Data Driven Online Training Program for Education Robotics Competition

Suprabha Jadhav[a*], Sridhar Iyer[a] & Kavi Arya[a]
[a]Indian Institute of Technology Bombay, India
*suprabhaj@iitb.ac.in

ABSTRACT

Educational Robotics (ER) is a field of study that aims to promote active learning and engage students with the use of artifacts. An IIT BOMBAY project, "e-Yantra" uses Project Based Learning (PBL) approach to train students to be able to solve real-world problems through an Educational Robotics (ER) competition through one of its initiatives titled "e-Yantra Robotics Competition (eYRC)". Students participate in the competition to gain skills, knowledge, and hands-on learning experience. But due to lack of thinking skills, exposure to different domains and other constraints like academic commitments, students find it difficult to compete and eventually drop out of the competition. To address this problem, this project focuses on designing a data driven training program that will prepare students to help gain skills required for Educational Robotics competition.

Keywords

Educational Robotics (ER), robotics competition, training program.

1. INTRODUCTION

Educational Robotics is a research field that positively impacts the students' learning experience by implementation of hands-on activities where robots play an important and active role [1]. Robotics activities can promote different learning outcomes such as problem solving, self-efficacy, computational thinking, creativity, motivation, and collaboration. Many robotics kits have been designed and developed for educational purposes that provide opportunities for students to explore, implement and receive feedback. To benefit students from a robotics competition, aspects such as design of competition, student training, mentor's scaffolding, and teaching pedagogies are important [2].

e-Yantra conducts an online annual Robotics Competition for students to implement solutions to the real-world problems on sectors like waste segregation, medicine delivery, road maintenance, soil monitoring etc. Competition comprises detailed problem statement, task documentation, self-paced video tutorials, robotics kits, discussion forum, live mentor interaction to help students to learn, compete, and resolve their queries [3].

Few of the popular international competitions such as World Robot Olympiad (WRO) – India [4], Micromouse, RoboGames, ABU Robocon [5], RoboCup (Robot Soccer World Cup), VEX Robotics

Competition, Zero Robotics tournament, Robofest India, B.E.S.T Robotics Design Contest, Botball Educational Robotics Program, FIRST: Robotics Competition are designed for students of different age groups.

2. CURRENT AND PROPOSED WORK

The aim of my work is to create an online training program for undergraduate students participating in the e-Yantra Robotics Competition. To attain this, following are the goals:

Goal 1: Examine the need for an online training program using a data-driven approach.

Goal 2: Define the structure of the training program.

Goal 3: Determine the effectiveness of the training program.

To address Goal 1, I did a thorough analysis of 11 well-known tournaments. The investigation included determining the competition's purpose and categories, target audience, mode of conduct, training, resources provided (before, during, and after the competition), mentor participation, and role.

On the official website of competitions, information about the above factors was found but specific information about training and resources provided to students during competition and the role of mentors and other scaffolds made available was not found. On the other hand, competitions do provide some resources, notes, guides, rulebooks, certification courses for educators.

From the studies [8] and [9], it is evident that a major attrition rate is seen especially after the initial task i.e., Task 0. Major self-reported reasons include task difficulty, difficulty managing time, team coordination issues, beginners (participating for the first time), university exams clashing with competition task deadlines, participation in other events, and so on. To understand the issue further, data was collected in two ways:

    A.   Semi-Structured Interviews
    B.   Survey Form

  A.   Semi-Structured Interviews:

Interviews were conducted for students/teams of the ongoing competition edition 2022. It was not feasible to conduct interviews for all the participating teams on each theme given the number as highlighted in Table 1 below.

Table 1. e-Yantra robotics competition theme details

Theme name	No. of teams
Sentinel Drone (SD)	374
Functional RoadBot (FB)	376

Theme name	No. of teams
Swatchhta Bot (SB)	372
Delivery Bike (DB)	372
Krishi Bot (HB)	372
Pharma Bot (PB)	372
HolA Bot (HB)	372
Total	2610

Though eYRC is a collaborative competition, it was also important to know individual insights which might be missed in a team interview. Individual interviews were decided for the following two reasons:

- If there are ongoing team clashes, the student may share without being judged or feared by other team members
- For a particular question, if one student shares some insight, another team member might not take the effort of thinking and would end up saying the same thing.

