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Educational Robotics in the Stage of Secondary Education: Empirical Study on Motivation and STEM Skills

Nuria Arís * and Lara Orcos

Facultad de Educación, Universidad International of la Rioja Logroño, 26006 La Rioja, Spain; lara.orcos@unir.net
* Correspondence: nuria.aris@unir.net

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Abstract: Educational robotics (ER) is increasingly present in secondary education classrooms and has acquired greater projection, especially with the appearance of championships, such as FIRST® LEGO® League. These competitions are based on a globalizing focus of the different areas of the curriculum, therefore, we consider that it directly links with the achievement of STEAM (science, technology, engineering, arts, and mathematics) skills. We present a research study that provides objective data based on the opinions of teachers and students that participated in this championship during the course 2017/2018 about its impact in the learning process. To this end, Spanish students and teachers answered questionnaires to collect their perceptions and assessments just after their participation. The results obtained allow us to conclude that both teachers and students believe this project promotes interest and scientific curiosity, as well as social skills through teamwork.

Keywords: educational robotics; STEAM skills; FIRST® LEGO® League; secondary education

1. Introduction

The evolution of educational robotics (ER) and its application in the classroom have grown and consolidated in recent years. Robotics is a motivational tool for students in the teaching–learning process since it allows working in an integrated way, while developing several competences at the same time, as Jiménez and Cerdas commented in a previous study [1]. In the case of the FIRST® LEGO® League project, students develop technological competence through the programming of a robot and work on other competencies through the other two pillars of the project, the scientific project, in which they have to look for an innovative solution to solve a problem related to the challenge stated in the year, and the values project, in which they have to design a poster to highlight the main values they have achieved. The project is considered very useful due to the fact that, through the use of several skills, such as problem-solving or decision-making, students can develop the skills and capabilities necessary to face the society in which they live today and will live in the future. This is the main foundation of STEM education (science, technology, engineering, and mathematics), which is based on the integrated work of these branches of knowledge and was created in the 1990s in United States of America (USA) with the aim of promoting the development and students´ interest in these branches of knowledge, due to the demand in professions related to them.

The development of these projects is becoming important in schools, and more teachers want their students to participate in these types of organized activities or championships. In this context, and with the appearance of the LEGO® Mindstorms®, we are interested in investigating the opinions of teachers and students about the impact of robotics on the teaching–learning process.

To understand educational robotics, we have to go back to the end of the 1960s to the Massachusetts Institute of Technology (MIT). The company LEGO® created the first programming software for children, LOGO®, which was a pioneer in the construction of didactic materials. In the last 30 years, ER has been introduced with force in schools, as can be seen in a previous study [2]. From the 1980s onwards, its diffusion and popularization have led to the inclusion of activities in schools through different projects [3].

The concept of ER implies an integrated approach, considering the complementarity between different areas and fields. The purpose of ER is to enhance interest and scientific curiosity and, at the same time, it aims to promote a series of skills, such as initiative, responsibility, autonomy, creativity, and teamwork. Likewise, there are studies, such as the one by Kandlhofer and Steinbauer [4], that show a high achievement in social skills and self-esteem in students that translates into greater motivation and global implications.

The theme of ER has been the object of extensive research that establishes its relevance and potentiality. In today's society, the mastery of technology is essential and additionally requires people to develop the ability to think and act creatively. It can be seen that institutions, such as MIT or Stanford University, continue investigating how to implement technology in the classroom. The projection and impact of LEGO® Mindstorm®, Scratch, or FabLab (Technological Manufacturing Laboratories) are also under investigation.

From the point of view of the didactic conception, it can be considered that ER is conceived as a means for creation and action [5], in which the student is able to develop digital languages, in this case, computational ones. When students learn how to program, it influences the improvement of problem-solving skills, and therefore personal autonomy, based on the constructivist approach, in which the student is the main actor in the learning process [6]. When carrying out activities with ER, students need to work in groups, as this enhances skills derived from collaborative work. Likewise, there are also generated high levels of motivation that favour meaningful learning [7]. As commented by Odorico in a previous study [8], the use of robotics for educational purposes was developed with the perspective of approaching the solutions to problems, since students spend most of their time simulating phenomena and building prototypes.

It is also interesting to comment on the theoretical model of Mishra and Koehler [9], called TPCK (technological pedagogical content knowledge). This model is based on three types of differentiated knowledge: content, pedagogy, and technology. Considering the theoretical basis of TPCK, we can divide integration in theoretical, pedagogical, and methodological. TPCK allows us to advance in new ways of approaching science, seeking and strengthening teaching models based on technology. In this sense, ER is perfectly integrated into TPCK model, since it favours the development of computational thinking.

In this context, it is also necessary to consider STEM methodology. This methodology arose in the 1990s, developed by the National Science Foundation in the United States, and aims that students can learn concepts related to science, technology, engineering, and mathematics, simultaneously and in an integrated way. This approach has evolved to the term STEAM with the inclusion of "A", expanding on the STEM methodology. It is a true integrated and global methodology based on the integration of art and design into scientific training to support them in school education and to influence companies to hire artists and designers for innovation projects.

