Evaluating the Long-Term Impact of RoboCupJunior: A First Investigation

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***Abstract*—This paper presents the concept and first empirical results of our endeavor to conduct a long-term qualitative and quantitative evaluation on the impact of the RoboCupJunior (RCJ) initiative. RCJ uses robots as technical tool to educate, motivate and inspire pupils and undergraduate students up to the age of 19. Our evaluation concept is based on three pillars (individual role models and careers, monitoring people on their way through RCJ, best practice examples by mentors). As a first step of our evaluation we have conducted nine semi-structured qualitative interviews with former RCJ participants. The main goal was to get the stories of their 'RCJ careers' and to find out if their participation in RCJ have had any effect on their future development. Especially we wanted to find out if and how RCJ has raised their interest in technology in general or a technical career in particular. Within the scope of this first attempt we take it as a fact that RCJ improves technical, management and social skills and instead we try to figure out why students seem to get 'hooked' on this activity. The motivational factors we have identified so far are *the social experience*, *the engaged community* and *feelings of success*, which should be considered as value concepts for teaching 'interactive technology skills' in general.**

***Index Terms*—RoboCupJunior, educational robotics, qualitative interviews**

I. Introduction

In general, we are currently facing an increasing disinterest from young people, and girls especially, in science and technology studies. Less students decide to go into technical studies at university level. As a consequence many countries are already confronted with the problem of not having enough researchers and engineers [7]. In order to work on this challenge there are cross-cultural activities such as RoboCupJunior (RCJ) that encourage pupils and students up to the age of 19 to get involved in science and technology by the means of a project-oriented educational robotics approach. Even if there is a clear subjective impression that such initiatives are useful and effective there are only a few studies investigating the long-term effects in qualitative and quantitative terms. In this paper we present a concept and first empirical results of a planned series of studies for a systematic evaluation of the Austrian RCJ initiative in specific. The evaluation concept is designed as a long-term endeavor (5-7 years) and rests on three pillars: (1) individual role models and careers, (2) monitoring people on their way through the initiative and (3) best practice examples on integration by teachers and mentors.

In a first study we aimed at the extraction of role models and later careers of former participants. Semi-structured qualitative interviews formed the basis of that evaluation. In a first proof-of-concept we conducted nine interviews. The aim was to identify the motivational factors that 'hooked' participants and to investigate their 'RCJ careers'. Almost all interviewees were enthusiastically talking about their RCJ activities. Many of them competed for years, continued in science and engineering studies and are still interested in RCJ (e.g. being referee at competitions, promoting RCJ at schools). Many former team members are still friends and now work together at university. Even if none of the teams reached top placements at the competitions they are still proud of their achievements. For instance one of the students presented her soccer robot at the interview (see figure 1).

In the following, we first provide some background information on RCJ and the current situation in Austria. Then we describe the method used, the participants, and finally our findings and conclusions.

II. Background

RCJ is part of the international scientific initiative RoboCup [24] that fosters research in advanced Robotics and Artificial Intelligence. The vision of RoboCup is that by 2050 a team of fully autonomous humanoid soccer robots will defeat the human world champions. In order to address children and young students as well, RCJ was established in 1998 within the scope of the RoboCup world championship 1998 in Paris. In 2000 the first international RCJ competition took place in Melbourne. Twenty-five teams from different schools in Australia, USA and Germany participated [20]. At the RoboCup 2011 in Istanbul there were about 1000 junior participants from 30 different countries forming 250 teams [4]. Every year the international RCJ competition takes place in a different city all over the world.

The project-based international RCJ initiative has a strong focus on education [19]. Pupils and undergraduate students up to the age of 19 are encouraged to get involved in science

Authors listed in alphabetical order.

and engineering. The goal is to improve technical and social skills, to foster teamwork and creativity, as well as to promote international contacts and knowledge exchange.

