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Candy Thrust and Beyond: Advancing Space Outreach through Student Led Initiatives in India

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Abstract

This paper describes how student led workshops can be used to support space education and outreach in India. The main example is the "Candy Thrust" workshop, where undergraduate students learn the basics of solid rocket propulsion by designing, simulating, and launching sugar rockets. The workshop introduces propulsion concepts, safety steps, motor performance, and use of Open Motor software before participants build and test their own rockets. Feedback showed that students gained confidence, problem solving skills, and greater interest in space related fields.The Students for the Exploration and Development of Space (SEDS) chapter at BITS Pilani, Hyderabad Campus developed other workshops using a similar format. These included three day workshops on printed circuit board (PCB) design and proportional–integral–derivative (PID) control systems, as well as egg drop challenges that introduced material safety and avionics in a simple way. The framework was also adapted for outreach outside the university. In partnership with the Nirmaan Foundation, SEDS conducted smaller and simpler Candy Thrust sessions for underprivileged students in an event named Ignite, showing that the model can be applied to learners with limited prior exposure to STEM. The planning and delivery process used in these workshops can serve as a benchmark for other SEDS chapters in India, offering a clear and practical method for running lowcost, hands-on training. This paper presents the framework of Candy Thrust and other workshops as examples of how student groups can bring technical learning to a wider range of students.

Keywords: Space Education, Candy Thrust, Space Outreach, SEDS BPHC, Experiential Learning, Workshop Format, Workshop Design

Acronyms/Abbreviations

SEDS: Students for Exploration and Development of Space
BPHC: BITS Pilani Hyderabad Campus
PCB: Printed Circuit Board
PID: Proportional–Integral–Derivative
ISRO: Indian Space Research Organisation
DAQ: Data Acquisition
BOM: Bill of Materials
I²C: Inter Integrated Circuit
PWM: Pulse Width Modulation
KNDX: Potassium nitrate dextrose propellant
SLP: Solid Rocket Propulsions

1. Introduction

The objective of this paper is to analyse how student-led workshops can be used to strengthen space outreach and education in developing countries like India, with a focus on practical, faster and more accessible methods. A second objective is to use the data, inferences, and experiences gathered from attendees, presenters, and sponsors to outline a clear format for how such workshops can be structured and conducted. This format is intended to serve as a reference that other institutions and student groups can adopt to run their own programs effectively.

The work primarily builds on the Candy Thrust workshop, which introduced undergraduate students to solid rocket propulsion through a cycle of learning, simulation, and supervised rocket launches, and on other workshops conducted by the Students for the Exploration and Development of Space (SEDS) chapter at BPHC.

In India, achievements by ISRO and the growth of commercial space activity have generated widespread interest in space amongst the people. However, access to STEM learning opportunities remains uneven and unstructured, particularly for younger(below graduate level) and underprivileged students. By giving participants an accessible first step into rocketry and practical aerospace education workshops like Candy Thrust resolve this situation

Alongside Candy Thrust, SEDS BPHC also organized other workshops, including three day sessions on printed circuit board (PCB) design and proportional–integral–derivative (PID) control systems, Rocket Recovery, as well as egg drop challenges that introduced principles of material safety in a simple and engaging way. In addition, smaller scale Candy Thrust sessions were conducted in partnership with the Nirmaan Foundation, enabling orphans and underprivileged students to participate and gain access to space education which they would not have received otherwise. These activities showed that the model can be adapted to different technical topics and to audiences with varied levels of prior exposure. The workshops were planned and delivered entirely by students, which made them approachable and easy to replicate.

The rest of this paper is organized as follows:

- **Section 2** – Describes the materials, methods, and frameworks used in the Candy Thrust workshop and other workshops conducted by SEDS BPHC.
- **Section 3** – Presents results from participant feedback and workshop outcomes.
- **Section 4** – Analyses the responses , identifies challenges and tries to identify potential solutions.
- **Section 5** –Introduces the model developed from these experiences, which can be used by other student organizations and institutions to design and run similar workshops as a benchmark.
- **Section 6** – Concludes with key observations and recommendations.
- **Section 7** – Provides supporting figures, charts, survey data and images.
- **Section 8** – Acknowledgements to all those without whom the paper would not have been possible
- **Section 9** – References used for this paper

2. Material and methods

This paper discusses the workshops conducted by SEDS BPHC and the responses received from participants. This section provides information regarding the way the workshops were conducted.

