, it should be admitted that these results were achieved in three months' time when learning activities were organized in each of the rounds. These results show that the situation has improved in comparison with the 1st round and it can have several explanations: the competence of the teachers involved in the project and working with the students of the target group has improved; some students from the 1st round were engaged in the project activities in the 2nd round and having a longer participation they have assessed their gains more positively. Comparing the students' assessment of the impact that robotics activities have exerted on the school subjects it is clear that students both in the 1st and the 2nd rounds have valued the highest the influence on the ICT knowledge therefore the total increase in this indicator is not so evident. The greatest increase is in the indicator about the knowledge in physics where the mean increase is by 0.5 points.

Table 11. **STUDENTS' OPINION AFTER THE ACTIVITIES IN THE 1st AND 2nd ROUNDS**

	1st round		2nd round		differences
	N	Mean	N	Mean	
How old are you	62	15.27	80	15.13	
6.1. Learning by using robots was fun	62	4.13	80	4.40	0.27
6.2. I have learned how to program robots	62	3.52	80	3.89	0.37
6.3. I liked to work in groups to do assignments with robots	62	3.68	80	4.34	0.66
6.4. I liked to make calculations for programming	62	2.98	80	3.50	0.52
6.5. I can use this knowledge in other activities	62	2.97	80	3.72	0.75
6.6. I liked to solve problems with programming by myself	62	2.79	80	3.44	0.65
6.7. I liked that others helped me to solve problems with programming	62	3.68	80	4.05	0.37
6.8. I liked to look for extra information needed for using robots	62	2.77	80	3.48	0.71
7.1. knowledge of Math	62	2.81	80	3.21	0.4
7.2. knowledge of physics	62	2.55	80	3.05	0.5
7.3. knowledge of ICT	62	3.66	80	4.06	0.4
7.4. attitude to learning	62	3.24	80	3.66	0.42
7.5. cooperation skills with classmates	62	3.69	80	4.10	0.41
7.6. cooperation skills with teachers	62	3.50	80	4.25	0.75
	Average 1st round	3.28	Average 2nd round	3.8	

Further the teachers' opinions about the differences after the first and second rounds were compared and the results are summarized in table 2. 203 teachers expressed their opinion about students. A part of the criteria included in the evaluation questionnaire are formulated in such a way that positive tendencies are seen if the teachers have

chosen higher levels in the scale from 1 to 5. The total changes in the mean indicators were from 2.88 in the criteria in which a higher assessment level is assessed positively (closer to the indicator 3, which was *sometimes*) in the second round and it was 3.68 (closer to the indicator 4, which was *often*). Assessing the second part of the criteria, the improvements of the situation can be assessed as positive if the teachers have assessed them with a lower value in the scale from 1 to 5. The mean indicator in these criteria in the first round was 2.24 (closer to the indicator 2, which was *rarely*), but in the second round the mean indicator of these criteria was 1.46 (between 1, which was *never* and 2, which was *rarely*), thus it is possible to conclude that on the whole the results are convincingly positive.

The greatest improvements in the teachers' opinion is in the behaviour criteria which proves that students' participation in the teaching/learning process has increased and their attitude to learning has become better. The answers about students were given not only by teachers who participated in the project activities but also by teachers who work with these students only during the compulsory teaching/learning process. Teachers were more sceptical about the changes in students' attitude after the first round but the results of the second round confirm that changes in students' behaviour and attitude have been noticed and approved. There are significant changes in the criteria: "Following the behavioural rules in the classroom", in which the mean has increased by 1.11 points, "Readiness to join out- of-class/school activities together with other classmates", in which the mean has increased by mean 0.97 points. As regards the criteria with a positive mean decrease the results have improved most significantly in the following indicators: "Aggressiveness to teachers", in which the mean has decreased by 1.05 points and the criterion "Using rude language with teachers", in which the mean has decreased by 0.96 points.
The obtained data prove that according to teachers the students' ability to accept and follow different rules during the organization of the teaching/learning process has improved significantly, which, probably is connected with students' motivation because the use of Lego robots has made the teaching/learning process more interesting and students perform the classroom regulations more willingly. These changes in the context with students exposed to the ESL risks is a considerable improvement because these students usually are passive and do not participate in the out-of-class activities; besides, the formation of new friendship relations and their strengthening can promote the students' motivation to stay in the education system. This allows concluding that students' behaviour and attitude to teachers has become more positive after the project activities. It should also be mentioned that students exposed to ESL risks often have a negative attitude to teachers and thus it is possible to maintain that the methodology and content used in the project diminishes the ESL risks because this attitude has improved considerably. The statement "Is ready for work in lessons" (the mean after the 1st round – 2.76; after the 2nd round – 3.68; the difference 0.92) assessed by the teachers also proves that students on the whole have become more motivated to engage in the learning process.
The least improvement in the teachers' assessment about the students was found in the problem solving area which is confirmed by the statements "Asks for help from teachers" (the mean after the 1st round - 2.87; after the 2nd round - 3.30; the difference 0. 43) and "Solves the learning problems by himself/herself" (the mean after the 1st round 2.93; after the 2nd round – 3.50; the difference 0.57). Basing on the results it is

