Educational Robotics and Social Relationships in the Classroom

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Abstract In a constructionist environment, robotics engagingly teaches traditional concepts, while applying them to compelling real-world problems. Educational robotics can help students develop soft skills, like teamwork, and improve the way they relate to each other. Researchers in different disciplines have devoted many efforts to exploring this dimension. One tool that may be useful for exploring the relational dimension of these activities is the sociogram. The case study reported in this paper presents findings from an experience which brought educational robotics, coding and tinkering to fourth graders in a primary school in Ancona (Italy). A questionnaire and a sociogram were administered to students, during curricular activities, before and after the project took place. The findings highlight some improvements in students' relations, but more investigation is needed into the process of describing students' relationships and their development in a project involving innovative methodologies and technology.

Keywords Educational robotics · Sociogram · Social network analysis · STEM · Constructionism · Coding · Tinkering

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1 Introduction

Students' ability to learn is inextricably linked to the classroom environment. Developing and mastering new skills requires students to feel safe and supported. Educational robotics (ER) brings new tools and methodologies into the classroom for acquiring technological, social and multidisciplinary skills and competences [1–12]. During ER activities, students usually work in small teams, which encourages them to collaborate. This helps students who are isolated to improve their social relationships. Sociometric tests developed by Moreno [13–15] can help teachers examine the structure and interactions of a group, and get valuable data about social relationships in the classroom. Sociometric tests can help focus the teacher's awareness of students who may not feel connected and need extra attention, and this helps create a supportive learning environment.

Sociometry has been applied to educational research in many contexts. Exploring this approach within ER activities is rather uncommon, but one example can be found [10].

The aim of the present work is to explore the suitability of this approach for understanding classroom interactions.

2 Materials and Methods

2.1 Participants and Procedure

In early 2018, two classes at a primary school (ISCED 1, grade 4) in Italy were involved in a project in which educational robotics was brought into the classroom. An external educator carried out the activities and received support from the classes' regular teachers. Consent to participate was provided for 26 students in group A, and 22 students in group B. Students were involved in activities related to environmental issues, such as separate waste collection and forest conservation. First, they explored the environmental issues; then, they wrote stories about them and brainstormed to choose elements and ideas to create a tale invented by the whole classroom. After this preliminary phase, students assembled and programmed robots over four lessons (two hours per lesson) using Scratch and Lego WeDo 1. They were divided into groups of three or four and introduced to the subjects of robotics (mechanical structure of a robot, difference between robots and machines, sensors and motors) and programming (sequential instructions only). At the end of the short course, they were able to think about dramatizing the story on environmental issues through robots. The third phase of the project was dedicated to creating a stage background for the story through tinkering and using waste materials. The last phase of the project involved sharing the artifacts, the story and their work with parents and other friends. During a school festival the two groups showcased their experience by presenting their stories, short videos and pictures from the workshops.

2.2 Methodology

Students were asked to complete a questionnaire and a sociometric test at the start (BL) and end (PT) of the project. The questionnaire was administered on paper and the items were in Italian: three items asked about the relationship with the instructor and the methodologies used, two questions were about assembling and programming the robot, two were on their interest in this kind of activity in the future, and two were about having fun or cooperating with their companions.

The sociometric test consisted of four questions:

- Write the names and surnames of those classmates you would like as study companions for a particular school subject. You can write as many names as you like.
- Write the names and surnames of those classmates you would not want as study companions for a particular school subject. You can write as many names as you like.
- Write the names and surnames of those classmates you would like as playmates. You can write as many names as you like.
- Write the names and surnames of those classmates you would not want as playmates. You can write as many names as you like.

The sociometric test is a method used to get a description of interpersonal relations within a group and to stress the social status of each member. It mainly focuses on the affective-relational perspective (play) and on the perspective of a group working towards a common goal (study). The resulting sociogram represents members of the group as nodes and their relationships as edges. If there is no relationship between two nodes, no edge is shown on the graph. To examine the data from the sociometric test, a matrix (adjacency matrix) is built by replacing its elements with choices (value 1), rejections (value -1) or no choice or rejection (value 0).

Both the questionnaire and the sociometric test were developed by an expert educator and psychologist.

To check whether the structure of the social network changes over time, we analyzed BL and PT sociometric data and focused on the density, mean indegree and mean outdegree of the network. The density of the network is the ratio of the number of links to the number of possible links; it represents the connectedness of the network. Density is connected to distance, and the distance can represent the student's role in the network. Mean indegree and mean outdegree are measures of degree centrality that are appropriate for directed networks like the ones we obtained from the sociometric test. The sociometric test evaluated the students in two areas: play and study. For each area, students were able to jot down as many names as they wanted as "choices" (people they wanted to play or study with) or as "rejections" (people they did not want to play or study with). Paired t-tests of mean indegree and mean outdegree at BL and PT were performed in order to test the significance of the differences between the two paired samples. Change from BL to PT was assessed by means of the Wilcoxon signed rank test.

Table 1 Mean values of answers to questionnaire items

	A		B	
	BL	PT	BL	PT
Q1	2.14	2.44	2.55	2.5
Q2	2.04*	2.52*	2.18	2.33
Q3	2.90	2.92	2.95	2.95
Q4	3	2.8	3	2.81
Q5	2.71*	2.32*	2.59	2.59
Q6	2.33*	2.8*	2.18*	2.91*

*Paired data showing a statistically significant difference ($\alpha = 0.05$)

3 Results

Mean values and results from the Wilcoxon signed rank test for two paired groups of data for both group A and B are shown in Table 1. Specifically, the results from question 4 (fun with classmates) and 5 (good collaboration with my classmates) are shown in Fig. 1. The results from processing sociometric data are reported in Table 2.