Interested individuals were encouraged to register via Google Forms. Publicity (except for *Ignite*) was carried out through online posts, public notices, door to door campaigns, and public stalls.

Surveys were collected at least 90 days after each event to allow sufficient time to observe the workshops' long term impact. Data was gathered through Google Forms and direct interviews with participants, volunteers, and SEDS members. The survey questions aimed to evaluate both the participants' experience and how the knowledge gained was being applied in their daily life.

Preparation Protocol

- Trial runs of all events were conducted in advance with SEDS members.
- Materials required for the workshops were procured at least a week ahead of time.
- By the time publicity began, the workshop content and methods were fully tested.
- Instructors were involved throughout the process, from initial planning to final execution, and their presentations were refined in practice sessions

The details in the workshops are as follows:

Candy Thrust:
Participants developed their own solid rocket motors using the following materials:

- KNDX fuel (prepared in advance by the organizers)
- Fine bentonite clay powder
- Pre marked acrylic cylindrical casing
- Nichrome wires
- Mallet
- Ignition charge for ignition (prepared in advance by the organizers)

The motors were tested on a static test bench with an ignition system, both prepared in advance by the team.

The workshop followed this format:

- Introduction to basic rocketry concepts
- Training on OpenMotor simulation software
- Demonstration of solid rocket motor assembly
- Participant assembly of rocket motors
- Static firing of motors
- Closing and discussion

The workshop was conducted over three days, with the final day dedicated to assembly and static testing**.**

Ignite

Ignite is an event organised by the Nirmaan organisation, which brings children from orphanages to BPHC to attend various workshops over a three day period.

For this event, the Candy Thrust workshop was adapted into a single 4 hour session by SEDS BPHC.

- The primary focus was on the practical assembly of rocket motors.
- Information about rocketry was kept very simple and accessible.
- OpenMotor software training was omitted due to time constraints and the nature of the audience.

These decisions were made intentionally to suit the participants, primarily middle school students from orphanages ensuring the activity was safe, engaging, and understandable within the limited time frame. Firing was done in a safe manner under the supervision of SEDS BPHC members as well as preparation of hazardous substances.

Equilibria (PID Workshop):
Participants developed their own ball balancer systems using the following:

- Sonic sensor
- Arduino Uno
- MPU6050 sensor
- Jumper cables
- Servo motor

The code was first tested on a pre-made model, after which participants modified PID parameter values to stabilize the system.

The workshop had the following subtopics explored:

- Teaching Arduino coding basics
- Teaching MATLAB software
- Teaching practical assembly of electronic components
- Teaching I²C and PWM concepts
- Teaching of Kalman filter
- Commencement of workshop

In the case of Equilibria, this was divided into two days, with the final day dedicated to assembly and testing.

PCB Workshop:
Participants learned how printed circuit board (PCB) design works and developed their own simple game boards using the following:

- Laptops (brought by participants)
- KiCad software (free PCB design tool)
- PCB kits provided by the organizers (including an Arduino, custom shield, LCD screen, buttons, etc.)
- Soldering irons (provided by the organizers)

Interactive sessions were conducted where instructors built the PCB step by step along with participants, guiding them throughout the process.

The workshop had the following format:

- Teaching the basics of PCB design and its applications
- Introduction to schematic design
- Creating custom footprints (e.g., for the LCD screen used in the project)
  Explaining PCB layout and routing, with emphasis on good routing practices
- Teaching basic Arduino code to be flashed onto the boards
- Testing and playing the completed game
- Commencement of workshop

The workshop was divided into three days, with the final product ready on the last day. Many participants expressed satisfaction at having designed and built something tangible themselves.

3. Theory and survey results

3.1 Candy Thrust

- **Results and Data**
  - 80% of participants had no prior knowledge of solid rocket motors.
  - 55% were not confident about building one before the workshop.
  - Initial views of aerospace: 1:1:2 ratio for "not approachable," "slightly intimidating," and "neutral."
  - Over half found instructions clear; a minority disliked the direct teaching style.
  - 45% credited OpenMotor for understanding design; 56% said hands-on modelling boosted confidence.
  - 60% felt safe despite use of hazardous materials.
  - 78% would recommend the workshop; half wanted advanced follow ups.
  - Some said it did not affect career choices, but it made rocketry feel more approachable.
- **Anecdotes and Feedback**
  - Successful ignition gave students a strong sense of achievement.
  - Even failed tests created excitement and kept engagement high.
  - A short session on rocket history helped participants connect with the subject.
  - Simulations improved understanding by letting students visualize designs.
- **Participant Suggestions**
  - Cover more advanced content; basics alone were not enough for some.
  - Include quantitative results using a simple DAQ system with avionics/electronics.
  - Expand to larger groups while retaining the close interaction of small batches.
- **Presenter Reflections**
  - Delivery leaned too much on lectures; participants were given procedures rather than space to solve problems.
  - Visuals and supporting material (videos, handouts) were lacking; a dedicated content team is needed.
  - Roles among volunteers were unclear; future events need better task division and central leadership.
  - Dry runs and quizzes with peers would help instructors refine delivery and check clarity. Backup instructors and stricter timelines with buffers are also recommended.
  - More hands-on activities could make sessions livelier and less lecture driven.