The use of robotics encourages students to learn to program, while they solve problems and develop both logical and analytical thinking towards space-temporal perception. This allows them to improve spatial orientation, as well as other skills, such as the elaboration of hypotheses [10], since their approach towards challenges causes them cognitive conflicts, for which they have to find a solution. This is what encompasses the computational thinking that makes the student capable of performing both ascending and descending analyses, being creative, and developing divergent-abstract thinking [11].

As commented by Bazylev et al. [12], ER initiatives in the classrooms are crucial to developing mechanisms of motivation towards learning that make students to be able to develop skills of leadership.

The increase in ER and STEAM education, implementing robotics kits, such as those of the BQ® brands, LEGO®Mindstorms®, Robotics KidsLab®, among others, are considered very effective in promoting an active, experiential, experimental and practical learning [13]. Therefore, we understand that the application of educational robotics and STEAM education allows the students to be the protagonists of their own learning and to develop all their potential, as well as their creativity and ability to be an entrepreneur.

2. LEGO® Mindstorms®

LEGO® Group® was founded by Ole Kirk Kristiansen in 1932 and LEGO® Mindstorms® was born in 1998 as a set of construction and programming tools with a great projection based on the methodology developed by Mitchel Resnick for the teaching of complex dynamic systems.

The Robotics Invention System® has enhanced the imagination of generations of LEGO® and robotics fans, reaching the development of a global community of users and students of all ages. The first computer capable of controlling LEGO® products appeared in 1986. Then, the LEGO® Group®, in collaboration with the MIT, developed the "intelligent brick" that brought LEGO® creations through computer programming in 1988. In 1998, the Robotics Invention System® was launched simultaneously in the United States and the United Kingdom.

In that year, the owner of LEGO® Group®, Kjeld Kirk Kristiansen and the famous inventor of FIRST® (For Inspiration and Recognition of Science and Technology), Dean Kamen, launched the FIRST® LEGO® League®. It is a robotics competition for primary and secondary students that introduce LEGO® Mindstorms® in competitions that go through regional, national and international phases. The first FIRST® LEGO® League® World Championship took place in Atlanta, GA in 2005. Its projection and interest in the educational community led to participation that exceeded 100,000 participants in 2007. Lastly, the LEGO® Mindstorms® NXT 2.0 platform was created in 2009 and LEGO® Mindstorms® EV3 appeared in 2013.

We found three great championships within the world of LEGO® Mindstorms®:

- FIRST® LEGO® League® (FLL) is an international championship that aims to encourage students to be motivated by science and technology. The challenge is to design, build, test and program a robot using LEGO® Mindstorms® technology and related to a real challenge posed to the contestants, which focuses on a different topic of science or technology each year. The objective is that students show their interest in these subjects since one of the parts of the championship is based on the assessment of a scientific project related to the theme proposed. The scientific project has its bases in project-based learning, so students build their learning in a transversal and multidisciplinary way, improving the interaction between knowledge [14]. The cooperative work is another fundamental aspect which is developed thanks to the third pillar of the project that is project of values.
- World Robot Olympiad (WRO) is an international competition in which different challenges are proposed each year and participants have to build a robot based on the challenge they like the most. The robots that participate in this competition have to be built with LEGO® material.
- Robotix® Championship is an activity that motivates and encourages young people while they discover and have fun when learning the subjects (STEM). It is set by the successful educational robotics platform for children LEGO® Mindstorm®.

The FIRST® LEGO® League® supposes a good dose of additional extrinsic motivation for the students while, at the same time, teamwork skills are enhanced. In Spain, this championship has been held since 2006. It is the most relevant international competition for children in the world, with the participation of more than 70 countries. The aim is to promote scientific and technological vocations through innovation, creativity, and teamwork [15]. In addition, it offers the possibility of greater integration of students with different and varied interests and abilities, moreover, they will be asked to present and defend their projects in English by answering the questions of an international jury.

From the point of view of the teachers, as Ma and Williams comment in [16], we have to encourage children to participate in ER projects even though they do not intend to pursue studies towards the sciences or engineering since there are many other skills developed.

The objectives that we propose in this study are:

- To explore the perceptions of the students about the variables of study related to the level of involvement and effort, the degree of participation, motivation, improvement in the learning process and teamwork.
- To investigate the perceptions of teachers related to the influence of the project in the students learning process, the development of STEAM competences, their level of motivation and teamwork.
- To relate the results obtained by students and teachers.

3. Methodology

3.1. Sample and Organization

The sample consisted of a total of 158 students from the secondary education stage and 61 teachers from several schools located in the Spanish territory, who participated in the FIRST® LEGO® League® tournaments in the 2017–2018 course and had answered the questionnaires.

Among the students, 57.6% were boys and 44.3% were girls, 98 were at the third, 52 at the fourth and eight at the second years of secondary education. Eighty-one percent of the students commented that, at the time of developing the project, they had the same participation in all the parts (scientific project, values project, and robotics).

Among the teachers, 57.4% were men and 42.6% women. Among them, 47.5% taught in the subject of technology and the rest in subjects of science, mathematics and computer science. Fifty-six percent of teachers had previous programming knowledge.

Regarding the organization of the project, teachers and students spent between 12 to 20 weeks, around five hours per week. Fifty-two percent of teachers developed the project during school hours and the 48% after school.

