

## Engineering Education of Robocon Students at a National College of Technology through planning Robot Contests for Junior High Schools

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### Abstract

Since 2012, Akita National College of Technology (Akita NCT) has planned a junior high school robot contest for Akita prefecture students in collaboration with the Akita Minato Lions Club. The contest includes two robot production training sessions and a competition. The competition, held in August, hosted 17 teams from 10 junior high schools. Although the junior high school contest objective was to increase interest in manufacturing, results showed enhancement of interest in robots and robot technology not only among junior high school students, but among the Kosen Robocon Team students who assisted in planning and managing the contest. They were in charge of creating ideas for game rules, production, and demonstration of prototype robots. They also served as competition referees. To work with the junior high school competition, they used their diverse knowledge and experience related to robotics. Consequently, they gained excellent experience as engineers, with multi-faceted thinking. This report presents an overview of the junior high school robot contest and presents results of a survey administered to junior high school students and the Robocon Team students, revealing strong effects of engineering education to Robocon team students at national colleges of technology.

**Keywords:** Engineering education, robot contest, manufacturing, junior high school, Robocon team student

### Introduction

Since 2012, Akita NCT, in collaboration with the Akita Minato Lions Club, has planned a junior high school robot contest for Akita prefecture students (Fig. 1), marking the first attempt at a junior high school contest. No such contest had been held before 2012 in Akita prefecture. In the Tohoku region, two similar contests are held in Hachinohe city in Aomori and Iwaki city in Fukushima. For the first time, Akita Minato Lions Club designed this robot contest to alleviate the disinterest in science shown by Akita prefecture children. In addition, the club was

approached to cooperate with Akita NCT and start this event. The contest includes two robot production training sessions and a competition. The authors are the Robot contest team (Robocon team) supervisors in Akita NCT. They have earlier reported on education through the Robocon (Abukawa et al., 2012). To hold the Robocon competition, the authors sought cooperation with Robocon team students, who have studied robot design and robot production intensively, and who have a high sense of robot capabilities, design, etc. In robot production training session 1, which was held on May 19, 2012, they presented ideas for a prototype robot for the junior high school robot contest and demonstrated Kosen Robocon's robots. They participated in the Tohoku Kosen Robot Contest Competition, which was much larger than that for the robots for junior high school. Moreover, they served as competition referees on August 11, 2012. A questionnaire was administered to junior

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 アイデア対決2012 **ロボットコンテスト**  
 秋田県中学校

自分のアイデアをもとにロボットを製作し、  
 ロボットコンテストに参加しよう!

開催日: **8月11日(土)** 10:00~16:00  
 秋田県立センター  
 会場: **ALVE (アルヴェ)** きらめき広場  
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主催: 秋田県ライオンズクラブ  
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 競技は赤・青の2チームのロボットが、競技フィールド中央部にあるチームの色の箱を、2箇所ある自分のチームのスタートエリアに積み上げていく。スタートエリアにある1段目の箱は1ポイント、2段目の箱は2ポイント、3段目の箱は4ポイント、4段目の箱は8ポイント。自分のチームのスタートエリアに積み上げた箱によるポイントの多いチームが勝者。ロボットに決められたコースを、スピードと正確性、そして箱を高くまで積み上げるアイデアです。

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 5月17日(土) ロボット製作講習会①  
 7月28日(土) ロボット製作講習会②、テストラン  
 8月11日(土) ロボットコンテスト

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Fig. 1 Poster of the junior high school robot contest for Akita prefecture 2012.



Fig. 2 Robot production training session 1 (May 19, 2012).

high school students and teachers after the junior high school robot contest in 2012. Results showed that some students regarded the competition itself and contents as “difficult”. Therefore, it was decided that the contents had become more enjoyable and readily comprehensible. Moreover, we cooperated actively with the Robocon team students. Consequently, an educational effect was also observed in Robocon team students. This paper presents an overview of the junior high school robot contest and presents results of questionnaires conducted for students and teachers of junior high school. Moreover, contents of the robot production training session 1 (2013), held on May 25, 2013, will be introduced, along with discussion of the results of the survey of Robocon students. Finally, we clarify the educational effects of Robocon students through planning and support of the junior high school robot contest.

