Robotics in Education: Methods of Getting Schools Involved in Robotics Project in Estonia

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Abstract. Robotics has been used in education for decades in helping students better understand collaboration, natural sciences, develop higher level problem solving skills. There are many educational robotic platforms available. The key element for schools is the support from higher level educational institutions. Convincing schools to join educational robotic projects is not an easy task because it requires higher investment of financial resources. Although there are solutions like endowments, qualitative analysis in Estonia has shown that decisions about investments made by schools are not based on that fact. Therefore, some other factors that would help universities in introducing the advantages of robotics at schools should be found.
In this paper, three different approaches are described and analyzed in order to get schools to join the robotic project in Estonia. Each case lasted for one school year during which the activities were applied. The outcomes of each case are presented.

Keywords: Educational robotics, LEGO MINDSTORMS, Robotic Theatre.

1 Introduction

There has been a growing interest towards educational robots used in schools. After Seymour Paper introduced programming language LOGO and the floor turtle, robotics became an issue in educational environment in the 1960-s [1]. There have been many other programming environments and platforms used since LOGO. One of the most widely used educational robotic platforms nowadays is LEGO MINDSTORMS [2]. LEGO MINDSTORMS is a line of toys manufactured by LEGO Group [3]. However, the work done in the field of robotics is mainly still on "the interest level" and it is not used as a part of compulsory education in general schools. Although there are some positive examples of robotics being used in the school curricula, these are mainly pilot studies [4].
The first step moving towards national use of educational robotics is marketing. Most of the educational robotic platforms are rather expensive for schools. Furthermore, without substantial curricula, schools take the responsibility for using robotics in effective ways. Fears of failure are even more justified if robotic sets are co-financed by third-party associations. This is the area that has not been paid serious attention to among scientists. The purpose of this study is to find different methods of introducing

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robotics to schools and through this activity achieve higher level of merging with educational robotics program among schools.
In the current paper we present three ways of introducing robotics to schools in the Estonian context. Each of these ways has its positive and negative sides according to its cost. Finally, we will outline the most effective method based on each case analysis.

2 Context of the study

The main curricula and support for educational robotics for schools in Estonia is provided by the University of Tartu, which is the biggest and oldest university in Estonia. Therefore, there is a matter of trust level included. Besides the university, there is a non-profit organization "Robotics" that consists of the same people. The reason for having such an extra institution is related to co-finance associations as communication and business with smaller organizations is much faster and more flexible than with large-scale organizations such as universities. The same applies to schools. As for robotic platforms used in Estonian schools, there is a national institution called "Tiger Leap" [5] that will fund 80 % of the cost of the sets for all the interested schools. In order to do that, schools have to make a contract that states the use of robotics in that school and also participation in the Estonian robotic contest. School must also have a trained robotic teacher. In most of the cases, it will be a science or an occupational guidance teacher. Trainings are held in Tartu University four times a year. There is also a second level training that teachers can attend to. Robotics platform used in Estonia is LEGO MINDSTORMS.

3 Methods

In the current study, we analyzed three cases of the work of the NPO "Robotics" and University of Tartu. One part of this work has been and is oriented towards getting more schools involved in robotic school project. Each case was analyzed according to the following plan.

1. Target group. Target group could be students, teachers, school board or a mix of the named parties.

2. Activities applied. By this, we mean the approach selected to the target group.

3. Resources needed. This means the human resources and supplies needed to conduct activity in case.

4. Results – the general outcomes of the selected approach and its cost effectiveness.

5. Reflection – what we have learned from the case.

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Data analysis consisted of three steps. Firstly, persons applying activities in different approaches composed descriptions about each approach. Secondly, descriptions were analyzed by one person to find similarities and differences between the approaches. Finally, a number of schools joining the program each year were analyzed.

4 Methods

4.1 Case 1: Teacher training and introduction of the robotics program through teacher-oriented media

Target group. Target group in this approach involves both school board and teachers. As in the case of very small schools, some members of the school board may get involved in the robotics project introduction more than usually. By this, it is meant that members of school board don't only make decisions on whether to join the project or not but also come to trainings.