3.2. Design

We propose a pre-experimental design based on a cross-sectional descriptive study to obtain information about the phenomenon under study at a certain moment, in this case, just after the end of the tournament. For this purpose, some questionnaires in which the main construct to evaluate is related to the STEM skills have elaborated, in order to explore the relationship between the impressions of students and teachers who have participated in the FIRST® LEGO® League Tournament in 2017–2018 school year. The variables of study are related to the degree of involvement, the experience of participation and difficulties, with the aim of corroborating whether the experience has met their expectations and to study their opinions about the use of ER as a didactic resource.

3.3. Information Collection Tools

The data was collected through two questionnaires, both for students and for teachers. According to the teacher's questionnaire, the items were evaluated in Likert scale of one to five (one for totally in disagreement and five for totally in agreement) and the premises raised on what the development of the project has contributed to the students in terms of work in equipment, STEM skills, and academic performance. The items that make up this questionnaire were:

1. What is the level of autonomy of students in the use of software?
2. To what degree do you consider robotics helped students to acquire computer skills?
3. To what degree do you think the project has helped students to enhance their creativity?
4. To what degree do you think the project has helped students' motivation for learning?

5. To what degree do you consider the project has helped students to foster the search for solutions to a problem?
6. To what level has the project helped to work STEM skills in an integrated way?

The questionnaire for students collected different aspects related to the level of involvement and effort, the degree of participation, motivation, improvement in the learning process and teamwork. The student had to self-assess according to the mentioned items on a Likert scale from one to five. The items of the students' questionnaire were:

1. What is the degree of your general motivation about the project?
2. To what degree has the project helped you to improve your fellowship?
3. To what degree has the project helped you to improve tolerance towards the other's opinions?
4. To what degree has the project helped you to acquire computer skills?
5. To what degree has the project helped you to improve your creativity?
6. To what degree has the project helped you to find solutions to a problem?
7. To what degree has the project helped you to improve your motivation for learning?
8. To what degree do you consider robotics useful for your professional future?
9. To what degree do you think that robotics is adequate to interrelate different curricular contents?

To determine the validity of the questionnaires, the technique of the judges was applied, submitting said questionnaires to the review of five professors of the Faculty of Education so that they could assess the pertinence of the items. Their indications were taken into account, and their formulation was made by consensus.

3.4. Data Analysis

The analysis of the data obtained through both questionnaires was based on a descriptive study of the data reported by the different items in which the percentage of responses of the scale (one to five) for each item was calculated.

On the other hand, a study of the correlations between the different items of both questionnaires was carried out. The statistic used, given the nature of the variables and the non-parametric assumptions, was Spearman's Rho correlation coefficient. The data was analysed with the statistical package SPSS and the null hypothesis was "there is no correlation between the variables" at both 0.01 and 0.05 levels of significance. If the level of significance obtained after the analysis was lower than these values, the null hypothesis could be rejected and the correlation between the variables could be affirmed.

4. Results and Discussion

4.1. Teachers' Assessment

Below there is a descriptive assessment of the information extracted from the analysis of the data reported by the answers of the teachers and the students in the project.

In relation to the teachers, the aim was to obtain information about their considerations of the contributions of the project in the students´ learning. In addition, data of the main difficulties that students showed during the project from the point of view of teachers was collected. In Figure 1, the percentages of the reasons why teachers decided to take part in the project can be seen. The majority of reasons were that it enables to integrate science and technology (34.4%), followed by the fact that it is highly motivating for students (31.1%), and that it will be necessary for students' future (21.3%).

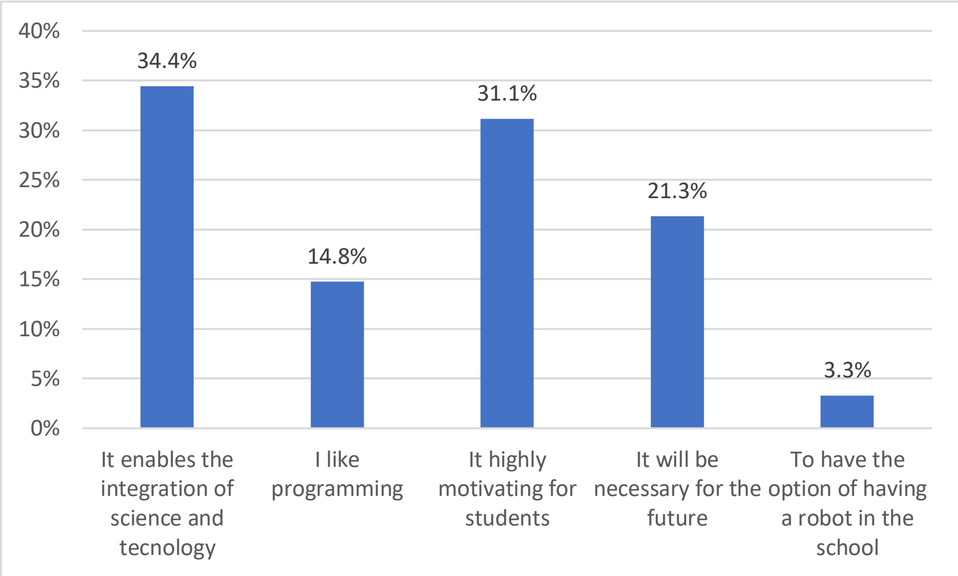

Figure 1. Percentages of responses of teachers' reasons to take part in the project.