RCJ, the competition, comprises of three disciplines: (1) Rescue, (2) Soccer and (3) Dance. The task in RCJ Rescue is to construct and program an autonomous robot to find its' way through a rescue arena. Here the challenge is to follow a black line on the floor, to avoid debris, to deal with gaps and a ramp and finally to detect and rescue the victim. The arena is composed of different rooms, each room increases the level of difficulty. In RCJ Soccer four robots, usually one striker and one goalkeeper per team, play soccer. Detecting the ball, identifying opponent players and teammates, as well as locating the goals are some of the challenging issues to deal with. Robots are only limited in size and weight so students can work out different innovative solutions. Finally RCJ Dance is a discipline that focuses on the combination of technical skills and creativity. The goal is to prepare a short on-stage performance of robots and humans. Important evaluation criteria are choreography, costumes, and decoration, as well as technical aspects of robot construction and programming.

Except for some minor adaptations each discipline remains the same from one tournament to the next. The idea behind it is to give students the chance to improve their robots at each competition and to make progress visible [7]. Students are allowed to use standard robotic kits such as the Lego Mindstorms NXT as well as self-designed robots. Figure 1 shows an example of a self-designed soccer-robot. Figure 2 shows the excitement of junior participants at the RoboCup 2009.

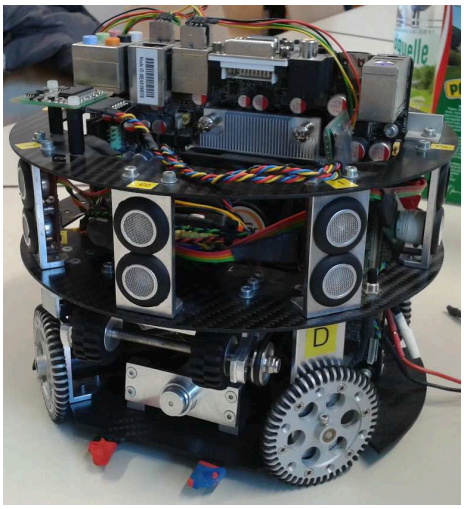

Fig. 1. A RoboCupJunior soccer robot.

In Austria RCJ was introduced in 2007. Various activities and events were organized in order to promote the initiative and to establish the first RCJ regional centers in Austria. Due to a rapidly increasing number of schools interested in participating in RCJ further regional centers were build up in order to establish a nationwide network. By now the Austrian RCJ network consists of eight regional centers, distributed among almost all Austrian provinces. A regional center offers standardized service packages to encourage schools, students and teachers to participate in RCJ. These include presentation at schools, introduction courses for pupils, training courses for teachers, renting robotics kits to schools, open-lab-days, as well as special events such as science weeks for students or robotics workshops. Presentation at schools usually serve as a first introduction for teachers and students to RCJ. Interested school classes can attend an introduction course, which lasts for about three hours. The courses have a strong focus on hands-on experiences. Using Lego Mindstorms NXT robotics kits attendees are introduced to the principles of robotics and programming. In addition training courses provide teachers with a basic knowledge and tools to integrate RCJ into their classes. Advanced courses and workshops deal with different programming languages, advanced hardware or special topics around RCJ. During the so-called open-lab-days teams can visit a regional center and use the available facilities (i.e. rescue arenas, soccer fields, robotics hardware) in order to prepare for a competition. Furthermore, experts answer questions and give hints on how to solve specific problems [7].

The current evaluation concept was initiated by the regional center Graz. It is located at the Institute for Software Technology at Graz University of Technology (TUG). The center organized the first national RCJ competition in 2008 and one year later the world championship. In 2011 an international research and education project *Technology and Education for Search and Rescue Robots (TEDUSAR)* was initiated in cooperation with University of Maribor (Slovenia). A central project objective is to build up a similar regional center structure in Slovenia, as well as to foster RCJ in both countries. RCJ is well established around Graz. There is a strong cooperation between university and schools located in the city and the surrounding regions. Every year many teams from these schools participate and succeed in national and international RCJ competitions. A remarkable number of former RCJ participants are now studying at TUG. A general problem is the increasing disinterest of young people, in particular girls in science and technology studies. By improving and extending the support activities already provided by the Graz RCJ

Fig. 2. A winning junior team at RoboCup 2009.

regional center, as well as by attracting more public attention, we aim to counteract the recent negative development and attract more students to science and technology studies.

