The Role of Robotics in Promoting the learning motivation to Decrease the Early School Leaving Risks

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Abstract: The activities of robotics for promoting the learning have been used in the world for a rather long period of time; however, in most cases they are applied in work with children and young people who have profound interest in electronics, mechanics, etc. while at the same time they are rather seldom used to involve students whose learning motivation is low, who have difficulties in particular school subjects and who can be considered the risk group for early school leaving. The university researchers and practicing teachers from several countries (Italy, Greece, and Latvia) are cooperating in the Erasmus+ project, the aim of which is to apply the learning activities of robotics to decrease the early school leaving risk. This priority was put forward because the project partners are convinced that the traditional learning strategies, the monotonous teaching/learning content and outdated pedagogical approaches that teachers are still using in their work is one of the reasons that creates these early school leaving risks. In order to solve this situation it is offered to verify how the robotics activities promote students' learning motivation, the willingness to improve their academic achievement and what teachers should take into consideration to promote it not only in children with the desire for high achievement but also in children who face difficulties in learning in the traditional educational process thus decreasing the early school leaving risks.

Key words: Learning activities of robotics, teaching/learning motivation, early school leaving

1 About the project

The project implementation is planned for 24 months and it was launched in October 2015. Nine partners from Italy, Greece and Latvia are involved in the project implementation. The main focus is laid on students who belong to the social exclusion risk group and who face a high risk of early school leaving. In order to attain the aim set in the project – to decrease the early school leaving risk criteria were developed to select such students with whom to work in future applying the activities of robotics. The criteria included the ones connected with the processes going on in the student's family and which could influence the student's motivation to learn as well as the ones that characterize the student's attitude to the study process, for instance, low academic achievement, behaviour problems, interaction problems, avoidance of doing the home assignments, etc. These selection criteria were given a concrete number of points and the task of schools was to select students who had the highest risk of early school leaving for the participation in the project activities which to a certain extent is also the project risk because the application of the activities of robotics in the students' group with low learning motivation has not been widely used so far and thus positive outcomes are predictable but they are not guartanteed, especially in such a short period of time because the impact of different programmes is observed with the displacement of time which means that positive outcomes most frequently are observed after a longer period of time. This is also one of the challenges for the project to show that activities of robotics are successfully applicable also in this target group. The second important activity in the project was the development of the teaching/learning content taking into consideration the fact that students who are involved in the activities of robotics have low learning motivation and their attitude to learning is negative. All in all ten robotics modules of learning that included such aspects of the learning process as the improvement of the mathematics, physics and computing competence as well as cooperation skills, social emotional competence and problem solving competence have been developed. The main emphasis in the teaching/learning modules is laid on students' practical activities with Lego Maindstorms robotics sets and the teacher functions as the adviser in the teaching/learning process who guides the students' activity.

2 Research methodology

In order to verify whether the aim set in the project – to decrease the early school leaving risk has been reached and the learning motivation of the involved students has increased several research tools have

been developed that were filled in both by the students and the teachers. ***Students*** had to fill in the questionnaire before and after the participation in the project activities. Questions in both the questionnaires were formulated in a different way and it had several reasons – to avoid a situation that students give the same asnwers both before and after the project activities and the second reason was purely practical, for initially students participated without actual knowledge of robotics; they did not know how learning would take place and what activities would be included in the lessons therefore the questionnaire that had to be filled in before the participation in the activities asked for the students' attitude to learning, about their learning motivation and problems they faced in everyday learning process. After the participation in the project activities students again were asked to fill in the questionnaire in which some questions though formulated differently contained the same idea that was expressed in the initial questionnaire in order to compare whether there had been changes in the students' attitude while other questions were formulated so as to receive answers related to concrete robotics activities and to find out how students assessed their progress. For instance, whether students consider that they had improved their knowledge in mathematics. The statements included in the questionnaire had to be assessed using the Lickertt scale where 5 meant – fully agree and 1 – fully disagree.