In Table 1 there are the mean values of the items evaluated in the teachers' questionnaire.

Table 1. Mean values of the items in the teachers' questionnaire.

Items	Mean Value
What is the level of autonomy of students in the use of software?	3787
To what degree do you consider robotics helped students to acquire computer skills?	3574
To what degree do you think the project has helped students to enhance their creativity?	4098
To what degree do you think the project has helped students' motivation for learning?	3967
To what degree do you consider the project has helped students to foster the search for solutions to a problem?	4115
To what level has the project helped to work STEM skills in an integrated way?	4213
Global mean	3959

As can be seen, the teachers have assessed all the items of the questionnaire in a very positive way, with an average value of four on the Likert scale, in agreement. The best score was the one related to the curricular integration that the project was supposed to enhance so that STEM skills were developed.

On the other hand, Figure 2 shows the data on the percentages of each level of the scale for each one of the items. As can be seen, more than 40% of teachers valued the majority of the items with a level 4 of the Likert scale (in agreement). In general, it can be said that teachers believe that the project has helped students to integrate science and technology and to increase their motivation, creativity and computer skills.

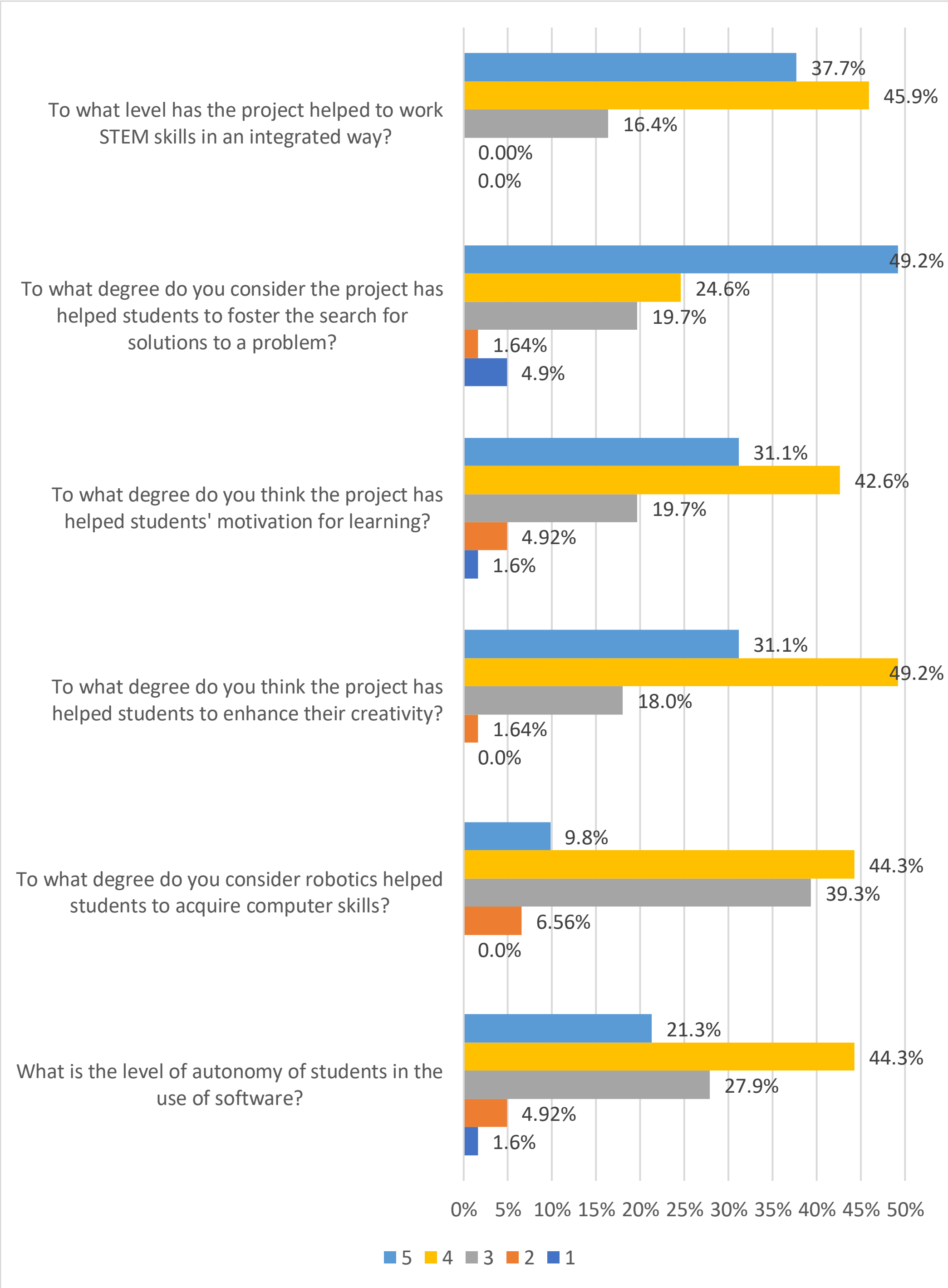

Figure 2. Percentages of assessment by the teachers of the aspects developed in the project in the students (one is totally in disagreement, two is in disagreement, three is not agree neither disagree, four is in agreement and five is totally in agreement).