III. Related research

As robotics in education has become more and more important within the last years, various conferences and workshops have been organized around the topic. Recent examples would be the *Second International Conference on Robotics in Education* [16] in Vienna (2011) or the international workshop on *Teaching robotics, teaching with robotics* in Darmstadt 2010 [11] and Riva del Garda 2012 [12]. A listing of further conferences and workshops can be found in [3].

Numerous papers and articles on educational robotics initiatives have been published. Some of them focus on specific initiatives like *RCJ, FIRST Lego League (FLL)*[1] or *Roberta*[2]. Others deal with the more general topic of educational robotics. As explained in [3] many publications deal with technical aspects of various robot platforms for education, the development of robotics curricula and teaching materials, as well as the integration of robotics into classes. For example the authors of [18] present a low cost micro-controller board for teaching robotics in schools in Australia. They describe design objectives, technical specifications and advantages of this controller board. The article in [1] presents the use of personal robots to teach Computer Science to undergraduates. It describes the robot hardware/software and outlines the content of the undergraduate course. Nourbakhsh and colleagues [13] describe the process of designing robot platforms and the curriculum for a high school robotics course. They provide a detailed technical description of the developed robot platform (regarding hard- and software). The final chapter deals with the findings of a short-term course evaluation.

In [15] the author gives a brief overview of different educational robotics competitions and describes one specific contest in particular. But, although this educational competition has been organized in Slovakia for ten years the paper does not cover any evaluation aspects.

The authors of [9] provide an evaluation of the *FIRST Robotics Competition (FRC)*[3]. FRC, which was founded in 1989, is a high school robotics initiative located in New Hampshire (United States). The program aims to get young people interested in science and technology. The main goal of this evaluation was to assess the long-term impact of FRC on participating students as well as to investigate the impact on schools and other supporting institutions. As a first step the authors conducted a retrospective survey of 173 former FRC participants who graduated high school between 1998 and 2003. The survey, which was distributed by email and mail, contained predefined questions regarding students' careers after graduating high school, working experiences and self-reporting impact of FRC. In order to compare selected outcomes of FRC participants, with outcomes of pupils who did not participate in FRC the study used a comparison group. As a second step the authors also visited ten different FRC teams and conducted interviews with team leaders, school administrators and mentors in order to gather information on the implementation of FRC in different schools and the impact on schools and supporting institutions. Although, the evaluation covered a period of several years the surveyed region was limited to two metropolitan areas (New York City and Detroit/Pontiac).

A similar study evaluating the impact of the FIRST Lego League (FLL) on participants, schools and other involved institutions was conducted in 2004 by Melchior and colleagues [10]. One of the main objectives of this study was also to find out strengths and weaknesses of the initiative in order to improve the FLL program. Methods used in this evaluation included surveys, site visits to competitions and schools as well as telephone interviews with mentors and coaches.

The two evaluations of [9] and [10] address several questions similar to those of our endeavor, for example the investigation of the long-term impact on former participants or the evaluation of strengths and weaknesses in order to take steps for improvement. They also comprise both quantitative and qualitative data. Nevertheless, since these studies were conducted in 2004 and 2005 data is not up to date.

Similar long-term evaluations have also been done in other scientific fields such as sociology, economy, medicine and education in general (i.e. [23], [14], [17] and [5]). In these fields there already exists a big amount of knowledge regarding quantitative, qualitative and mixed research methods ([2], [8], [6]). Therefore methods applied in those studies and areas could be adapted and used for our concept of evaluating the long-term impact of the Austrian RoboCupJunior initiative.