To calculate the number of interviews considering different factors, the following was planned:

Table 2. Interview preparation details

Total themes	7	
Level	Low, Medium, High scorers	
Categories	Individual	Team
No. of teams to be interviewed/theme	1	1
Total members/team	2-4	2-4
Total no. of students to be interviewed	2-member team: 14 4-member team: 28	NA
Total no. of teams to be interviewed	NA	7
Total	14-28 students	Team

Random sampling was done to choose low, medium, and high scorer teams for 7 themes as shown in Table 3:

Table 3. Interview categories

Score/Level	Individual	Team
Low	HB, PB	FB, SB, DB
Medium	SD, SB, DB	KB, PB
Top	KB, FB	SD, HB

The objective of the interview was to understand challenges faced by participants, resources availability, and need for additional training. After 11 interviews, I started getting similar responses so no more interviews were conducted. The interview details are stated in Table 4.

Table 4. Interview details

Interview Time	~ 40 mins each
Platform	Webex
Data collection	Audio and Video recording

Figure 1 and Figure 2 shows few instances from interview transcript analysis:

S1: We had to learn all the basics. "Provided resources were enough but not sufficient"… We were exposed to the concepts for the very first time… Resources were good to get started..
As competition has deadlines knowing beforehand about the software will help teams "Basic information can be provided" through a training program

S2: If I did not have previous knowledge, it would have taken time to complete..
Training would be "good idea for newcomers"

S3: "Referred to a lot of YouTube links and stackoverflow" that consumed time..No additional support is required

S4: It's a competition, no training is required. Competitors will increase.
Self-learning should happen.."For learning, a training program is useful"

Figure 1. Screenshot of interview transcript done for individual interviews. S1 - Student 1, S2 - Student 2, S3 - Student 3, S4 - Student 4.

Following are few overall interview findings or insights:

- Low scorer teams lack knowledge so need training programs to learn basics.
- Top scorer teams either have learnt about domain knowledge through previous competition participation or done some courses so are able to submit the tasks.
- Training programs should contain theme-specific topic, coding.
- The training program should cover basics and should not clash with academics.
- The training program will be good for newcomers.

T1: Do not know how to code.. Difficulty in understanding octave..
"Participants will get a better idea". It will reduce the number of problems that are faced later.

T2: Referred additional resources and videos.. Training program "will be helpful to complete tasks easily, to improve skills, no need to refer additional resources, helpful if you give examples, how it works"

T3: "Advantage of knowing concepts before hand". Resources were helpful..
Beginners might find it difficult.."Training program would help to interpret info"

T4: Searched a lot..Not able to find.." Basic tutorials will be helpful"..
Don't know the correct path to reach solution. Additional support in form of video tutorials.. Training program can "help to learn new things, basics can be helpful"

Figure 2. Screenshot of interview transcript done for team interviews. T1 - Team 1, T2 - Team 2, T3 - Team 3, T4 - Team 4.

B. Survey Form:

Apart from interviews, a survey form was designed to collect data from larger groups of participants. It was to understand the need, topics, and duration of the training program. Total 2012 responses were received. Following are few insights:

1) Students were asked if there is a need for a training program before the start of competition. Figure 3 shows that 1645 (81.75%) students out of 2012, expressed the need for a training program. This resembles the responses received through interview. Students esp. from low and

medium scorer teams expressed that they are completely new to the topics introduced in the competition. As they lack basics, most of their time is invested in going through the resources and learning and less time is left to work on the tasks which leads to missing out on deadlines.
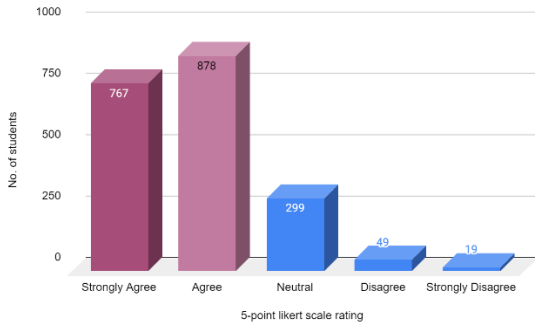