We want to highlight that almost 50% of the teachers evaluated item 2, related to whether the project helped develop problem-solving skills, with a five on the Likert scale (totally in agreement). This result is considered very positive since one of the aims of the ER is that students can develop STEM skills to perform decision making and to search for solutions.

The percentages of evaluation of the teachers in terms of what part of the project they believed to be the most interesting for students is in Figure 3.

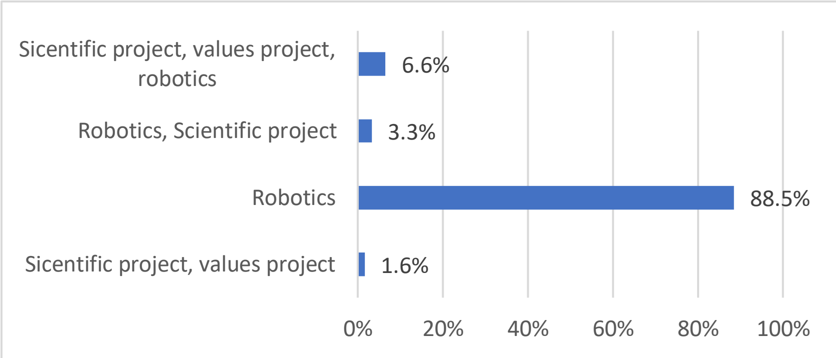

Figure 3. Percentages of evaluation of the motivation of students in each of the part of the project by the teachers.

As can be seen, 88.5% of teacher agree that robotics is the most motivational part. Figure 4 shows the data of the main difficulties that teachers believed students had when carrying out the project. According to the data, 47.5% of the teachers considered that the highest level of difficulty is related to the part of robotics, especially with the use of sensors of light and colour, and 39.3% with the development of the missions that the robot has to perform.

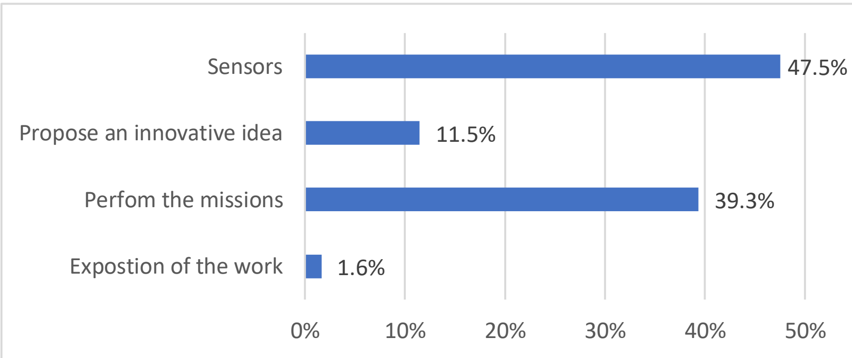

Figure 4. Percentages of evaluation of the students' main difficulties in the project by the teachers.

4.2. Students' Assessment

The data obtained from the mean values of the items evaluated in the students' questionnaire are presented in Table 2.

Table 2. Mean values of the items in the students' questionnaire.

Items	Mean Value
What is the degree of your general motivation about the project?	4348
To what degree has the project helped you to improve your fellowship?	4044
To what degree has the project helped you to improve tolerance towards the other's opinions?	3987
To what degree has the project helped you to acquire computer skills?	3975
To what degree has the project helped you to improve your creativity?	3842
To what degree has the project helped you to find solutions to a problem?	3867
To what degree has the project helped you to improve your motivation for learning?	3918
To what degree do you consider robotics useful for your professional future?	4051
To what degree do you think that robotics is adequate to interrelate different curricular contents?	4228
Global mean	4029

As can be seen, the evaluation of the items by the students has also been very positive, the motivation and the fact that the project helps to integrate curricular contents being the most valued.

The percentages obtained on each of the levels of the items are showed in Figure 5. Most of the students have evaluated each item with levels 4 and 5. The item most valued by students is that it has helped to integrate curricular contents (58.9%), aspect with which teachers were also in agreement, which leads us to think about the potential of robotics for the development of STEM competencies. In relation to whether the project helped students to strengthen problem-solving skills, as mentioned above, almost 50% of teachers rated it with a five on the Likert scale and 24.6% with four. In the case of students, the percentage of ratings of five and four is similar, but the cumulative total is similar to the overall score of teachers. These results are very interesting because they help us to show that both teachers and students consider the use of ER, in line with the research project, help students to develop a fundamental skill, such as problem-solving.