3.1 Ignite

Event Overview

A one day workshop at BPHC introduced middle school children from orphanages to solid rocket propulsion. Sessions covered simplified propulsion basics, safety considerations, hands on assembly of sugar rocket motors, and supervised static tests. Most data for this report was collected through interviews with Nirmaan and SEDS volunteers present at the event.

Results and Data

- None of the participants had prior knowledge of solid rocket motors.
- All participants reported finding the instructions clear, though implementation showed significant errors, likely due to language barriers.

- No participants expressed concerns about material safety.
- Over half wanted advanced follow up sessions.
- Three participants approached after the workshop with questions about pursuing aerospace or propulsion careers.
- Random grouping of children was not optimal; grouping by learning pace or aptitude would improve outcomes.
- The presenter should not have been the sole communicator; reliance on translation chains slowed and complicated interaction.

Anecdotes and Feedback

- Successful ignitions created pride and joy among participants.
- Unsuccessful ignitions generated excitement, curiosity, or indifference, depending on the group.
- Language barriers caused major mistakes, even in cases where safety warnings had been repeated.

Participant Suggestions

- Split the workshop into groups for students learning at different speeds.
- Include native language speakers to improve communication.
- Allow each child to build two rocket motors instead of one, so mistakes in the first attempt could be corrected in the second.

Presenter Reflections

- Language barriers made delivery very challenging; a native Telugu speaker should ideally co-lead future sessions.
- Visuals and supporting materials were adequate, but stronger team by team guidance was needed.
- Volunteer roles, especially among Nirmaan members, were unclear. Defined responsibilities and central leadership are required in future.
- The same challenges identified in Candy Thrust were observed again in Ignite

4. Results and discussions

Given the nature of the workshops, analysis of the events yields both objective and subjective results. Due to limited data availability, and because the same parameters were not measured repeatedly, no reliable baseline could be established. As a result, much of the usable information consists of anecdotal evidence, participant feedback (subjective responses to subjective or objective questions), and objective data that nevertheless requires interpretation in a subjective context. Both categories of findings are discussed in detail below.

Objective Findings

A significant decrease in the total number of applicants to SEDS BPHC was observed in 2025–2026 compared to 2024–2025, falling from 155 applicants to 117 applicants, representing a 24% decrease. Whereas applicants in Archangel(Team conducting most of the workshops) increased from 20 to 30 , representing a 50% increase. This difference in growth can be largely attributed to the impact of the workshops conducted during this period, as well as the improved perception of Archangel within the broader student body on campus.

Additionally, the success of Candy Thrust prompted Nirmaan to incorporate a rocketry workshop into the Ignite event, which ultimately hosted up to 60 participants — the functional limit of the session. Initially, there was an attempt to accommodate over 130 participants, but operational and technical constraints from both SEDS and Nirmaan prevented this. This limitation could potentially have been avoided through the implementation of a pre-designed, standardized workshop format, making this a prime example of the need for such a framework

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Subjective Findings

Feedback from participants highlighted several recurring challenges:

- Language barriers
- Variation in preferred presentation speed
- Limited opportunities for self experimentation

Each is discussed in detail below.