Teachers were asked to fill in several research instruments:

1. The evaluation of student's risks, in which teachers had to provide information about the level of student's academic achievement, the missed lessons, the special needs and the subjects in which the student had the highest and the lowest academic achievements. Teachers were asked to fill in the evaluation about the student's special needs only at the beginning of the project informing whether the student had any of the special needs; teachers had to give the rest of the information both before and after the robotics activities in order to receive precise information about the average assessment and the number of missed lessons to be able to record changes in students' academic achievements and thus draw conclusions about changes in the learning motivation.
2. The evaluation of students' attitude to learning, motivation and problem solving strategies before and after the robotics activities. The statements included in the questionnaire had to be assessed applying the Lickertt scale where 5 meant – observable in all situations, and 1- not observable in any of the situations (in the questionnaire before students' involvement in the robotics activities) and 5 – considerable improvements are observed in all situations and 1 – no improvements are observed in any of the situations (in the questionnaire after students' participation in the robotics activities). Teachers filled in the assessment about students after their participation in the robotics activities about 203 students although a greater number of students had been involved in the activities. This questionnaire was necessary to record changes in students' attitude because it had been predicted that probably it would not be possible to observe essential changes in the academic achievements.
3. Structured observation in which teachers had to evaluate students' attitude to learning, motivation and problem solving strategies during the implementation of each particular teaching/learning module of robotics when teachers had to assess students' different actions on the Lickertt scale from 0 to 4, in which 4 meant – does more than it is expected from him/her and 0 meant – the activity is not observed. This observation was necessary in order to state changes in students' attitude in dynamics as well as to understand whether the developed teaching/learning modules were appropriate for the students included in the early school leaving risk group.
4. The assessment of the introduction process of the robotics activities in which teachers could freely express their thoughts about the whole process giving answers to 10 questions aimed at assessing teachers' opinion about the developed teaching/learning modules, the solutions that were used handling different challenges as well as the understanding if the developed teaching/learning modules corresponded to the students of the project target group.

3 The role of robotics in the motivation change during the teaching/learning process

The teaching/learning process in school is complex and often rather unclear for students. For students to have the willingness to learn and improve their competences their own involvement plays an important role which is also significant for the development of motivation as one of the main factors so that students are actors of their cognitive development thus decreasing the early school leaving risks.

Different studies on students' motivation to get involved in the learning process have been performed which in the majority of cases concentrate on the individuals' desires and needs and applying bot rewarding and punishment system as the key driving force of motivation. During the last 30 years the socially cognitive view on motivation has dominated which means that the individual's conviction about his/her abilities, the desire for achievement, assumptions about the level of intellectual capacities and the conviction about the individual's ability to influence his/her academic achievements [2].

The sense of self-efficiency is the one that, on the one hand, influences the behavior and attitude to what is happening around and, on the other hand, the behavior and things happening around exert impact on the individual's sense of self-efficiency. Students who feel higher self-efficiency get more involved in the learning process and are more successful in self-regulation (they set aims, apply more effective strategies for the attainment of their aims, evaluate their own learning and assess their achievements) as well as they are able to organize effective learning environment (they eliminate or lower the impact of disturbing factors, choose effective partners in learning, etc.). However, self-efficiency can be influenced also by the expressions of behavior and happenings in the surrounding environment (teachers' assessment, social comparison with the peers) [2]. Bandura (1997) also maintained that the individual summarized information in order to measure one's self-efficiency both interpreting and comparing one's performance with that of other people and modelling one's performance [3]. Yet it is also important to remember that the sense of self-efficiency is the one that develops and if the student due to any reasons fails in the learning process then the sense of self-efficiency does not develop. It is particularly topical if the students have some objective reasons that hinder the development of the sense of self-efficiency, e.g., the social economic conditions in the family, or the student's special needs that influence the student's motivation to overcome different difficulties resulting in gradual alienation from the teaching/learning process, and which leads to early school leaving.

The recent studies on motivation have focused on the development, ecological and socialization factors that can influence the individual's motivation. It is clear that motivation is closely connected with academic achievement and thus also with overcoming different obstacles that can be both considered as the social exclusion risks, the learning difficulties and the personality features that play a certain role in the teaching/learning process and, on the one hand, can influence students' motivation and, on the other hand, these factors themselves are motivating for overcoming the obstacles or for the selection of evasion strategies that is one of the key problem factors in education because students whose chief motivation is evasion are hard to be involved in different activities despite the fact whether these activities are really exciting because their conviction is based on the idea that they are not able to achieve higher levels. Teachers find it very hard to overcome such obstacles.