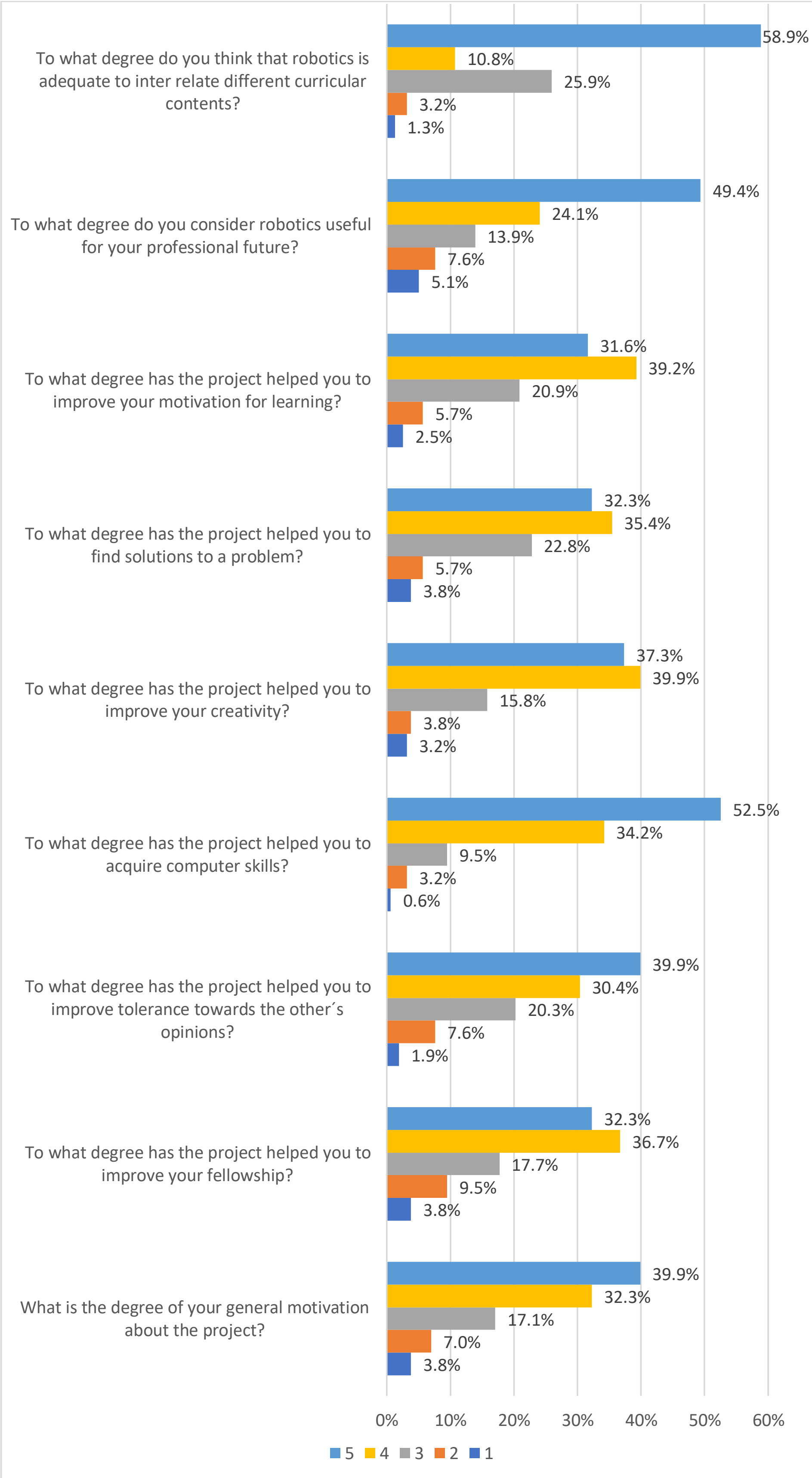

Figure 5. Percentages of assessment of the aspects developed in the project by the students.

The fact most valued by students is that the use of ER has helped them to acquire computer skills with 52.5% of students who voted with a five on the scale. On the other hand, 49.4% of them consider that robotics is very useful for their professional future, followed by the 24.1% who consider it is useful.

The percentages of the most motivating parts of the project for the students, from their own point of view, are in Figure 6. They agree with teachers that the most motivational part is robotics. However, while the opinion is more widespread among teachers, with 88.5% of evaluations, as mentioned above, 43% of students chose the scientific project or the values project instead of robotics. This leads us to think that teachers consider that the pillar that most influences students to take part in the project is robotics, but students have also enjoyed the other parts, giving a very important sense to its globalizing approach.

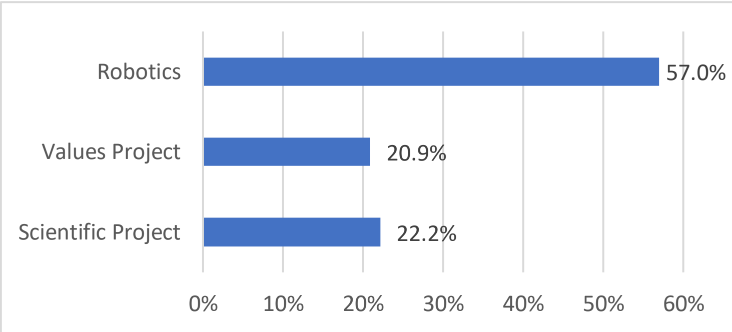

Figure 6. Percentages of evaluation of the motivation of students in each part of the project.

It should be also mentioned that 86.1% of the students answered that they would like the ER to be an integrated subject in the curriculum. Due to this concern, the Ministry of Education, Culture and Sports of Spain, presented in January 2018 the report on "Programming, Robotics and Computational Thinking in the Classroom", highlighting the Autonomous Communities in which subjects or curricular contents of robotics have been introduced (MECD, 2018).