Activities applied. This case involves two stages. First, there is an announcement of a robotics program and teacher training in newspapers, on important educational websites and in teachers' mailing lists. Information reached teachers directly or through school board. Secondly, teacher training was conducted. It did not usually involve more than 20 teachers per training. Teachers got to know more about robotics and methods of teaching with it. Training lasted always for two days and was more practical than theoretical following the constructivist approach [6]. Training did not assume any previous skills in robotics or programming. This was clearly stated in the advertisements. Training was completely free of charge for teachers.

Resources needed. This type of approach needed the least resources. Setting up advertisements was plainly a task for one person. Training, on the other hand, needed computers with the correct software, robot kits, accommodations, meals and at least 2 persons conducting the training. Usually these were university students with robotics teaching experience.

Results. We did not encounter any problems with teachers signing up for the training. Sessions were fully booked. There was and has always been an issue of dropping out of the course. Reasons for that in most cases are time management. Few cases showed loss of interest. This approach was definitely less effective than the other two approaches. The cost of advertisements and training was not substantial. The conducted analysis carried out one year after the training showed that 29 % of schools that took part in the training did not join the project. Teachers' feedback showed that an impact among educators was substantial, but it was complicated for teachers to convince their school board.

Reflection. This case gave more qualitative feedback on trainings than served primary purpose of gaining more repercussion among schools. Qualitative feedback also pointed out that teachers were afraid of robotics and programming when joining the training. Premises changed quickly during the first day of training. As a result, this

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seemed to be a problem for school teachers wishing to attend the course. There were few examples of the teachers being compelled by school board to take part of the training. In these cases, school most likely joined the program. In other ways, if initiative was shown by the teachers, it was more difficult to get the approval towards robotics program from the school board. Although teachers were enthusiastic at the end of the course, it was fairly not enough when communicating with the school board. To avoid that, robotic kits were given out for a week so teachers would have more to show back at school. This relieved the situation.

4.2 Case 2: Robotics' introduction at schools

Target group. In this case, the target group was primary students and school board. Teachers had already been to training. One visit involved maximally 20 students.

Activities applied. Activities involved school visits and teacher trainings. We built up a team with necessary knowledge and skills to go to schools and introduce robotics to students and school board. The program involved introductory and hands-on part. Firstly, there was a slight demonstration of robot's capabilities and equipment. It was followed by a practical part that generally gave students the opportunity to try the robots with simple programming. This means that no computers were involved. MINDSTORMS NXT has an opportunity to try out simple five steps programs without computer connection. In some schools, the software was pre-installed to computers and programming was held in computer class. Still, it was quite importunate for the teams and schools to get the software installed. In some schools, it turned out that the software did not work correctly with robots. Bad experiences with robots were something school boards took into account. These activities were observed by at least one member of the school board. It was also tried out at schools which did not have any teachers trained before. They saw the robots first time at school. Activities lasted for one school lesson (45 minutes).

Resources needed. It needed more resources than the first approach. More robot kits and two trained teams to visit schools were key elements in this case. Team usually consisted of two university students. There were two teams because of time flexibility.

Results. Teachers that attended trainings invited robotic teams over to schools to demonstrate robots and see how students work with this kind of equipment. A lot of school boards were convinced by seeing robots and methods of teaching robotics. The second method of the second case of visiting schools with robots without previously trained teachers did not improve the results. Seeing robots as complex constructors that require programming was too much for the teachers to handle. Although school board was at a supportive position, it was hard to find teachers attending the course.

Reflection. This case was a noticeable improvement in comparison to case one although it was still too time consuming. It was found out that the best times for teachers to attend trainings were school holidays. In sight of this, only four trainings per year could be held. After each training, there was certain period of visiting schools to convince school board members.

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4.3 Case 3: Robotics theatre

Target group. In this case, the target group was similar to second case, primarily students. The school board and teachers were on the same level as they observed the introduction program. The size of target group for one session was 50 students.