A more comprehensive study with special focus on RCJ, covering a four-year period (2000-2004), has been done by Sklar and colleagues [20]. The authors collected data during the annual international RCJ events. The study provides both statistical data (number of students, participating countries, gender distribution) as well as evaluative results. However, the focus was put more on quantitative performance data (e.g. the number of teams) than on qualitative evaluative results (e.g. self-reporting and questionnaire data). As a pilot study authors conducted open-ended video-taped interviews of mentors at the competition in 2000. In the subsequent years quantitative questionnaires were used in order to get feedback from students and mentors. The study aims to provide a status report on the initial four years of RCJ, however only from a quantitative perspective, such as performance data (e.g. number of teams) and self-reporting data (i.e. questionnaires). The qualitative experience of RCJ was not investigated. There is a lack of knowledge on the stories behind participants' 'careers' or their future educational and personal development. Data was exclusively collected at annual international RCJ competitions. [20], [21], [22]

In [7] results of an evaluation of the first three years (2007-2010) of RCJ in Austria are outlined. The paper presents only preliminary results though, again focusing on statistical data

[1] http://www.firstlegoleague.org/
[2] http://www.iais.fraunhofer.de/roberta.html
[3] http://www.usfirst.org/

regarding number of participating students, teams, mentors and countries at annual national competitions. As already stated by the authors a more systematic evaluation, covering more than these three years and also considering later careers and the qualitative experience of participants is needed.

Beside these two works of [20] and [7] very few long-term evaluations of RCJ can be found. As stated in [3] most evaluations are limited regarding the observation period and population. Most of the available studies also seem to look for a proof of how RCJ is successful. Within the scope of this first study aiming at the extraction of role models we have decided to go for a different approach. We have decided to regard the perspective that RCJ is successful as a fact, and instead look for the reasons why this is and what are the ”hooks” behind this initiative. We see that RCJ fosters not only technical skills, but also management, communication and social skills. Students learn how to handle larger projects, and how to work in teams and how to deal with conflicts. We also see how participating in RCJ increases the students' self-confidence. Our goal is to find out the reasons for why this is the case and subsequently use the findings to improve and extend on the RCJ support actions we already provide. As a consequence we hope to attract more students to participate in RCJ and to engineering and scientific educations in Austria. Furthermore, we are as well convinced that these hooks also could be applied on other topics and teaching activities. We are aware that nine qualitative interviews are just a starting point to identify the inherent values of the RCJ initiative. Thus, we planned a series of follow-up studies, such as ethnographic studies of the teachers, content-related analysis of the teaching material and a long-term shadowing study of selected students from different age ranges. Although, this paper only presents the preliminary findings of the first round of interviews it provides a proof-of-concept of the first pillar of our evaluation strategy.

IV. The Study

For this initial study we have conducted nine semi-structured qualitative interviews [25] with former RCJ participants. Qualitative research methods have their origin in the field of sociology and anthropology. Conducting interviews is one specific qualitative research technique which is frequently used in the area of psychology, educational science and sociology but also empirical software engineering (i.e. case studies). Though, qualitative interviews are rarely used in the field of robotics. Preparing and analysing semi-structured interviews is a very time consuming and resource demanding data collection technique. However, qualitative interviews provide information that could not be obtained by using quantitative methods (i.e. feelings, opinions, moods, facial expressions,...) [8].

The main goal of our first attempt was to get former participants' stories of their 'RCJ careers' and to find out if their participation in RCJ have had any effect on their careers after that. As described by Flick and colleagues in [6] a list of specific predefined questions acted as a guideline to ensure that important topics were covered during the interview. We put a lot of effort into formulating these questions in an open, none-directional way. The open-ended questions, such as *Do you remember some person, some situation or some activity especially? And why?* not only allowed the discovery of unforeseen information but also enabled the interviewer to deviate from the predefined guideline (a richer description of these questions can be found in the next section). Beforehand, interviewees were informed about the general purpose of the interview, i.e. evaluating the long-term learning effects of RCJ. The reason for stating the purpose of the interview clearly at the beginning of the interview was to avoid influencing or steering the interviewees in a specific direction. Interviewees were also asked to sign an informed consent stating that all collected data were to be treated confidentially, personal information was to be made anonymous and specific statements and stories were to be omitted in future publications and presentations of this data (the latter on request).