Figure 3. Need of training program

2) Students were also asked to rate if they referred to a lot of external resources while working on the tasks during competition.
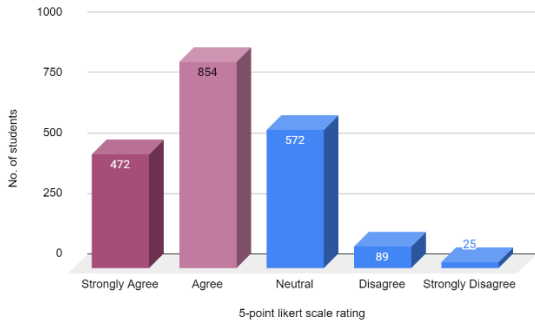

Figure 4. Referred external resources

Figure 4 shows that 1326 (65.90%) students felt that provided resources were inadequate and that made them refer to additional resources. This may be because as students lack basics they look out for more information.

3) Students were further asked if the training program at the start of competition would help them and how it would help them. Figure 5 shows the result for the former part where 1687 (83.84%) students responded that it would be helpful.
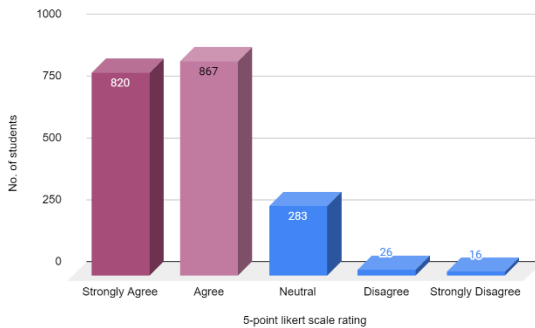

Figure 5. Help of training program

For the latter part of the question, text responses were analyzed. Out of 2012 responses, 512 were read thoroughly. Major responses stated the training program would help them to understand basics, gain knowledge, understand tasks better in competition, would be beneficial for newcomers, preparation before the competition would save time during competition which will help them to meet deadlines and not drop out and few responses were related to thinking and problem-solving skills. Above data collection and analysis helped me understand that students do need a training program and would be beneficial for reasons stated above.

To address Goal 2, further analysis of the survey responses was done. Following are the few insights:

1) Figure 6 shows the results for the duration of the training program. Student responded that the training program should either be less than or equal to 4 weeks. This may be because the competition is already 7-8 months long competition. Having a program more than 4 weeks will make it difficult for the students to manage their other activities. As per interview response from few teams, having the training program before the competition would be beneficial for them as they have summer break during that slot. So, a four-week program will not interfere with their academics.
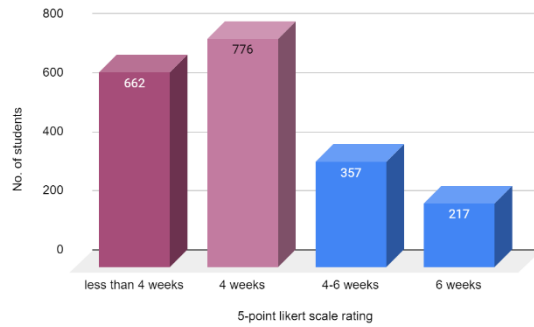

Figure 6. Duration of the training program

2) When asked if students would like to attempt a training program, the results obtained are as shown in Figure 7.
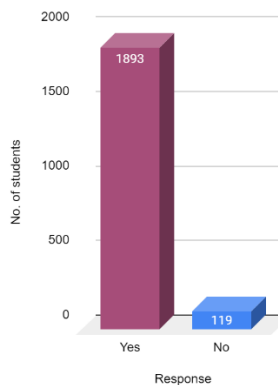

Figure 7. Attempt Training program

3) Students were also asked about what they think which topics should be covered in the training program. They responded with varied domains with most frequently

occurring Robotics and Embedded System (17.59%), Image processing (6.46%), Python (4.72%) and others were more theme specific topics. Student response is like the analysis done for domains covered in past years of e-Yantra Robotics Competition.