Activities applied. It was clear that in order to increase the speed of schools joining the program we had to go further from teacher trainings and just simple introduction visits to schools after the training. A complicated show of robots involving kids was developed. It started with explaining different parts of robots in general. This was followed by a robotic theatre where robots acted out two popular fairy tales under false names. Theatre lasted for about 12 minutes and ended with a robot dance. Theatre was a mix of complicated programming, using different NXT sensors and timings. Qualitative feedback has shown that it was still graspable by students and therefore a user-friendly experience. In addition, inner programming was replaced by using correct computer software. In order to achieve that, teams had 12 laptops with them all times. When the theatre ended, voluntary or pre-decided students got the opportunity to try out programming and solve a little task. If it was not decided before who will attend programming part, there were problems with the students left out. In all schools, 12 laptops allowed together 24 students to take part in practical part. It was found that 24 students is the maximum number that 3 team members could handle. No previous programming experience was assumed. Firstly, programming environment was explained. When pupils got their robots moving, a simple moving assignment was given. Both the robotic theatre and practical part lasted for one school lesson. Teams visiting the schools had conditioned the school board to come over to see both parts. As visits were completely free for schools, this condition was not hard to meet.

Resources needed. This is the case that needed most resources. Robotic theatre equipment together with the laptops was located in several metal suitcases that together need a little van for transportation. Instead of two students, three were needed. With regard to time consumption, one day per school was acceptable. It was possible to visit more than one school per day, but schools had to be close together.

Results. By results, this was the most effective way of getting the schools involved. One school out of ten claimed after the visit that they will not be interested in the robotics project. Other schools signed up teachers for trainings and started the contract with Tiger Leap.

Reflection. In this case, it seemed to be the right decision that schools would not pay anything for the visit. We stated that it is not compulsory for schools to join the project after our visit. It decreased pressure. It was clearly stated for schools that robotic theatre is not for entertainment, but introducing robotics project. The downside of this approach was that schools had to find the place to order the robotic theatre themselves. It cannot be stated that it would decrease the speed of schools joining. Schools and teachers are communicating with each other. The information about the robotic theatre is spreading orally. It would also be possible to send information about robotic theatre to mailing lists, but this would result in overbooking and a situation where some schools are not reached.

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5 Discussion

The last two approaches applied in Estonia were developed in accordance with the outcomes of the first approach described in this paper. It was clear that the third approach was the most efficient but also the most expensive and time consuming. The second method developed through our group discussions when it was clear that teacher training is not enough to convince schools to join. Although schools knew about the possibilities and opportunities, it was more about taking high level risks than positive outcomes for schools. In the second case, the reason why the team set up the opportunity of programming robots with computers was mainly the lack of necessary equipment. Schools did not have any experience with children programming and that was one of the main negative assumptions - that their pupils will not manage in such high level technical environment. That is one of the reasons why programming with laptops in schools increased the level of positive image of programming robotics. Therefore more teachers were positive about joining the training.

The second case involved still advertisement-based invitations. Teachers first had to come to training in order to get the team to visit school. Decision about participation was still made on an advertisement level. In the third case we tried to overlook this by explaining all aspects of robotic projects and contracts directly to school board. There were some positive examples of schools where teachers participated in the case one but joined the project after experiencing case three. Some examples include schools that passed case one, but joined the project one year later without experiencing any other method of approach. In our opinion, schools preserved interest, but did not have sufficient funds to buy the sets. Compared to case one and two, the third has a negative possibility of being entertainment not an introduction of robotics. As the robotic theatre is free of charge, schools may take advantage of this. Examples of this are a couple of schools that asked us to come back to show robots to all students in school. That is one of the reasons why there is a limit to two theatres and practical lessons per school. We did not experience this shortcoming in case two although assumptions for that kind of behavior were present. The reason for that is time. This means that during the educational robotics project since case one, schools changes information about their projects and it has to be taken into account. In the third year of the program, a lot of schools already knew about educational robotics and the possibility of having the visit of a robotic theatre. Teacher trainings are present in every case, although they might not be the best choice of convincing school board; they are still key elements of introducing robotics in classrooms [6]. Communication with the school board on such delicate subjects as money investment should be a task for experts, who have greater knowledge on educational robotics. The feedback from teacher trainings also confirmed the lack of confidence when answering to the school board. Improvement in cases two and three confirm that. The difference between case two and three is more technical than methodical. A big improvement in the methodical part is the practical lesson because that is the exact work teachers are going to experience in classroom. Seeing it functioning has a positive image for teachers as well as school board.