The main difficulties that students have had when carrying out the project are in Figure 7. As can be seen, all difficulties are related with robotics, the sensors and the missions' development being the parts which students found the most difficult, from their point of view, the aspect on which they agree with teachers.

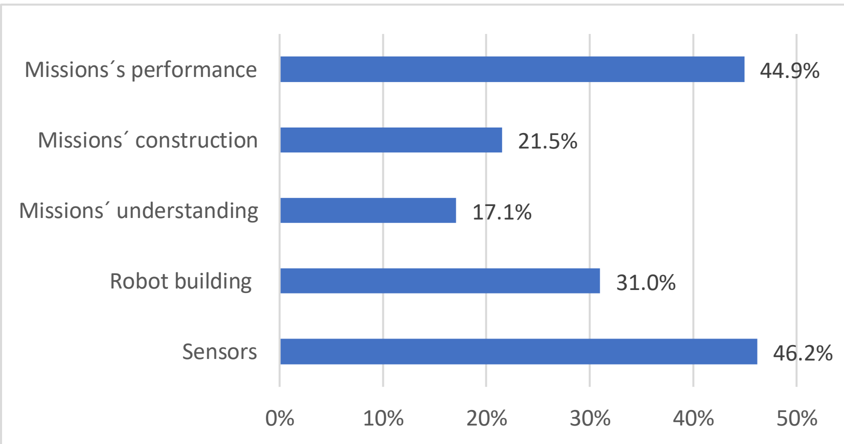

Figure 7. Percentages of evaluation of students about the difficulties when carrying out the project.

The relationship between the different items of the questionnaires has been analysed through the study of the correlations. Spearman´s Rho statistic has been used due to the nature of the variables.

The results of the correlations of the items assessed in the teachers' questionnaire are shown in Table 3.

Table 3. Results of the correlation test between the different items of the teachers' questionnaire (Numbers 1 to 6 are the items of the teachers' questionnaire).

	Teachers	1	2	3	4	5	6
1	Spearman Rho	1000	0.278 *	0.295 *	0.142	0.107	0.288 *
	Sig. (2 tails)	.	0.030	0.021	0.276	0.413	0.024
2	Spearman Rho	0.278 *	1000	0.564 **	0.456 **	0.360 **	0.374 **
	Sig. (2 tails)	0.030	.	0.000	0.000	0.004	0.003
3	Spearman Rho	0.295 *	0.564 **	1000	0.604 **	0.520 **	0.356 **
	Sig. (2 tails)	0.021	0.000	.	0.000	0.000	0.005
4	Spearman Rho	0.142	0.456 **	0.604 **	1000	0.540 **	0.225
	Sig. (2 tails)	0.276	0.000	0.000	.	0.000	0.081
5	Spearman Rho	0.107	0.360 **	0.520 **	0.540 **	1000	0.391 **
	Sig. (2 tails)	0.413	0.004	0.000	0.000	.	0.002
6	Spearman Rho	0.288 *	0.374 **	0.356 **	0.225	0.391 **	1000
	Sig. (2 tails)	0.024	0.003	0.005	0.081	0.002	.

**. The correlation is significant at level 0.01 (2 tails) *. The correlation is significant at 0.05 level (2 tails).

Form the teachers' point of view, as can be seen, there is a correlation between different items at the two levels of significance, 0.01 and 0.05. At level 0.01, it can be seen that item 2 (acquiring computer skills) is correlated with items 3 (creativity), 4 (motivation), 5 (search for solutions) and 6 (work STEM skills). Item 3 (creativity) is correlated with items 4 (motivation), 5 (search for solutions) and 6 (work STEM skills), and item 5 (search for solutions) items 4 (motivation) and 6 (work STEM skills).

At the level of significance 0.05, it can be seen how item 1 (degree of autonomy) is significantly related to items 2 (computer skills), 3 (creativity) and 6 (working STEM skills).

A direct relationship is established between ER, motivation, creativity and autonomous work. We can infer that ER generates high motivation in students and autonomy in decision-making helps to foster the appropriate conditions for creativity. In the same way, the fact of improving their computer knowledge contributes to the teachers' perception of how the autonomy of students has increased.

The results of the correlations of the items valued in the students' questionnaire, with Spearman's Rho statistic, are shown in Table 4.

The results in Table 4 show the correlations between the items of the students' questionnaire at the significance levels of 0.01 and 0.05. At a level of 0.01, there is a significant correlation between item 1 (general motivation) and items 2 (companionship) and 3 (tolerance), with the two last also correlated. Item 4 (computer skills) is correlated with item 5 (creativity) and 6 (search for solutions), which are also significantly correlated. Item 7 (motivation for learning) is correlated with items 4 (computer skills), 5 (creativity) and 6 (search for solutions), item 8 (utility of robotics for the future) with the 4 (computer skills), 5 (creativity), and 7 (motivation towards learning) and 9 (relate different curricular content) with 4 (computer skills), 5 (creativity), 7 (motivation for learning) and 8 (utility of robotics for the future).