Along the changes in the paradigm of education when the emphasis to a great extent is put on active involvement of students in the learning process and the new competences necessary for the 21st century the education environment needs to change as well. The use of technologies sometimes is mentioned as one of the solutions. It is claimed that technologies promote children's interest, motivation and creativity because the child becomes the centre of learning. The child himself has to act, to seek solutions and construct his knowledge. When introducing the robotics activities in the teaching/learning process this aim has been reached because the recent studies in education prove that the application of technologies in the teaching/learning process increases students' motivation [9], [4], [10]. These studies resulted in the conclusion that students who were more motivated to learn were also the ones who would be more ready to participate in the robotics activities, to perform more difficult tasks and to cope with different challenges than those students whose learning motivation was low. The task of this project is to search for the solutions how to develop the sense of self-efficiency, to facilitate the learning motivation in those students whose motivation can be described as the evasion motivation.

S.Papert (1993) in his research proved that students were able to make and program robots themselves in order to acquire new skills; however, teachers need to remember the key principles of the formation of motivation [8]. R. A. Emmons (1989), analyzing the conditions of the formation of motivation has worked out the "Hierarchy of aims" and in the first (highest) level he places the motives to be an educated person which is followed by the personality features in the next level which in his understanding means the willingness to achieve the set aims [5]. R.A.Emmons also points out that the willingness to achieve the aims has to be viewed in the context with the desire for success therefore he mentions the desire for success as the next level on which all the higher levels are based [5]. He places

the activities which the individual chooses to perform in order to achieve these aims and specific tasks (e.g., to plan time for a certain activity, to search for additional information that helps to solve some task, etc.) as the foundation for all this hierarchy of achieving the aims. This allows considering that working with robots can be both – the aim to achieve something and the aim can be also to master the working with robots. It is not important from the point of view of motivation what the individual student's highest aim is which he wants to reach in the concrete period of time and the desire for success functions as the driving force to overcome different obstacles in the learning process which consequently also decreases the early school leaving risks.

It is also important to remember about the aims of motivation when one is willing to diversify the teaching/learning process and introduce work with robotics in it. Comparing the researchers C. Ames (1990) and M.L. Maehr & L.A.Braskamp (1986) whose theoretical motivation models are based on the idea about two important aims, one of which is to improve one's skills and knowledge, and the other aim is being able to apply the acquired skills and knowledge and C.Migdley & T.Urdan's (2001) approach about three important aims in which the improvement of skills and knowledge and their application in practical action is supplemented with such an aim as evasion which the author explains as the willingness to evade from the application of one's knowledge and skills in order not to seem less competent than others [1], [6], [7]. Thus it is possible to conclude that the aims of motivation include not only the desire for achievements and their application but also the students' willingness to evade from the improvement of knowledge and skills and their application has to be taken into consideration which can actually serve as a challenge for teachers when introducing new approaches in the teaching/learning process that initially students make themselves interested but in a longer period of time they may become challenging as there is greater need for students' involvement both when acquiring new knowledge and applying them in practice but for students whose learning motivation is underdeveloped and whose main motivation is connected with evasion a simple change of pedagogical strategies as such does not give much. This asks for thinking that it is necessary to work out strategies to lessen such evasion and to motivate students for setting the aims and for activities that will help to achieve the set aims which is important for a successful learning process. One of the recommendations is to establish a positive learning environment and to focus on students' strengths in order to show them that the set aims are attainable and then gradually moving towards more complex tasks, at the same time providing the feedback on what has been achieved and what still needs improvement. At present schools put more emphasis on finding the mistakes that increases the evasion strategy and influences students' choices- to learn what is easier and to oppose those learning activities which require a longer span of concentration, perseverance and the positive results take time to be achieved.