possible to conclude that students engaged in the project use different evasion strategies instead of solving their problems. The third lowest achievement during the project according to teachers goes with the statement “Is ready to do extra assignments to improve achievements” (the mean after the 1st round – 2.74; after the 2nd round – 3.46; the difference 0.72).

Table 12. **TEACHERS' OPINION AFTER THE ACTIVITIES IN THE 1st AND 2nd ROUNDS**

	1st round		2nd round		
	N	Mean	N	Mean	differences
Preparation of homework assignments	203	2.70	278	3.58	0.88
Cooperation with teachers in a positive way	203	3.07	278	3.92	0.85
Cooperation with classmates during lessons in a positive way	203	2.96	278	3.71	0.75
Readiness for work in lessons	203	2.76	278	3.68	0.92
Understanding of the connection between learning and achievements	203	2.85	278	3.68	0.83
Readiness to do extra assignments to improve achievements	203	2.74	278	3,46	0,72
Following of the behavioral rules in the classroom	203	3.05	278	4.16	1.11
Readiness to join out-of-class/school activities together with other classmates	203	2.82	278	3.79	0.97
Readiness to join activities led by other classmates	203	2.77	278	3.58	0.81
Motivation to learn the subject you teach	203	2.86	278	3.73	0.87
Motivation to understand his/her mistakes to correct them	203	2.90	278	3.70	0.8
Motivation to improve achievements	203	2.80	278	3.64	0.84
Motivation to overcome difficulties in learning	203	2.81	278	3.62	0.81
Readiness to works hard to achieve the aim	203	2.70	278	3.55	0.85
Beeing late for the beginning of lessons	203	2.25	278	1.62	0.63
Problematic behaviour during recess (break)	203	2.22	278	1.53	0.69
Aggressiveness to other students	203	2.28	278	1.42	0.86
Aggressiveness to teachers	203	2.26	278	1.21	1.05
Using rude language with classmates	203	2.19	278	1.49	0.7
Using rude language with teachers	203	2.18	278	1.22	0.96
Rejection to do assignments during the lessons	203	2.26	278	1.59	0.67
Aggressive reaction in situation of conflict	203	2.30	278	1.58	0.72
Solves the learning problems by himself/herself	203	2.93	278	3.50	0.57
Asks for help from teachers	203	2.87	278	3.30	0.43

Solves the conflicts in a calm way	203	3.37	278	4.20	0.83
			278	3.81	
Readiness to reach learning aims	203	2.87	278	3.45	

The obtained results allow drawing the conclusion that the use of robots as agents is successful to change the attitude of students exposed to the ESL risk, to promote the development of the learning motivation and problem solving skills despite the fact that students were involved in these activities only for three months on average (1-2 times a week) which is a very short period of time to achieve significant changes in students' attitude and motivation.

Although there could be critical remarks that students' motivation in the compulsory and non-formal learning process cannot be compared because the context is different, the working with robots was organized after the lessons and students did not have the obligatory tasks that are marked it still makes the researchers think about the organizational principles of the compulsory teaching/learning process that creates a negative attitude to it in students.

Changing the organizational principles of the teaching/learning process, engaging students in an active study process and changing the hierarchy of student-teacher relations using robots as agents of learning, changes in students' attitude to learning are attained and students' learning motivation is improved. This leaves a positive impact on the ESL risks because it shows students that the learning process can be interesting and meaningful, that the teacher can be a cooperation partner. This allows hoping that the ESL risks of the students involved in the project have decreased.