For later analysis all interviews were recorded. As described in [6] various different methods for analysing semi-structured qualitative interviews exist. Our approach was to transcribe and afterwards qualitatively analyse the interviews by means of content analysis in order to identify patterns for RCJ inherent values (see section V).

A. The guiding questions

From talking to former mentors and teachers at the regional centre in Graz we listed twelve specific questions and several sub-questions to be used if the interviewees not themselves came to talk about all topics we wanted information about. The first questions covered overall information (current educational program, potential work status, etc.) as well as information about the first contact with RCJ (when, how, and so forth). The second part dealt with questions about the specific activities the interviewee had taken part in, the preparations for potential RCJ competitions and the competitions (success, team-members, and so forth). The third part of the questions encompassed questions regarding positive and negative memories, remarkable situations and/or specific remembered persons during the interviewee's RCJ career. In addition two specific questions were formulated: *What did you learn?* and *Has RCJ affected somehow what you do today?* We are aware that the two last questions can be seen as too directional. As mentioned in the previous section we wanted to be complete open with our aims in order to allow the discovering of unforeseen information and new insights. After discussing this issue extensively we finally agreed on asking these additional questions only in case the respondents did not already answer them during the interview.

B. The interviewees

In order to examine a longer period of time participants who took part in a RCJ competitions before 2009 were contacted. To find such RCJ participants we browsed past national competitions lists, contacted former teachers, and as well asked the other RCJ regional centers in Austria for help. The people we ended up interviewing in turn provided us

with contact information to their former teammates. It should also be mentioned that all our interviewees were immediately willing to participate in our study.

In the end we interviewed nine former RCJ participants (two women, seven men). Five attended the same gymnasium in Graz (hereinafter referred to as *Gymnasium Graz1*), one a different gymnasium in Graz (*Gymnasium Graz2*), two a polytechnic high-school in Styria (*Polytechnic Styria*) and one a polytechnic high-school in Lower Austria (*Polytechnic Lower Austria*).

Currently two of the participants are studying *Telematics* at Graz University of Technology (TUG) (4th semester), two *Software Development and Business Management* at TUG (4th,6th), one *Software Information Engineering* at Vienna University of Technology (4th), one *Electrical and Audio Engineering* at TUG and University of Music and Performing Arts Graz (6th), one *Geomatics Engineering* at TUG (4th) and two *Informatics* at TUG (4th, 2nd).

The nine interviewees were part of five different teams that participated in various national and international competitions from 2008 to 2011. Subsequently we provide a brief introduction of the interviewees and their relationship. In order to ensure anonymity we are using fictive names for both members and teams.

Johanna, *Martin* and *Roland* who all attended *Gymnasium Graz1*, are currently studying at TUG. During their RCJ time (2008-2011) they were always part of the same soccer-team (*Team II*). *Verena* and *Simon* attended *Polytechnic Styria* and are now studying at TUG as well. At the first competition in 2008 their team (*Team III*) participated in RCJ Rescue. For the 2009 competition they decided to build their own robot from scratch to compete in RCJ Soccer. Members of Team II and Team III know each other from former RCJ competitions. Johanna provided us with contact information to Martin, Roland, Verena and Simon.

Patrick and *Walter* attended *Gymnasium Graz1* and are now studying at TUG. Their team (*Team I*) took part in four different national and international competitions from 2008 to 2009 (RCJ Soccer). Although they attended the same school like Johanna, Martin and Roland they don't know each other. Together with one friend *Christian* (*Gymnasium Graz2*, now studying at TUG) formed *Team IV*. From 2008 to 2010 they competed in RCJ Rescue. There is no relationship between Christian and the other eight interviewees.

Finally *Samuel* took part in various competitions (RCJ Dance) between 2009 and 2010 where he always acted as team captain. He attended *Polytechnic Lower Austria* and is currently studying at Vienna University of Technology. Again, there is no relationship to other interviewees.