Above analysis leads to the conclusion that it is essential for students to get acquainted with different robotics concepts and research says that it should be taught through problem solving activities. According to ABET-mapped competencies (problem solving, communication, teamwork, ethics, life-long learning, math, science, engineering knowledge; engineering tools; experiments and data, design, contemporary issues, understand impacts), problem solving is an essential competence for undergraduates in engineering domain [6]. Authors have also identified problem solving as one of the important learning outcomes for Educational Robotics competition [2]. Various authors like Jonassen, Polya, Simon, Bransford and Stein, Hayes and Sternberg have proposed different problem-solving strategies that can be used while designing problem solving activities for the training program. Technical paper [7] states different principles that form the basis of problem solving in classroom or computer-based settings.

Work for Goal 3 is in the planning stage. We are planning to design an online training program that will be made available in the online mode and would include video tutorials, problem solving activities based around robotics and quiz.

3. ADVICE SOUGHT

Out of the above three stated goals, work for goal 1 is accomplished whereas for goal 2 is in progress. I need feedback on the work done towards two goals. For goal 3, I aim to design and implement the training program. I plan to collect the following data at three different instances through the training program:

1) Start: Pre-Questionnaire (this will give me an understanding of their prior knowledge)
2) During: Videos watched, problem solving activities, quiz attempted (this will give me feedback on the module wise content)
3) End: Semi-structured interviews, Post Questionnaire (feedback to their experience to further improvise the program)

This data will give feedback for the training program. The effectiveness of the program will be measured in competition with two groups (control and experimental). Research is at the early stage, and I hope the consortium can provide suggestions on following two questions:

1) What more data can be collected through the training program?

2) What are the analysis techniques that can be used?

4. ACKNOWLEDGMENTS

5. REFERENCES

[1] Angel-Fernandez, Julian & Vincze, Markus. (2018). Towards a Formal Definition of Educational Robotics. 37-42. 10.15203/3187-22-1-08.

[2] S. Evripidou, K. Georgiou, L. Doitsidis, A. A. Amanatiadis, Z. Zinonos and S. A. Chatzichristofis, "Educational Robotics: Platforms, Competitions and Expected Learning Outcomes," in IEEE Access, vol. 8, pp. 219534-219562, 2020, doi: 10.1109/ACCESS.2020.3042555.

[3] S. Krithivasan et al., "Learning by competing and competing by learning: Experience from the e-Yantra Robotics Competition," 2014 IEEE Frontiers in Education Conference (FIE) Proceedings, Madrid, Spain, 2014, pp. 1-8, doi: 10.1109/FIE.2014.7044136.

[4] "World Robot Olympiad (WRO) - India," [Online]. Available: https://wroindia.org/ [Accessed on: January 20, 2023.]

[5] "ABU Robocon," [Online]. Available: http://www.aburobocon2022.com/ [Accessed on: January 20, 2023.]

[6] Passow, H.J. and Passow, C.H. (2017), What Competencies Should Undergraduate Engineering Programs Emphasize? A Systematic Review. J. Eng. Educ., 106: 475-526. https://doi.org/10.1002/jee.20171.

[7] Foshay, Wellesley & Kirkley, Jamie. (1998). Principles for Teaching Problem Solving.

[8] R. Ekatpure, S. Jadhav, K. Karia and K. Arya, "Musical Mimicry to Learn Audio Processing," 2019 IEEE Tenth International Conference on Technology for Education (T4E), Goa, India, 2019, pp. 214-217, doi: 10.1109/T4E.2019.00048.

[9] K. Karia, R. Bessariya, K. Lala and K. Arya, "Learning While Competing - 3D Modeling & Design," 2018 IEEE Tenth International Conference on Technology for Education (T4E), Chennai, India, 2018, pp. 93-96, doi: 10.1109/T4E.2018.00026.