It would be advisable to seek possibilities how to use robots (or other non-human agents) in the compulsory teaching/learning process in order to change the responsibility focuses in reality from the teacher who is responsible for the organization of the teaching/learning process to the student who is responsible for the construction of his/her knowledge.

A robot can be used in the teaching/learning process not only as a non-human agent of learning but also as a learning tool because it helps to improve the student's knowledge in different school subjects – not only in the science subjects but also arts and social subjects, e.g., English, geography, etc. because the focus of the developed curricula is for students to solve real life problems while constructing and programming the robots. Robots as a learning tool help to implement the immediate feedback which the students need in practice in order to form the awareness about the construction of knowledge as a personally significant process.

The fact that students acknowledge the positive impact of working with robots but teachers who are together with students only during the compulsory teaching/learning process assess this impact as less significant can be explained by the situation that a small number of teachers was involved in the project activities with students but the answers were provided by all teachers. The teachers who work with students on everyday basis during the compulsory teaching/learning process without changing either the content of learning or the teaching methods can take no notice of fast changes in students' attitude because the time period was too short and they had already formed a concrete attitude to students exposed to ESL risk. Another aspect

that has not been verified in this research but which cannot be excluded is that teachers treat students who are exposed to ESL risk more negatively thus, to a certain extent, even making these ESL risks stronger and teachers find it difficult to change their attitude if they themselves are not involved in the process of changes and do not see the capacity and readiness of these students to act if they are ensured such a possibility.

This, in its turn, creates challenges in the further process of acquiring education for students who do not feel accepted, whose learning motivation is low and who have experienced that it is possible to learn differently. This, to a certain extent, can even intensify the impact of risks if there are no all in all changes.

Many countries give more and more importance to the improvement of teachers' pedagogical competence in teacher education, laying more emphasis on the subject knowledge but this creates even new exclusion risks. If teachers do not know how to use the latest research developments, technologies and technological solutions to motivate all their students not only those who are inquisitive and motivated then their use can create only new groups of those who are excluded.

Further are analysed the teachers' answers given in the survey developed for the project needs in which teachers had a possibility to express freely their opinion about the developed curricula. At first, teachers were asked to give information about the country they represented, the project school they worked at and which of the developed curricula they used in their work with students. This was followed by open ended questions, e.g.: "*Please briefly describe your students' interest in activities provided during all Robotics lessons"; "Which activities did they like the most?"; "Which activities did they not like?"; "Which activities were challenging for them? How was it solved?"; "What worked well? Why did it work well?"; "What did not work well? How did you cope with it?"; "Did you observe some aspects which showed that students' motivation to learn rose during the project? What kind of aspects can you name?"; "What kind of difficulties did you face regarding the work of your students with robots during the Project?"; "What kind of difficulties did you face regarding the cooperation among the students during the Project?"*

Positive assessment was received from teachers that points to the Strengths of the project, like the following:

The interest was generally high. For several students this is almost remarkable because in the normal school's life they show normally very little interest.

The implementation of the majority of our activities worked well. The preparation of the project helped a lot. One reason for that is that we avoided lots of theory and focused on practical activities.

The following examples show the assessment that indicates the Weaknesses:

As soon as the task became more difficult, the students lost their interest (for example, what is the magic number, etc.) It`s strange that students didn`t want to think how to dress the robot in an interesting way in order to make it dance.

The children didn`t like tasks where they have to make calculations, the tasks where a great accuracy was needed.

*Challenge was in the project **Go to park** how to go into the first vacant garage and to understand the cycle of the program, because it is not taught to 11-12 years old children.*

Some examples to point to the Threats:

They didn't like the tasks they failed and which contains logical conclusions.

The students didn`t like the theory, they wanted to experiment themselves.

The challenge was tasks, in which a teacher pushed pupils to search solutions by themselves without given sample.

Students were looking for solutions by experimentation and on the Internet.