Figure 3 outlines interviewees and their relationships, their former RCJ team/school, as well as date and place for the competitions and disciplines they participated in (note: the numbering of teams has no meaning). Each of the five circles represents a former RCJ team; different frame colors indicate different schools. Touching circles (Team II and III) indicate that their members know each other and currently are doing courses together at university. Arrows pointing from one member to another mean that the 'source-member' provided us with contact details about the 'target-member'.

V. Results: The hooks

All of the interviewees are and were technically interested (computer science, mathematics, electronics, physics) even before they got involved in RCJ. Six of them stated though that RCJ was at least one deciding reason for choosing their specific study direction.

Except Patrick and Samuel none of the interviewees had comprehensive previous experiences in the field of robotics. Before getting in contact with RCJ Patrick already had a Lego Mindstorms robotic kit and together with a friend he had programmed a chess-robot. Samuel had participated in the *Hexapod*[4] robotics competition several times (before 2008). Simon stated that he never was very interested in robots before getting involved in RCJ but always enjoyed playing with Lego. Verena explained that a friend of her told stories about his participation in the Hexapod competition some years before she was introduced to RCJ. Roland only heard about robotic tool-kits using graphical programming languages but he had no practical experience before his first robotics introduction course in school.

All nine interviewees were initially introduced to RCJ by their teachers either by offering optional school subjects and projects or by providing Lego kits for designing and programming robots during leisure time.

After analysing the recorded interviews (as described in section IV) we identified patterns for RCJ inherent values, which we call *the hooks*. Three major hooks could be identified, namely "social experience", "engaged community" and "feelings of success", which will be described in detail in the following subsections.

A. The social experience

To take part in RCJ means many hours of collaborative work. Decisions have to be made, tasks have to be distributed and disputes among the team-members have to be settled. During preparation, the journey to the competition and the actual competition team-members spend a lot of hours together. However, all of the interviewees expressed their positive memories on this.

"Although this was a very time-consuming activity it was the right and good decision to take part in RCJ"[5] - Walter

Interviewees also stressed the special atmosphere and the possibility for socialising during the national and international competitions. Furthermore RCJ participants were regarded to be open-minded and helpful, in also sharing their experiences and technical skills among the teams. Johanna mentioned how, unlike the various Judo competitions in which she already took part in, the atmosphere at RCJ events is not that competitive,

[4] http://www.fh-ooe.at/campus-hagenberg/studiengaenge/bachelor-studien/hardware-software-design/hexapod-meisterschaften/

[5] All citations were translated to English, as all interviews were originally conducted in German.

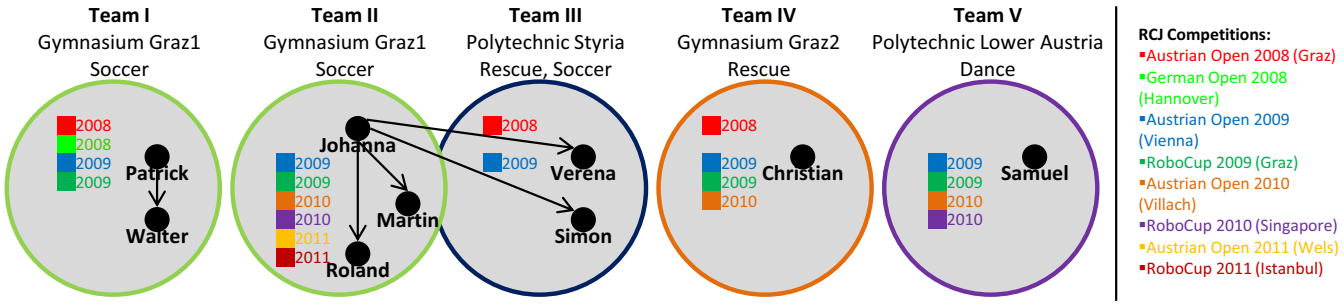

Fig. 3. Teams, schools, members, relations, RCJ competitions and disciplines.

but rather cooperative.