### Robot contest for junior high school students in Akita prefecture

#### 1) Overview of the robot contest

The Robot contest theme in 2012 was “Pile up!! Port tower construction game”. The rules demanded that robots stack styrofoam cubes high.

The “Selion” port tower at Tsuchazaki port area in Akita was used as a motif illustrating the game objective. However, the Robot contest theme in 2013 is “Aim for the goal! Sports robot shooting game”. A robot must catch the table tennis balls, transport them, and shoot them at targets set on a slope. For the separate contest objectives of 2012 and 2013 each rule, “4ch remote control robot construction set dx (Tamiya Inc.)” and production expense of 5000 yen were distributed to junior high school students’ teams to make improvements of robots in the team, with a dimensional limit (width, height and depth are respectively within 40 cm) and within the 5000 yen limit for improvement costs. For the 2013 rules, the limitations were the same as those of 2012, with no limitation of the height dimension. In Robocon in recent years, usually, radio control and advanced control technology are used for robot control, but in this contest, a wired controller is used. The emphases

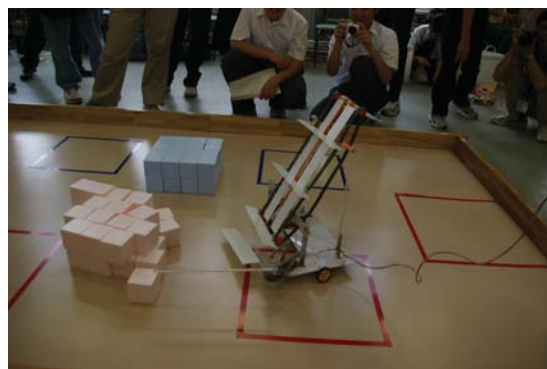


Fig. 3 Robot production training session 2 (July 28, 2012).

of the contest are on development of robot mechanisms, robot mechanism improvement, and interesting robot movement and behavior.

#### 2) Robot production training session 1 (May 19, 2012)

Robot production training session 1 was held on May 19, 2012 in Akita NCT. During this session, the robot construction set (Tamiya Inc.) and production expenses of 5000 yen were distributed to junior high school student teams. In addition, using a projector, the robot classification, rule description of the robot contest, and advice on robot production and machinery for various elements were explained. Moreover, according to the junior high school robot competition rules, the idea of the robot and prototype robot designed by Akita NCT Robocon student were presented to junior high school students (Fig. 2). However, in this case, we showed no robot in a finished form or in motion to the junior high school students. The possibility of interfering with junior high school students about the original robot design was our concern.

That day, the Robocon team students finally exhibited and controlled the motion of a robot that participated in the Kosen robot contest in the Tohoku area. The robot was larger (1.5 m × 1.5 m × 1.5 m) than the robot produced for the junior

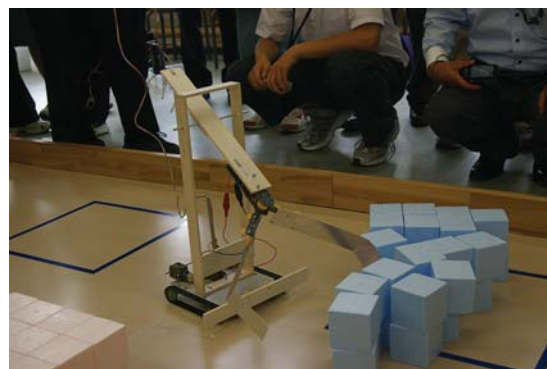


Fig. 4 Robot “AKAFUJI” prototype version. (Robot production training session 2 on July 28, 2012)

high school robot contest.

