

Igniting Agency: Building a Firefighter Robot for Safer Communities in Nepal

Global STEAM & Leadership Challenges – Case Study



Robotics and STEM Project Exhibition Showcase

“In the narrowest, most vulnerable corridors of our cities, textbook formulas aren't enough to save lives—ingenuity is. By turning a classroom robotics lab into a workshop for public safety, our youth proved that they are no longer just passive consumers of technology, but the active protectors of their community

—[Ujjwal Koirala](#), STEAM educator and [Teach For Nepal](#) Alumnus

In the ancient, beating heart of Kathmandu and across dense urban hubs like Pokhara and Biratnagar, history and modern density live side by side. Many of these historic neighborhoods grew in unplanned ways over centuries. Houses are built tightly together, linked by highly congested pathways and incredibly narrow streets. While these neighborhoods preserve Nepal's rich cultural beauty and history, their layout creates a major public safety hazard. When a fire breaks out, traditional large fire trucks physically cannot pass through the narrow lanes to reach the center of the emergency. The consequences of this infrastructure gap have been devastating. Over the years, local communities have suffered severe losses of life, property, and hope. Most tragically, even brave first responders have lost their lives, becoming trapped while trying to fight fires in high-risk, tight spaces.

At Lympiya National School, we believed our science curriculum could no longer ignore this local reality. We set out to prove that technology education becomes truly meaningful when students step out of their textbooks to solve real, urgent community crises.

Building the Foundation: The Mini Robotics Lab

To turn this vision into reality, the school leadership established a specialized, resource-efficient mini robotics lab right on campus. We formed a dedicated club of 30 interested students from Grades 8, 9, and 10. These students jumped into a rigorous 60-hour training program that blended theoretical STEM principles with practical building loops.

To ensure our small-scale rescuer would actually work in the real world, the student club didn't just stay inside the lab. They carried their initial cardboard mockups directly into the narrowest corridors of Kathmandu to talk with local residents and neighborhood elders. These community members pointed out that standard wheels would immediately get stuck in the deep cracks of the ancient stone

pavements. It was this direct community feedback that led our student team to pivot entirely away from standard wheels and engineer a heavy-duty tracked drive system instead.

Before tackling the complex fire safety project, students built their foundational technical skills by working with over 40 distinct STEM models and robotics components :

- **Unmanned Ground Vehicles (UGVs):** Prototyping obstacle-avoidance rovers, maze-solving units, and search-and-rescue chassis to understand tracked navigation.
- **Unmanned Aerial Vehicles (UAVs):** Assembling mini drones and remote-controlled models to study aerodynamic lift, electronic speed controllers (ESCs), and radio frequency communication.
- **Mechanical Physics Applications:** Working with hydraulic models, DC power supplies, and gear systems to master mechanical advantage, torque maximization, and rotational work equations.

The Engineering Challenge: The Small-Scale Rescuer

With a strong foundation in place, we asked our student team a critical question: *How can we use our engineering skills to solve the real urban fire safety issues we see around us?* Inspired by stories of local rescue operations, the students decided to design a compact, lightweight, remotely operated rescue robot capable of entering high-risk, confined areas where humans cannot safely go.

Technical & Scientific Systems Engineered:

- **Tracked Movement Mechanics:** The young engineers bypassed standard wheels in favor of a heavy-duty tracked drive system. This configuration optimizes the distribution of weight over a larger surface area, providing the necessary traction and torque to climb over rubble, cross cracked stone pavement, and navigate the steep slopes of older alleys.
- **Wireless Systems & Electronics:** Students configured an onboard power system that runs smoothly for 30 minutes on a compact battery pack. They balanced the electrical current to support continuous mechatronic driving alongside a 30-meter wireless communication link.
- **Thermal Insulation Engineering:** To protect the internal circuitry, sensors, and camera units from the extreme heat of fire zones, students designed a specialized waterproof and heat-resistant protective body.
- **Real-Time Video Feedback:** The chassis features multiple real-time cameras. This allows the robot to send live video feeds back to rescue teams outside the hot zone, mapping hidden escape routes and finding trapped residents without risking human lives.

The road to innovation was far from easy. During early test runs, the high electrical current required for continuous mechatronic driving completely drained our prototype batteries within minutes, crashing the wireless video link. Rather than giving up, our Grade 9 students spent a week recalculating power distributions, ultimately configuring an optimized dual-circuit power system that safely extended runtime to 30 continuous minutes.



Final Prototype of the Firefighter Rescue Robot

Measurable Impact, Lifelong Agency

The 60-hour project culminated in a public, student-led STEM Exhibition. Our young robotics team successfully demonstrated over 40 distinct technical designs to an audience of school administrators, parents, industry professionals, and local community members. This public showcase transformed the students' relationship with technology. They were no longer just passive consumers memorizing tech facts from a screen; they stood as confident creators and civic innovators explaining their own work.

The exhibition proved that when a school provides open workshop spaces, students build essential technical skills alongside core leadership traits: communication, teamwork, and real accountability.

From Metrics to Mindsets: Key Educational Takeaways

Reflecting on this innovation journey, three core educational lessons stand out:

- **Real Problems Drive Hard Work:** Students absorb complex science and math much faster when they are using those formulas to build solutions for real issues affecting their families and neighbors.
- **True Collaboration Multiplies Impact:** This project succeeded because it brought everyone together. The school leadership, students, technical mentors, and the local community joined forces to turn a basic classroom lesson into a meaningful innovation journey.
- **Build for Long-Term Scalability:** A single robot prototype is only the beginning. This experience shows us that robotics clubs, hands-on labs, and school exhibitions can become a foundation for future-ready classrooms across Nepal.

Going forward, Lympiya National School plans to expand its robotics club model, launch new community-focused project teams, and assist neighboring schools in building practical, hands-on learning labs. We have proven that the true purpose of modern education is not to train children to pass traditional exams—it is to inspire them to shape the future of their communities.

For more information about the **Future of Work initiative**, visit the official [website](#).
Join the **Global STEAM Community** through [this link](#).

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