OSERVATION RESULTS (1st and 2nd round)

Indicators: 0 – can't be observed; 1 – low level ; 2 – can be observed almost in all situations; 3 – can be observed during all Project; 4 – does more than expected

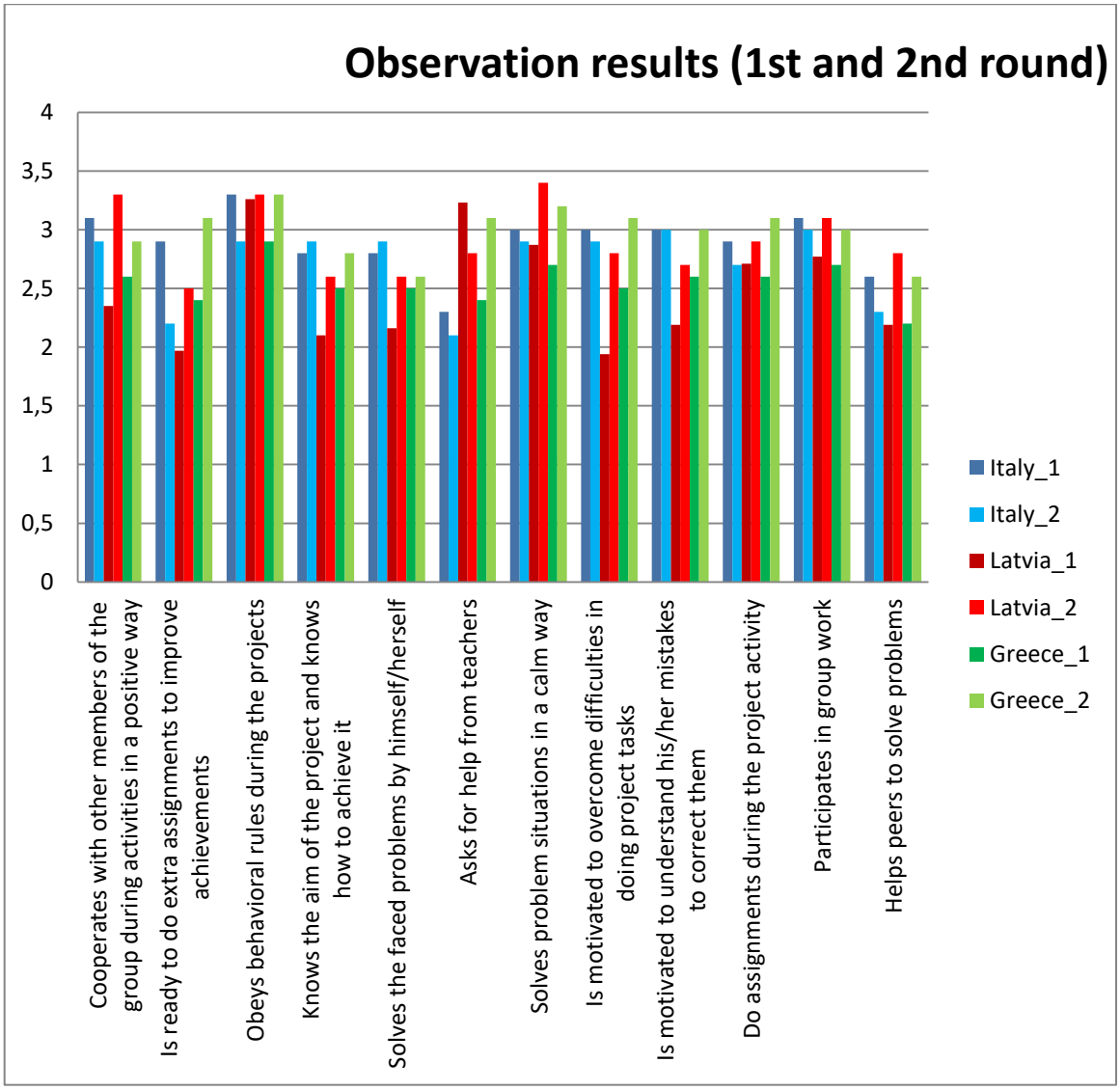

Fig 2. **OBSERVATION RESULTS 1st and 2nd round (Countries comparison)**

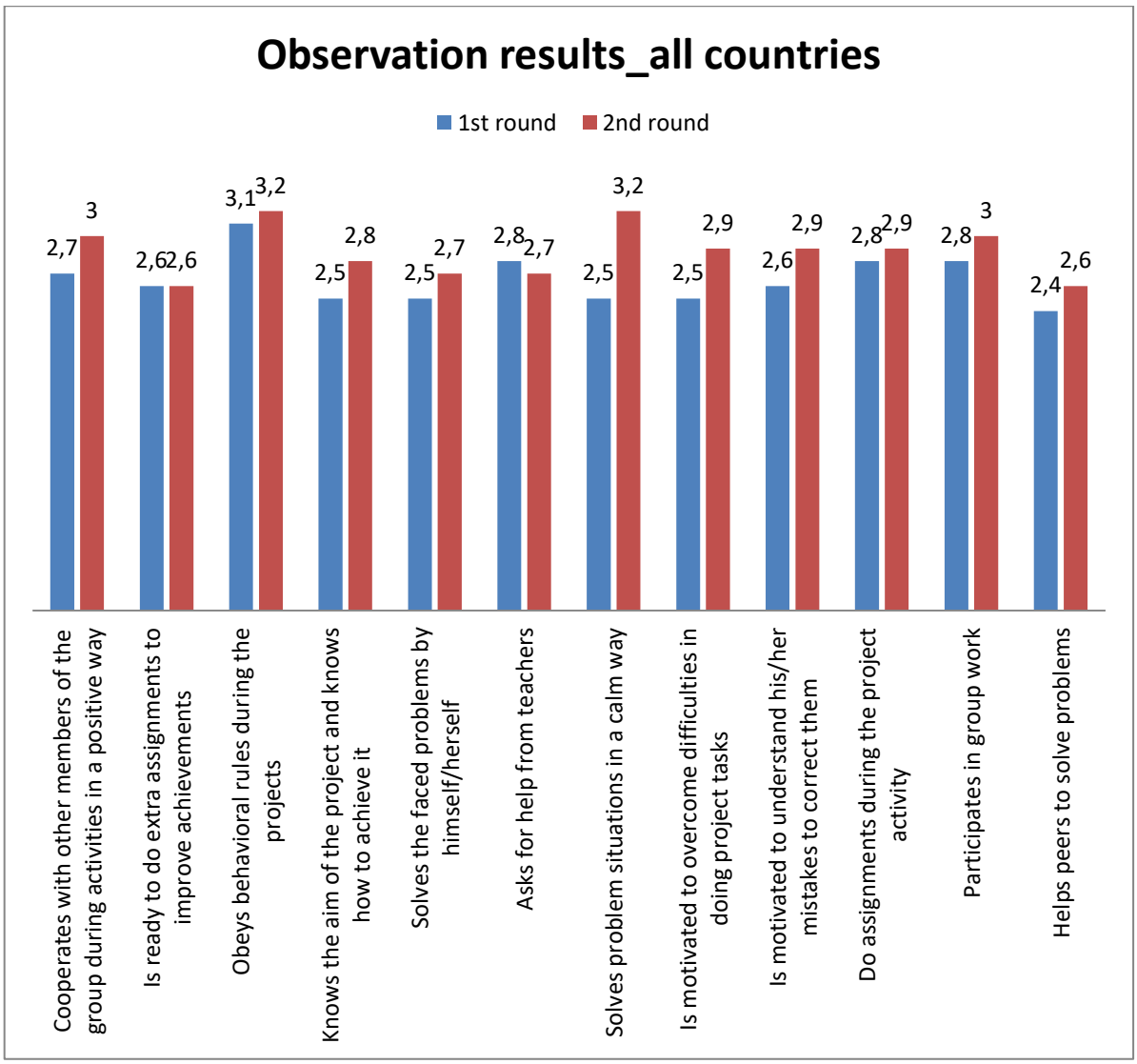

Fig.3 OBSERVATION RESULTS_ 1st and 2nd round

TEACHERS ANSWERS ABOUT STUDENTS MOTIVATION DURING THE PROJECT

Some students were asking for more information (mainly about robotics, competitions, further development, etc)
Yes. 1. Students came after school hours (the majority of them) in order to complete the programs we had planned to do (school year: 2015-2016) 2. Students helped in the preparation of our participation in Athens Science Festival and six of them were in the Festival for about 8 hours, where they demonstrated and explained to visitors the programs they had made (school year: 2015-2016) 3. Three of the students that participated in our last year's 1st implementation were teachers in our three workshops attended by 31 elementary school pupils and some of their teachers this year (school year: 2016-2017) 4. Students of this school year implementation are volunteers to present some of the roboesl activities in workshops to cubs' scouts at our