"During school time I also took part in international Judo competitions but I have never seen before such a strongly developed competitive thinking among participants. At RoboCupJunior it is completely different, all the helpfulness and cooperativeness." - Johanna

Patrick enjoyed the long technical discussions with other competitors and the possibility to learn from each other.

"It's good to see that there are a many other people who share the same interests. During the RoboCupJunior competition we learned a lot from other teams." - Patrick

Johanna, Martin and Roland, all members of Team II (*Gymnasium Graz1*) reported that they met everyday after school in order to prepare for the first competition. In sum the team took part in six national and international competitions. They also voluntarily acted as main referees for the soccer competitions at the RCJ Austrian Open tournament 2012. All three members are studying now. They are still friends, meet regularly and do common projects together at the university. Similar stories were told by Patrick and Walter; the former members of Team I are still good friends and although their third teammate is currently studying at ETH Zurich they manage to meet and discuss their common RCJ experiences several times a year.

Interviewees also mentioned negative memories. For instance Simon reported various problems within Team III (communication problems, two members were kicked out, the robot did not work at the day of the competition). In contrast though, his teammate Verena, who acted as project leader, did not mention these issues explicitly. The story she told was much more positive compared to Simon's. Despite their different perspectives though they are still in touch and are also doing some courses together at the university.

To continue, Samuel took part in four RCJ and various other robotics competitions. He talked about his experiences of being a team-captain, about how hard it was to motivate other team members and to delegate work. He also mentioned the problems arising when working together with good friends and described the difficult situation when another boy wanted to become captain as well. However this did not turn him down, but instead motivated him to compete again, to recruit new members and to improve his abilities in order to become a better team-leader. After graduating from school Samuel decided to become mentor for RCJ teams at his former school.

All in all the social experiences described by the interviewees can be categorized into the following components: friendship (meeting after school for preparation, still good friends, working together at university), project management (dealing with problems among members, motivating teammates, being a captain) and competitions (cooperative atmosphere, discussion with other teams, socializing with students from other countries). We don't claim that RCJ is the only reason why people stay in touch or why interviewees improved their social skills, but all of these examples and stories show that there definitely is a strong social aspect within RCJ: interviewees worked together preparing *for RCJ*, they took part in *RCJ competitions*, they dealt with controversial issues *within a RCJ team* and they experienced the special atmosphere during a *RCJ tournament*.

B. The engaged community

The interviews revealed that the schools can be considered as important part of the engaged community around RCJ. The *Gymnasium Graz1* is perhaps the best example of an "engaged community school". It is a very committed school within the RCJ community in Austria. The school offers robotics courses to their pupils. Furthermore, it provides financial and infrastructural support to student-teams. Every year several teams from this school take part in national and international competitions and achieve respectable placements. The school established its' robotics courses in 2007 (Patrick's and Walter's class was the first to participate in those courses).

As previously mentioned all interviewees were initially introduced to RCJ by their teachers. There were exclusively positive statements regarding those teachers. Half of the respondents indicated the former teacher as the most influential person during their RCJ career.

"We had a very dedicated informatics teacher. We learned a lot and he was also the reason why we initially participated in RoboCupJunior." - Verena

As another part of the engaged community we have identified academics/researchers and members of the organizational staff. For Christian the most remarkable person was a specific member of the organisational staff who also acted as trainer and judge in several competitions. Three interviewees indicated a particular university professor as the most memorable person during their RCJ career. They stressed his helpfulness in general, his support during competitions and the good

cooperation between him and their former teachers.
"This professor even tried to help us fixing a specific problem at the day of competition." - Simon

Finally, parents need to be mentioned as part of the engaged community. The interviews revealed that parents often provided financial support (i.e. for travelling) and acted as role models. For instance the fact that his father studied Mechanical Engineering led Walter to choose a technical study as well. Moreover Verena's father was the main sponsor and supporter of her team. He provided all required hardware to build a soccer robot.