4 Findings

The project involves three countries (Italy, Greece and Latvia) and 7 general comprehensihe education institutions. When launching the project activities the assessment of attitude and motivation was performed on 270 students but the final evaluation instruments were filled in for 203 students. The working with robotics activities in the first stage lasted from February till May, 2016 (in Greece in some schools till April). The project programme intended that students implemented 10 different modules of learning robotics in an increasing level of difficulty; however, students managed to implement only 3 modules till the end of the academic year. This has several reasons: firstly, teachers who have to work with the developed modules are not familiar with them therefore time is needed for the teachers themselves to master the teaching of robotics activities. Secondly, students who are in the early school leaving risk group, which means that their attitude to learning is negative and their learning motivation is more characterized as the "evasion" motivation are involved in these activities therefore more time is needed for those students to master the necessary knowledge for the programming of robots in a positive atmosphere. If students with low or "evasion" motivation have to do something at a speed that does not correspond to their speed of perception then such activities can only exert negative impact on the development of the learning motivation and even strengthen the early school leaving risks because when facing difficulties these students get "approval" that learning is difficult, thus their sense of self-efficiency gets lower and it leads to the formation of the vicious circle when the teachers try to work more with these students who belong to the risk group but these activities push back these children and young people more and more from education as a result.
The present article analyzes the data that have been collected from the students and teachers' survey after the participation in the robotics activities.

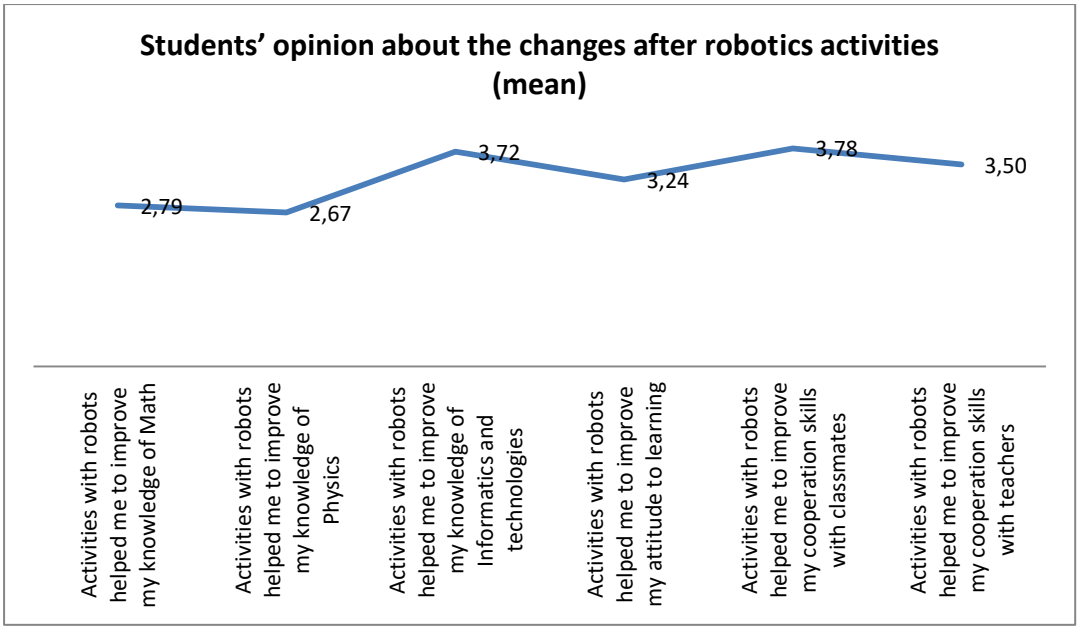

Fig. 1. ***Students' opinion about the changes after robotics activities (****1– completely disagree, 2 – rarely agree, 3 - somehow agree, 4 – mostly agree, 5 – completely agree)*

The analysis of the summarized results (see Fig. 1) about the changes the students see after the working with robots allows concluding that students see the greatest changes in their cooperation with classmates (the mean is 3.78), students indicate the changes in their knowledge in informatics as the second greatest change (the mean is 3.72) and they have marked their cooperation with the teacher as the third highest (the mean is 3.5), which means that in the majority of cases the answers came closer to the version that students agree to a great extent that changes have taken place. The findings prove that using robots in the learning process it is possible to achieve changes in students' attitude to learning and learning motivation because mutual interaction with the classmates and teachers points both at the openness of the young people belonging to the target group to the acquisition of knowledge as well as the positive impact of performing practical activities, because when working with robots students had to learn in practice how to program them and therefore they had to master different knowledge in mathematics, physics and computing in order to teach robots to do what had been intended in the particular teaching/learning module.