1. Language Barriers

This challenge was evident in all workshops and particularly pronounced in Ignite, where the primary audience consisted of middle school students from orphanages. There was often a significant difficulty in understanding even basic instructions, and complex phenomena were even harder to convey. The solution employed was to use translators; however, this proved inefficient. Translators were not from SEDS BPHC and thus had to first understand the material themselves before conveying it in another language, resulting in information loss and frequent miscommunication between instructors and participants. The use of diagrams, visual tools, and demonstrations helped mitigate the severity of the problem, but did not fully resolve it. Potential solutions to the issue are as follows:

- Bilingual instructors to be utilised
- Translators familiarised with the material beforehand
- Usage of diagrams and such systems that surpass language barriers
- Prerecorded videos by bilingual instructors if availability on location is not possible
- Encourage written question and have native speakers of the particular language or people struggling with the instruction language being consulted in dry runs of the workshop
- Provide pre translated material to the participants to ease into the process
- Define the terms before the concept starts for people with a weaker vocabulary
- Ways to analyse understanding of the audience on the topic, so more problem solving that each member has to actively take a part in

2. Variation in Presentation Speed and Learning Rates

Maintaining participant attention was challenging, particularly given the wide variation in background knowledge and the often unclear awareness participants had of their own starting points. The workshop had to balance the delivery of prerequisite material with tight time constraints, creating a tension between coverage and depth. Moreover, inherent differences in learning speed persist — a problem for which no perfect solution exists. While this cannot be entirely eliminated, steps can be taken to ensure all participants reach a baseline level of understanding.

Possible solutions are as follows:

- One proposed approach is to organize learners into groups based on their speed and adapt instruction accordingly. Group learners by learning speed. Organize participants into groups based on how quickly they grasp concepts, and tailor instruction to each group.
- Provide preparatory materials – Share reading lists, short videos, or quizzes before the workshop to create a shared baseline of knowledge.
- Use frequent checkpoints – Include quick assessments or discussions during the workshop to gauge understanding and adjust pacing in real time.
- Encourage peer learning – Foster collaboration so that participants can assist each other, bridging individual gaps and reinforcing concepts.
- Balance coverage and depth explicitly – Identify core topics that everyone must understand, while offering optional advanced content for faster learners.

3. Limited Opportunities for Self Experimentation

Participants often struggled to fully grasp concepts and appreciate the breadth of problem solving strategies without hands-on experimentation. In many cases, they were given only a single attempt, without access to a comprehensive catalogue of potential variations or their effects. Furthermore, instructor knowledge limitations occasionally compounded this issue. A potential solution would involve developing and providing an accessible information repository, offering participants multiple opportunities to engage in the practical components, and structuring certain instructions as flexible guidelines — encouraging participants to discover solutions independently. Such measures could make the workshops more engaging, memorable, and educational.

- Create an accessible information repository – Develop a well organized catalogue of variations, their effects, and relevant background material for participants to reference during and after the workshop.
- Offer multiple practical attempts – Provide participants with more than one chance to experiment, refine, and re apply concepts, reinforcing learning through iteration.
- Structure instructions as flexible guidelines – Instead of rigid step by step instructions, offer adaptable frameworks that encourage exploration and problem solving.
- Promote independent discovery – Design activities that let participants test hypotheses, observe results, and draw conclusions themselves, strengthening conceptual understanding.
- Address instructor knowledge gaps – Conduct periodic instructor training or provide expert backup resources to ensure facilitators can confidently handle diverse questions and scenarios.

Summary

These findings indicate a clear need for the development and implementation of a dynamic workshop format — one that accommodates a wide range of participant needs, adapts effectively to individual learning preferences, and reduces logistical and technical inefficiencies. The specific requirements and proposed structure of such a format are discussed in the following section.

5. Proposed Workshop Model

From the experience of Candy Thrust and other workshops, we observed that success depended not only on the technical content but also on how the event was structured and delivered. To address recurring challenges such as uneven learning paces, language barriers, and unclear task division, we propose a simple and adaptable workshop model that other student groups can use as a benchmark.

5.1 Stages of the Event

The event is divided into four stages to ensure a logical and sequential flow:

- **Preliminary stage** — Develop the overall workshop plan, prepare a rough bill of materials (BOM), and submit the plan/BOM for required approvals.

- **Pre event stage** — Finalize the plan and BOM, assign member tasks, and run dry runs with peers to refine both content and delivery. Quizzes or peer feedback can help instructors check clarity. Backup instructors should be prepared, and strict timelines with buffer periods should be enforced.

- **Event stage** — Run the main workshop, including centralized instruction, group activities, and hands on work. A central coordinator manages time, safety, and transitions.

- **Post event stage** — Record activities in detail, collate logs and photos, collect survey data at the right time, and prepare reports for future iterations.

5.2 Division of Work

To minimize organizational friction, responsibilities are split into four categories:

- **Primary administrative** — Non technical coordination such as scheduling, permissions, registration, communication, and progress tracking.