Besides all the positive stories, the interviewees also brought up several negative memories and issues. Samuel for instance complained about the lack of coordination between different schools and also the lack of support provided by RCJ regional centers when organizing journeys to competitions (i.e. flights to the RoboCup competition in Singapore 2011). Although Christian spoke in high terms of his former informatics teacher (*"helpful, enthusiastic, dedicated"*) he criticised the school as such. Initially, he explained, the school was neither interested in Christian's team nor provided any support (for example they were not allowed to use the computer lab). But after the team made it to the finals at RoboCup 2009 this success was communicated as a great achievement of the school. Similarly, Christian and Samuel complained that they were given little support by their school administration (at least the beginning of their RCJ career).

We can see that students need to be supported by their engaged community. But, as it appears difficulties described might have been part of the hook itself. Students developed self-confidence, they felt proud of themselves by succeeding. This shows that provided support has to be well balanced therefore students get the chance to manage problems and difficulties on their own.

C. The feelings of success

Austria is a relatively young member of the international RCJ initiative. The first time a junior team took part in RoboCup was in 2007. Since then several notable placings have been achieved, but in all objectivity Austrian teams are still not on an international top-level. Nevertheless, the subjective feelings of students about the placings matters. During the interviews we heard various different stories of success. Both Johanna's and Patrick's teams achieved first and second places at national competitions. In addition to those measurable successes, Patrick mentioned a specific situation during their first participation in 2008. The robot crashed one day before the competition started, thus his team had to work the whole night to fix the problem. It was a great success for them to get the robot moving again and to be able to take part in the competition even if they did not compete very well. Samuel provided a detailed explanation of his robotics activities. Together with some friends he put together the first RCJ team at his school, promoted RCJ in following classes, and still gives robotics presentations to students. For him it was a big success that his achievements and activities in RCJ have helped to establish RCJ in his old school.

To conclude, we would like to quote Martin. His team came in third at RoboCup 2009, which was indeed quite a remarkable placing, and asked for the most memorable success he replied without thinking:
"When we scored our first goal, it was the 1:0, we were overjoyed." - Martin

VI. Conclusions and future work

In this paper we presented a concept based on three pillars (individual role models and careers, monitoring people on their way through RCJ, best practice examples by mentors) and first results for a long-term evaluation of the impact of the RCJ initiative. The aim is to explicitly reveal the values inherent to this pedagogical approach. For this first study we have conducted semi-structured qualitative interviews with nine former RCJ participants (two female, seven male) in order to identify what 'hooked' them. The interviewees attended different schools in Austria and took part in various national and international RCJ competitions from 2008 until 2011.

In a first attempt we wanted to preliminary test the concepts' first pillar: role models and careers. Therefore, we did not want to find evidence for RCJ being successful in how it fosters technical, management and other soft skills; we took that as a proven fact and basis for our work. Instead of gathering quantitative performance data on Austrian RCJ initiative we wanted to gather and analyse qualitative data to gain insights in the reoccurring motivational factors. These first interviews demonstrated that RCJ in its pedagogical approach generates three important factors (*the hooks*) namely the social experience (friends, teamwork, and international contacts), the engaged community (schools, motivating teachers, academics, and family) and the feeling of success (personal development, placing, and positive memories).

It is not sufficient to only know that RCJ is successful for pupils and undergraduates, but why. There is also a need for more long-term evaluation in the area of educational robotics in order to improve pedagogical approaches. Therefore we planned a series of follow-up studies, such as ethnographic studies of the teachers, content-related analysis of the teaching material and a long-term shadowing study of selected students from different age ranges. These follow-up studies will also ease the limitations of the study presented in this paper, such as the small number of interviewees, which all had successful RCJ experiences. Moreover, we later want to expand the work to different regions in Austria as well as to different countries.

Our aim is as well to set up a better supporting framework for youngsters just started with RCJ. The goal is to follow these students to learn more about the long-term effects of RCJ. Similarly, we are interested to see if the now observed trend that students keep their social network, which they established through the RCJ initiative, for their later career as science and technology student, is reported also by other students. Perhaps at some point, they even go to senior levels of RoboCup as a team.

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