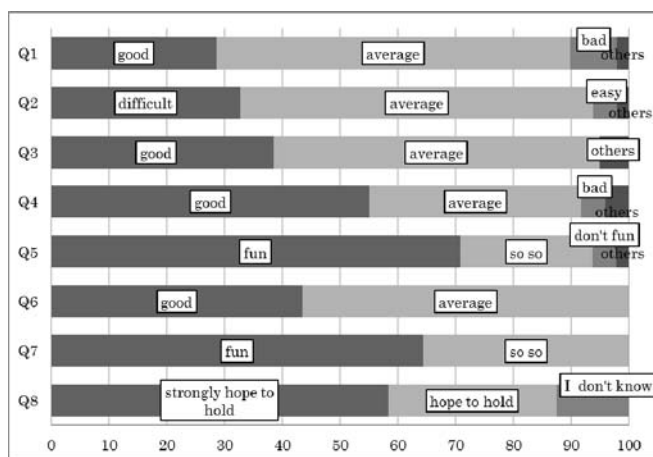
### 3) Robot production training session 2 (July 28, 2012)

Robot production training session 2 was held on July 28, 2012 in Akita NCT. The robot that junior high school students designed and manufactured in about two months was moved as a trial run in an actual competition field (Fig. 3). All teams combined and drew lots for the final competition on August 11, 2012. In addition, rule changes were discussed. The competition, held in August, hosted 17 teams from 10 junior high schools.

Although Robocon team students served as referees of the competition in August, they had a dry run as referees in the trial-run session on July 28, as described above.

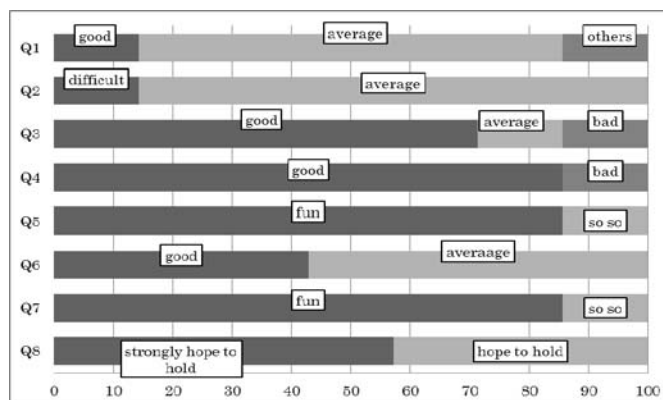
### 4) Competition (August 11, 2012)

The junior high school robot contest competition was held on August 11, 2012 in the Akita Community-based Center “ALVE” near Akita station. The 17 teams were divided into 5 blocks, with each block playing games in a round robin arrangement. Then one top team of each advanced to the final tournament. In the final tournament, the four teams “IZUMI KURO (Izumi Junior High School, Akita city)”, “SKS Minder (Honjokita Junior High School, Yuri Honjo city)”, “Index (Akita University Affiliated Junior High School, Akita city)” and “AKAFUJI (Dai-ichi Junior High School, Odate city)” played against each other. “AKAFUJI” won because it had higher scoring ability, control ability, and moving stability. Moreover, as a reason for victory, the “AKAFUJI” team used metal parts and wooden parts as robot components (Fig. 4).



Q1 Contents of competition; Q2 Difficulty of competition;  
 Q3 Robot production training session 1;  
 Q4 Robot production training session 2; Q5 Competition;  
 Q6 Event management; Q7 All about robot competition;  
 Q8 Next year's Competition

Fig. 5 What do you think about ----? Survey result for junior high school students about 2012 competition.



Q1-Q8 are the same as those shown in Fig. 5.

Fig. 6 What do you think about ----? Survey result for junior high school teachers about 2012 competition.