Number of schools joined per case is available in Figure 1. Each case lasted for one school year. The period for case one was 2007-2008, 2008-2009 for case two and

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2009-2010 for case three. Schools that passed case one, but joined later, during the period of case two, are still examples of case one. The same applies for case two.

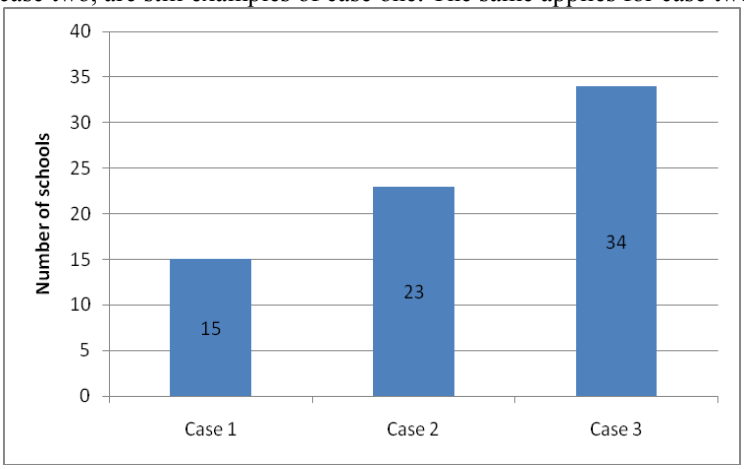

Fig. 1. Number of schools joined with the robotics project by case.

6 Conclusions

Our three cases have shown that achieving higher level participation in educational robotics program is not an easy task and very much connected to marketing. Above all, it is important to encourage schools by providing technical explanations and support. It is possible to continue with the method of case three as pace is quite high for one team. It would require at least a second team and extra equipment if we'd send out information on hand-outs with information of free robotics theatre. As there are many other science theatres visiting schools and charging them, it is assumed by schools that it is the same for robotics. It is an obstacle that we need to eliminate. Qualitative analysis also implicates that schools are concerned about the sustainability of the project. Important knowledge for them is the continuing educational material support and help from the University of Tartu and NPO Robotics. Second task is to have as many outputs for the project in the form of national competitions that schools can attend to as possible. This increases the level of trust as also the knowledge of the fact that the robotic theatre will always go back to schools where project is already started.

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References

1. Papert, S.: Basic Books: Mindstorms - Children, Computers, and Powerful Ideas. New York, USA (1980)

2. Alimisis, D., Moro, M., Arlegui, J., Pina, A., Frangou, S., & Papanikolaou, K.: Robotics & Constructivism in Education: the TERECoP project. In Proceedings of the 11th European Logo Conference: Bratislava (2007)
3. LEGO MINDSTORMS Education, http://www.lego.com/eng/education/mindstorms/default.asp
4. Hussain, S., Lindh, J., & Shukur, G.: The Effect of LEGO Training on Pupils' School Performance in Mathematics, Problem Solving Ability and Attitude: Swedish Data. Educational Technology & Society. 9(3), 182--194 (2006)
5. Tiger Leap Foundation, http://www.tiigrihype.ee
6. Alimisis, D., Frangou, S., & Papanikolaou, K: A Constructivist Methodology for teacher Training in Educational Robotics: the TERECoP Course in Greece through Trainees' Eyes. In: 9th IEEE International Conference on Advanced Learning Technologies, pp 24—29. (2009)

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