lab (we made arrangements with the neighboring scouts to make at least one workshop)
They wanted to complete their robotic activities and to participate in the creation of a presentation video concerning their tasks (those who are fluent in English spoke while the others helped in video and presentations).
It is difficult to see in such a short period significant change of students behaviour and attitude. However, the students could work as a team, the eldest helping the youngest.
It is difficult to see in such a short period significant change of students behaviour and attitude.
I think not all students increased their motivation to learn in so short time. But obviously they are more interested in engineering, have learned to solve problems and to work in groups.
The main achievement was students ability to work in groups helping each other. Eldest helped the youngest.
It`s difficult to judge. The period of time was short.The classes were at the end of the studying year, according to this we can`t see the dynamics of success.
We observed the involvement of the students; they worked independently looking for the solution and they didn't give up easily
During the project students showed increasing autonomy and initiative in coding and searching originals solutions.
Very interesting was the the time that students spontaneously dedicated to compare their opinions and their solutions
The most impressive thing was the interest which several student showed for some activities during the project. A lot of them showed a real interest towards a school acitivity for the first time.
They were definitely interested in Natural Sciences.There were not many students with studding difficulties in my group who need to raise motivation for studding. There were students- an autist, the children who had problems with communication and seclusion. They became more open and presented their tasks with a proud.
The project stimulates to develop skills in information technology and maths. The students improve their skills by working in a team, teaching and helping each other to do the task to the end.

CONCLUSIONS

It is possible to use the robotics activities to achieve changes in students' attitude to learning, to increase their motivation to learn and to participate in the solution of problems; however, several conditions should be taken into consideration:

1. It is necessary to explore students' values, attitudes and special needs so that when organizing (although pedagogically correct) teaching/learning process it would not promote either the students' exclusion or the development of the "evasion" motivation that can increase the early school leaving risk even more.
2. To include in the teaching/learning process aspects that promote the development of students' sense of self-efficiency which is especially important for students with low learning motivation.
3. Always to give students the feedback about the work done and to promote the students' participation in self-assessment in order to facilitate students'

understanding about the connection between one's learning and the academic achievements.

4. To show students how the acquired knowledge and skills can be applied in the real life (e.g., starting one's own blog) thus decreasing the early school leaving risk.

The obtained results allow drawing the conclusion that the use of robots as agents is successful to change the attitude of students exposed to the ESL risk, to promote the development of the learning motivation and problem solving skills despite the fact that students were involved in these activities only for three months on average (1-2 times a week) which is a very short period of time to achieve significant changes in students' attitude and motivation.

It would be advisable to seek possibilities how to use robots (or other non-human agents) in the compulsory teaching/learning process in order to change the responsibility focuses in reality from the teacher who is responsible for the organization of the teaching/learning process to the student who is responsible for the construction of his/her knowledge.

A robot can be used in the teaching/learning process not only as a non-human agent of learning but also as a learning tool because it helps to improve the student's knowledge in different school subjects – not only in the science subjects but also arts and social subjects, e.g., English, geography, etc. because the focus of the developed curricula is for students to solve real life problems while constructing and programming the robots. Robots as a learning tool help to implement the immediate feedback which the students need in practice in order to form the awareness about the construction of knowledge as a personally significant process.

The fact that students acknowledge the positive impact of working with robots but teachers who are together with students only during the compulsory teaching/learning process assess this impact as less significant can be explained by the situation that a small number of teachers was involved in the project activities with students but the answers were provided by all teachers. The teachers who work with students on everyday basis during the compulsory teaching/learning process without changing either the content of learning or the teaching methods can take no notice of fast changes in students' attitude because the time period was too short and they had already formed a concrete attitude to students exposed to ESL risk. Another aspect that has not been verified in this research but which cannot be excluded is that teachers treat students who are exposed to ESL risk more negatively thus, to a certain extent, even making these ESL risks stronger and teachers find it difficult to change their attitude if they themselves are not involved in the process of changes and do not see the capacity and readiness of these students to act if they are ensured such a possibility.

Many countries give more and more importance to the improvement of teachers' pedagogical competence in teacher education, laying more emphasis on the subject knowledge but this creates even new exclusion risks. If teachers do not know how to use the latest research developments, technologies and technological solutions to motivate all their students not only those who are inquisitive and motivated then their use can create only new groups of those who are excluded.