These ideas were not seen in the other teams. Metal and wooden materials can easily yield a lighter robot having a stronger structure. Furthermore, the degrees of freedom in robot design are increased. At the beginning of the event, as described later, the authors decided to teach simple metal material manufacturing processes (cutting, drilling, sanding, etc.) to junior high school students the next season. Before the final game, a team introduction and announcement of robot technology for the team which lost league qualification was performed. As an exhibition match, Akita NCT team and Akita Minato Lions Club team played against each other. Akita NCT Robocon team students, technical staff, and teachers served as competition referees.

## Results and discussion

The questionnaire was administered to students and teachers of junior high school after the junior high school robot contest in 2012 (Tanaka et al., 2013). The results for junior high school students are presented in Fig. 5. Those for teachers are depicted in Fig. 6.

As shown in Fig. 5, the responses to question 1 (Q1) showed that about 85% of students (including responses of “good” and “average”) regard the robot contest 2012 contents as suitable. However, according to Q2, it was recognized that about 35% students thought that the competition was “difficult”. Regarding the robot production training sessions 1 and 2, students think they are generally good (Q3, Q4). However, some students answered that they were “bad”.

As shown in Fig. 6, some junior high school teachers regarded the competition as “difficult” (Q2). For the robot production training sessions, about 72–85% teachers reported these sessions as “good” (Q3, Q4), but about 15% reported the sessions as “bad”. These “bad” results in Figs. 5 and 6 must be considered seriously.

Results obtained to date clarify that various changes and improvements should be made in the contest in 2013. Robocon team students who helped



robot contest management offered various opinions, impressions, and comments about the contest in 2012. As of June 15, 2013, robot production training session 1 in 2013 (May 25, 2013) had been completed. The points of improvement are the following.

1) Robocon team students show and demonstrate robot movement to the junior high school students in an actual competition field. The competition field was built about 2 months faster than last year. It gives a good opportunity for junior high school students to create a robot image faster.

2) Robocon team students were instructed one-on-one on how to process the metal (scribe work, drilling, cutting metals, sanding work) to junior high school students.

The robot production training session 1 in 2013 and training of metal processing are portrayed respectively in Figs. 7 and 8 (May 25, 2013). Reactions of the junior high school students and teachers to the session and training were good. The questionnaire was administered for Robocon team students of Akita NCT after the Robot production training session 1 in 2013 (May 25, 2013). The results are presented in Fig. 9. In question 1 (Q1) "Do you think that, as a result of making the prototype robot for junior high school students, the Robocon team ability of has improved?" In relation to this question, 100% of students think it is effective for the Robocon team ability. The percentages of other items obtained were the following: technical ability (50%), knowledge about robots (about 20%), planning ability (15%), and presentation ability (7%), and coaching ability (7%) (Q1-2).

Moreover, for the opportunity of demonstrating a prototype robot to junior high school student in the real competition field in advance, (Q2, Q2-2) about 85% of Robocon students think it is effective for improve Robocon team ability. Furthermore, they think that the effect is greatest for communication ability (50%), presentation ability (37%), and planning ability (12%).

Regarding the training of metal processing (presented in Fig. 8), about 72% of Robocon students think it is effective for improvement of the Robocon team ability. Furthermore, they think the effect is regarded as greatest in the order of coaching ability (43%), communication ability (32%). Technical ability and presentation ability were each 11% (Q3, Q3-2).

Then one can consider the result from Q4 to Q5-2. Comparing Q4 and Q5, about 72% of the Robocon team students think that contents of the 2012 contest were interesting, which includes "very interesting" and "interesting". However, in Q5, the percentage of fun decreases to 15%. Comparison of the results of Q4-2 and q5-2 revealed that the percentage of difficulty became a lower value in the results of 2013.

Subsequently, the robot production training session 2 in July and the competition in August 2013 will be held. After the competition, the authors will implement a questionnaire for junior high school students and teachers. We hope the competition in 2013 will be fun,



Fig. 7 Robocon team students show the robot in a real competition field (25 May 2013).



Fig. 8 Robocon team student teach junior high school students how to cut metal parts (25 May 2013).

easier-to-understand and more meaningful than last year for junior high school students.