- **Technical instruction** — Delivery of lectures, demonstrations, and guided problem solving. Presenters must be able to handle both planned and unplanned questions.

- **Technical preparation** — Development of kits, test rigs, simulations, slides, code, and demonstrations. A dedicated content team can help improve visuals and handouts.

- **Administrative support** — Non technical tasks such as venue setup, printing, inventory, participant check in, volunteer coordination, and publicity.

5.3 Structure of the Event Stage

Each workshop follows a six step structure:

1. **Pre workshop survey** — Collect participant background, language preferences, and expectations to form balanced groups and identify needs.

2. **Centralized instruction** — Short opening by the lead presenter to introduce objectives, essential background, safety rules, deliverables, schedule, and common resources.

3. **Problem statement** — Clearly define the task or challenge participants must work on, along with the success criteria.

4. **Group wise instruction** — Split participants into small teams, each guided by an instructor who adapts the pace and detail to the group. Translators or native language presenters should be included when needed.

5. **Practical application** — Participants build, test, and refine their projects. Encourage controlled trial and error learning, with DAQ or other measurement tools included where possible.

6. **Final discussion** — Conclude with group presentations, review of results, lessons learned, and immediate post event feedback.

5.4 Guidelines for Implementation

To ensure the success of this model and address the specific challenges we encountered, we also propose the following eleven guidelines:

1. **Group participants effectively**: Use pre workshop surveys and visual assessments to split participants based on their knowledge and learning speed.

2. **Prioritize linguistic diversity**: Ensure that presenters have a diverse linguistic background to overcome language barriers.

3. **Provide historical context**: Make participants aware of the history and potential uses of the technology they are learning about.

4. **Integrate simulations**: Whenever possible, have participants run simulations to provide them with direct, hands on experience.

5. **Offer multi format materials**: Provide instructions and materials in various formats, such as documents and videos, for easy reference.

6. **Provide a tangible takeaway**: Give participants something they can take home at the end of each day or at the conclusion of the workshop.

7. **Ensure presenter expertise**: All presenters must have a comprehensive knowledge of the subject to ensure the model's success.

8. **Conduct practice sessions**: Perform multiple teaching iterations before the final workshop.

9. **Allow for mistakes**: Create a safe environment where participants are encouraged to learn through trial and error.

10. **Keep sessions concise**: To prevent participant and instructor burnout, schedule the workshops over a period of several days with only a few hours of instruction each day.
11. **Take Utmost Care of safety**: Inexperienced people should not handle hazardous substances without adequate measures

This framework reflects both the strengths and challenges of our past events. By combining clear structure with adaptable teaching methods, it provides a practical template that other SEDS chapters and student groups across India can adopt for consistent and scalable outreach.

6. Conclusions

The series of workshops conducted by SEDS BPHC — from Candy Thrust to PCB design, PID control, and Ignite — illustrate the impact that student led initiatives can have in making technical education more approachable, engaging, and practical. These initiatives provided participants with valuable hands-on experience, boosting both confidence and interest in STEM.

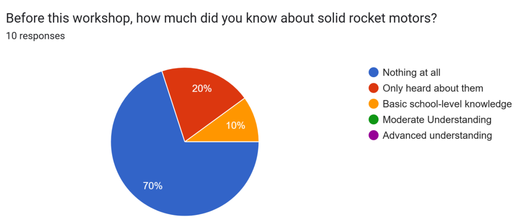
At the same time, recurring challenges — including language barriers, varied learning speeds, and demand for more advanced content — underscored the need for a structured and adaptable framework. The model proposed in this work addresses these gaps by defining clear stages, assigning specific roles, and introducing flexible teaching strategies suited to diverse audiences.

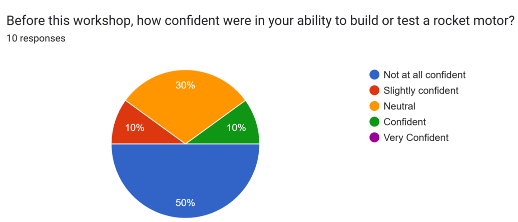
If widely adopted, this approach can serve as a benchmark for other student groups in India, enabling them to design and deliver effective, hands-on workshops. In doing so, it can expand access to space education, enhance technical training, and inspire a new generation of students to pursue engineering and science.