At a level of 0.05, item 6 (search for solutions to a problem) is correlated with items 8 (utility of robotics for the future) and 9 (relate curricular content).

These results allow us to demonstrate the high potential of robotics in the classrooms from the point of view of the students. It is established that teamwork is related to greater interaction with others and to the possibility to increase social skills, such as tolerance and companionship. It is also noted that the fact of working with computer software, has allowed students to search for solutions while combining curricular contents in an integrated and creative way. The project of ER is itself a globalizing factor of the different areas of the curriculum, so we consider it to be directly linked to STEM skills achievement.

Table 4. Results of the correlation test between the different items of the students' questionnaire. (Numbers 1 to 9 are the items of the students' questionnaire).

	Students	1	2	3	4	5	6	7	8	9
1	Spearman Rho	1000	0.306 **	0.242 **	0.004	−0.084	0.008	−0.131	−0.079	−0.188 *
	Sig. (2 tails)	.	0.000	0.002	0.963	0.294	0.925	0.100	0.327	0.018
2	Spearman Rho	0.306 **	1000	0.483 **	−0.077	−0.151	−0.074	−0.120	−0.148	−0.172 *
	Sig. (2 tails)	0.000	.	0.000	0.339	0.058	0.356	0.132	0.063	0.031
3	Spearman Rho	0.242 **	0.483 **	1000	0.038	0.023	−0.043	−0.033	−0.005	−0.045
	Sig. (2 tails)	0.002	0.000	.	0.639	0.771	0.588	0.677	0.947	0.577
4	Spearman Rho	0.004	−0.077	0.038	1000	0.355 **	0.364 **	0.412 **	0.350 **	0.264 **
	Sig. (2 tails)	0.963	0.339	0.639	.	0.000	0.000	0.000	0.000	0.001
5	Spearman Rho	−0.084	−0.151	0.023	0.355 **	1000	0.383 **	0.540 **	0.243 **	0.256 **
	Sig. (2 tails)	0.294	0.058	0.771	0.000	.	0.000	0.000	0.002	0.001
6	Spearman Rho	0.008	−0.074	−0.043	0.364 **	0.383 **	1000	0.501 **	0.164 *	0.168 *
	Sig. (2 tails)	0.925	0.356	0.588	0.000	0.000	.	0.000	0.040	0.035
7	Spearman Rho	−0.131	−0.120	−0.033	0.412 **	0.540 **	0.501 **	1000	0.231 **	0.309 **
	Sig. (2 tails)	0.100	0.132	0.677	0.000	0.000	0.000	.	0.003	0.000
8	Spearman Rho	−0.079	−0.148	−0.005	0.350 **	0.243 **	0.164 *	0.231 **	1000	0.337 **
	Sig. (2 tails)	0.327	0.063	0.947	0.000	0.002	0.040	0.003	.	0.000
9	Spearman Rho	−0.188 *	−0.172 *	−0.045	0.264 **	0.256 **	0.168 *	0.309 **	0.337 **	1000
	Sig. (2 tails)	0.018	0.031	0.577	0.001	0.001	0.035	0.000	0.000	.

**. The correlation is significant at level 0.01 (2 tails) *. The correlation is significant at 0.05 level (2 tails).

5. Conclusions

Given that it is the first experience and that this study is at its initial phase, in this article we have considered the data provided by the questionnaires in an exploratory way, although we are optimistic because the results obtained confirm the effectiveness of the integrating project.

In terms of the achievement of the objectives we proposed at the beginning of our study, we can conclude that they have been accomplished through the results obtained in the statistical study carried out. Both the students and the teachers have valued the project in a satisfactory way, especially its integrating approach.

In particular, in reference to the teachers' perceptions, they consider that participating in the project has helped students to integrate science and technology and to increase their motivation, creativity and computer skills. The ER is perceived as very favourable for the students' learning and, in particular, for the achievement of STEM skills. The results are very positive and allow us to conclude that ER generates high motivation in students. Likewise, the autonomy in decision-making provides appropriate conditions to develop creativity and autonomous work.

In relation to the perceptions of the students, we conclude with a very positive assessment of robotics in the FIRST® LEGO® League ® tournament. Students had the opportunity to develop their technological competence through the programming of a robot while they enhanced other skills through the other two pillars, the scientific project and the values project, promoting the transversal work and, therefore, verifying the assumptions of Alcober et al. [14].

It is also established that the fact of considering that working as a team in the RE project, has helped them to promote their social skills, dimensions of the Values Project. Finally, this experience leaves a very positive impression on students who value the importance of robotics in their professional future.

On the other hand, the study of the correlations between the different items has reported very interesting results since they show the relationship between the use of ER, motivation, creativity and autonomous work that also helps students in decision making and the development of social skills, which allows us to corroborate the contributions of Kandlhofer and Steinbauer [4].

All these skills have been developed in all students without exception, regardless of whether their skills in science or technology were not good or if they did not intend to continue studying in these areas. This fact allows us to note the statements of Ma and Williams [16] in relation to the benefits of the project for all of the students.

In view of this first study, we feel conscious about the need and motivation to continue deepening the subject, and with the implementation of future editions, we will be able to establish comparative studies with greater significance. Moreover, we believe that some improvement can be made in terms of the selection of the constructs in the questionnaire.

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