A significant change in interest towards the robotics workshop was found (question 6) in both groups involved. No significant results were found for questions 4 and 5, but we can qualitatively observe that scores tend to be lower for PT. This negative trend seems to be corroborated by the sociometric analysis.

The results in Table 2 show that the project somehow increased each student's choices in the "play" area. No significant results were found in either group for the "study" area. The density of the network was not tested for significance, but it increased from BL to PT in both groups for both choices and rejections.

4 Conclusion and Future Work

Overall, the project recorded a high level of satisfaction in the groups involved (Table 1). Notably, the students' interest increased significantly (question 6). This result suggests that short workshop activities are effective in increasing interest in STEM subjects. Answers to questions 4 and 5 showed a decreasing or stable trend between BL and PT.

Conversely, the sociometric data in the area of play showed a significant increase in the mean number of choices. Moreover, although not significant, the same trend can also be observed in the areas of study and rejections (see Table 2). This is an exciting result that needs more investigation to uncover the underlying variables (for example, personal or group-related variables).

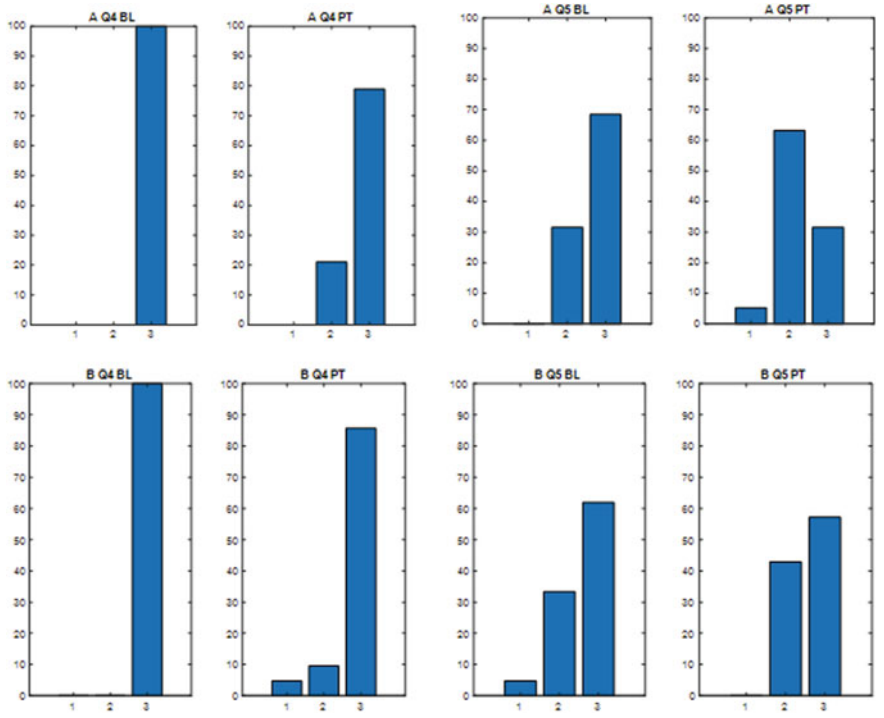

Fig. 1 Results from question 4 (Q4) for groups A and B before the activities started (BL) and after the activities ended (PT)

The overall picture of these two classes was that, in group A, there were more popular students (those who received more choices than others) and more rejected students (those receiving more rejections than others) than in group B. The density of the network was not tested for significance, but it showed an interesting trend: it increased from BL to PT, showing that more relations grew out of the collaborative environment of the ER activities. This result is not unforeseen, as some of the relevant literature advocates ER's capacity to stimulate social skills [1, 3–12].

Nonetheless, the present research, and other research like it [10], shows that more questions need to be answered on methodological research grounds and on the study of social relations within a study group. Some students, in fact, did not improve their status after the ER activities, as in [10]. This issue should be examined in depth, perhaps by including a number of background variables in the study, like gender, race or socio-economic status. Furthermore, variables like the duration of the activities or the way groups are formed for particular activities may affect the creation of social relations and thus deserve more attention in future studies.

Table 2 Results of the analysis of sociometric data

				Mean indegree	Mean outdegree	Density
Group A	Play	Choices	BL	7.45*	7.45	0.35
			PT	8.82*	8.82	0.42
		Rejections	BL	5.59	5.59	0.27
			PT	6	6	0.29
	Study	Choices	BL	6.27	6.27	0.30
			PT	6.50	6.50	0.31
		Rejections	BL	5.27	5.27	0.25
			PT	5.55	5.55	0.26
Group B	Play	Choices	BL	4.59*	4.59*	0.21
			PT	6.45*	6.45*	0.31
		Rejections	BL	4.95*	4.95*	0.24
			PT	6.5*	6.5*	0.31
	Study	Choices	BL	4.82	4.82	0.23
			PT	5.32	5.32	0.25
		Rejections	BL	5.18	5.18	0.25
			PT	6.23	6.23	0.30

*Paired data showing a statistically significant difference ($\alpha = 0.05$)

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