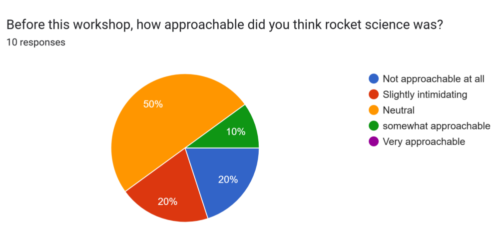
7. Appendix

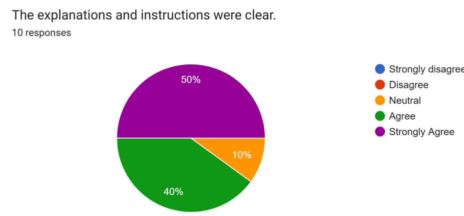
7.1 Data Charts

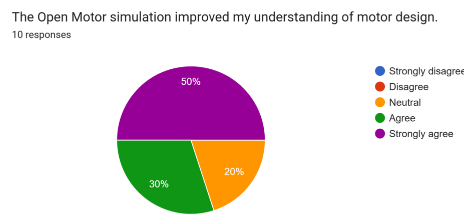
Each response represented a single team from the workshop, making it a strong reflection of the collective experience. While we acknowledge that the sample size was not very large, the responses still covered the majority of the workshop's participants. To strengthen our analysis, we also complemented these responses with anecdotes and observations, which provided additional depth and context to the insights gathered.

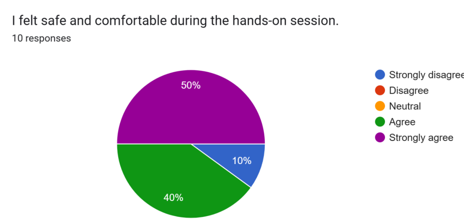


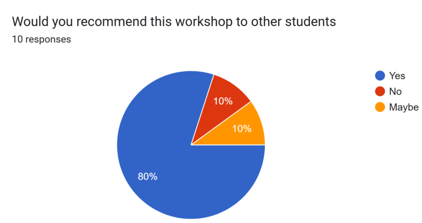


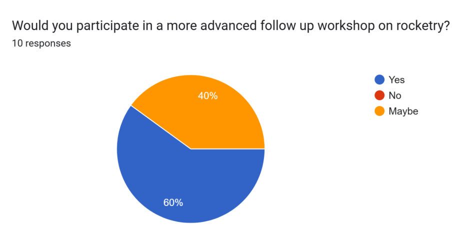




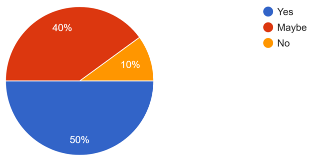




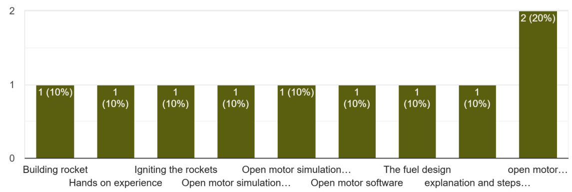




Do you feel likely to pursue aerospace or STEM - related activities after this experience?
10 responses



What was your favorite part of the workshop?
10 responses



One thing you learned or found memorable.
10 responses

- What regression means physically
- The testing of rocket period
- Testing the rocket
- My rocket exploded and another rocket had some crazy thrust 🤩
- Burning rocket
- History of rocketry , rocket fuel , Open motor simulation
- Igniting the rocket fuel.
- History of rocket fuel and open motor software
- Carefulness

7.2 Workshop Pictures

Candy Thrust (1)

Candy Thrust (2)

Candy Thrust (3)

Ignite with NIRMAAN (1)

Ignite with NIRMAAN (2)

Ignite with NIRMAAN (3)

Rocket Recovery Workshop (1)

Rocket Recovery Workshop (1)

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We thank SEDS BPHC for assisting with logistics and safety during Candy Thrust , PID , PCB.

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9. References

[1] **openMotor** — Open source internal ballistics simulator for rocket motor design. Available on GitHub as openMotor under MIT License. GitHub

[2] **BPS.space**: Developer of model rocket hardware such as the Signal R2 flight computer and thrust vectoring mounts. BPS.Space

[3] **Charlie Garcia**: Aerospace engineer (MIT '19) and launch systems developer who has publicly discussed collegiate rocketry and propulsion system development. 2021.satelliteinnovation.com

[4] **Indian Space Research Organisation (ISRO) – Outreach**: ISRO's engagement programs, national space exhibitions, and student outreach efforts