## Conclusion

As described in this paper, the results of a survey conducted of the Robocon team students were considered. Results show that the activity of the junior high school robot contest had an educational effect on students. They are aware that it has improved not only the technical ability and knowledge of robots related to the manufacturing ability or Robocon, aside from presentation ability, communication ability, but also the coaching ability and planning ability, which had not been considered at all until now.

Up to that time, they had participated in the Kosen Robot Contest only as competitors. To work with the junior high school competition, they used various knowledge and experience related to robotics.

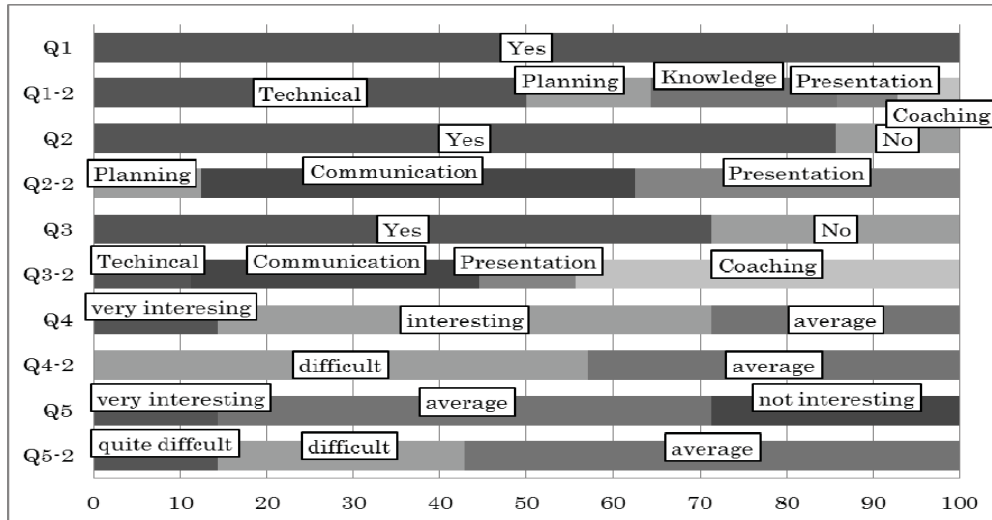
Consequently, they gained excellent experience as engineers, with multi-faceted thinking. This report presents results of a survey administered to junior high school students and the Robocon Team students, revealing strong effects of engineering education to Robocon team students at national colleges of technology.

Based on these results, the authors hope that Robocon team students can win the Kosen Robocon tournament of the Tohoku area, giving full play to their abilities as engineers.

**References**

Abukawa, Y, Kobayashi, Y, Nishino, T, Tanaka, M, Matsuo, K, Tsuji, N and Niiba, T (2012), *Robocon Activities in Akita National College of Technology*, Proceedings of Technology and Society Division JSME, No. 12-69, pp.7-8. (in Japanese)

Tanaka, M, Nishino, T, Kobayashi, Y, Matsuo, K, Tsuji, N and Niiba, T (2013), *Robocon Activities in Akita National College of Technology Part 3: Robocon Team Activities in Community Events*, Reserch Report of Akita National College of Technology, No. 48, 34-39. (in Japanese)



- Q1 Does Robocon team ability improve to make the robot for junior high school student?
- Q1-2 What kind of ability?
- Q2 Does Robocon team ability improve to show and explain about robot for junior high school student?
- Q2-2 What kind of ability?
- Q3 Does Robocon team ability improve to show how to o the scribe line, cutting, drilling and sanding the metal parts?
- Q3-2 What kind of ability?
- Q4 Do you think that the competition held in 2012 was interesting for junior high school students?
- Q4-2 Do you think that the competition held in 2012 was difficult for junior high school students?
- Q5 Do you think that the competition hold in 2013 will be interesting for junior high school students?
- Q5-2 Do you think that the competition hold in 2013 will be difficult for junior high school students?

Fig. 9 Surveys result for Robocon team students.