Table 1 ***Descriptive statistics – teachers' opinion about the changes in students' attitude (mean)*** *(1– completely disagree, 2 – rarely agree, 3 - somehow agree, 4 – mostly agree, 5 – completely agree)*

Descriptive Statistics

	N	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error
Preparation of homeworks	203	2,70	1,231	,227	,171
Cooperation with teachers in a positive way	203	3,07	1,167	,035	,171
Cooperation with classmates during lessons in a positive way	203	2,96	1,127	,067	,171
Readiness for work in lessons	203	2,76	1,191	,272	,171
Understanding of the connection between learning and achievements	203	2,85	1,178	,282	,171
Readiness to do extra assignments to improve achievements	203	2,74	1,224	,322	,171
Following the behavioral rules in the classroom	203	3,05	1,242	,063	,171

Readiness to join out of class/school activities together with other classmates	203	2,82	1,109	,279	,171
Readiness to join activities led by other classmates	203	2,77	1,148	,305	,171
Readiness to reach learning outcomes	203	2,87	1,242	,302	,171
Motivation to learn the subject you teach	203	2,86	1,278	,304	,171
Motivation to understand his/her mistakes to correct them	203	2,90	1,286	,298	,171
Motivation to improve achievements	203	2,80	1,286	,346	,171
Motivation to overcome difficulties in learning	203	2,81	1,285	,393	,171
Readiness to work hard to achieve the aim	203	2,70	1,271	,498	,171
Valid N (listwise)	203				

Analyzing the answers given by teachers after students' working with robotics activities (see Table 1) it is possible to conclude that teachers see the greatest changes in the indicators "cooperates with teachers" (the mean is 3.07) and "observes the rules of behavior" (the mean is 3.05). Although the observance of the rules of behavior seems not to be directly related to the learning motivation still it is one of the primary indicators that students' motivation is connected with the willingness to participate and in a dependent way indicates to the changes in the learning motivation that is very intrinsic for students facing early school leaving risk.

5 Discussion

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. The students' level of preparedness, their ability to keep the attention and the interest in the activities that need to be performed have to be taken into consideration otherwise students' motivation can decrease because when facing difficult tasks students whose learning motivation up to the present has been more expressed as the evasion motivation can find robotics tasks even more complicated and thus the evasion motivation will develop even to a greater degree.
2. 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.
3. 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. This means that it is necessary to use meaningful praising and encouragement in the pedagogical process especially with children who belong to the social exclusion risk group.
4. 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.
5. To show students how the acquired knowledge and skills can be applied in the real life (e.g., starting one's own blog) to promote students' motivation to learn thus decreasing the early school leaving risk.
6. Students' progress has to be continuously evaluated and changes in students' attitude have to be evaluated as well in order to assess whether the offered learning activities do not promote the lowering of students' sense of self-efficiency.
7. It is also important to understand whether the robotics tasks (or any other technology tasks) are used in order to learn by using other resources or students are ensured the possibilities which otherwise can not be ensured. It is important to remember that technologies without definite pedagogical strategies give only a short-term effect because students for some time find it interesting. If the

teacher has clear strategies that promote learning and knows what and how to apply them then technologies, including robotics activities can become a significant additional resource for promoting academic achievement. It is important to remember that actually the essential thing is not how comfortably the teacher feels when using the technologies but the students' cognitive and social progress because there is no such money in the world to ensure the professional development to all teachers with all possible technologies that nowadays are available.

It is absurd to simply put technologies in the class/school without changing anything in the learning process. It is necessary to concentrate on the changes in the learning process itself in order to ensure a developing educational environment using technologies. /S. Papert/ [8]

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