# Project Proposal

**Printable Robotic Boats in Early STEM Education**

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## 1 Background

STEM (Science, Technology, Engineering, and Math) education is increasingly important as new technologies become integrated into our society, and robotics has the power to engage students in multiple disciplines of engineering [1]. However, existing educational robotics kits cost hundreds or thousands of dollars and are mostly geared toward middle- and high- school age students [2]. This leaves robotics unaffordable to many schools, as well as neglects to introduce robots to impressionable elementary-age children. In addition, students are proven to learn more and be more engaged when allowed to design for themselves (Project-Based Learning) [3], instead of following the manufacturer's instructions for an unmodifiable robot, as most existing robotics kits provide [4]. Existing kits are also mostly only car-like vehicles, limiting the types of experimentation possible [5].

## 2 Objectives

We aim to increase technology literacy and inspire interest in STEM by bringing affordable and engaging robotics kits to children as young as kindergartners. The target cost is under $100 per robot, reducing the financial barrier of robotics education and making it possible to provide one robot per student, ensuring that every student can take creative ownership over her own robot. To broaden the robotics curriculum, we will design a robotic boat, which introduces new scientific concepts that existing robotic cars do not address, like hydrodynamics and buoyancy. The robots will have modifiable parameters for the students to experiment with, encouraging Project-Based Learning.

## 3 Methods

We are modelling our boat on existing paper robot cars [6], which are made of a flat sheet of low-cost material such as paper folded into a 3D structure, with basic electronics moving the vehicle. We will use Robot Compiler (RoCo) technology [7, 8] to create a

printable pattern for the paper chassis, with design parameters for student modification, such as length and width. This method of construction encourages iterative design [9], engaging students firsthand in the engineering design process.

In tandem, we will create a mobile or web-based app to control the boat, simplifying the programming of the electronics to a control system that kindergartners can understand. We will test our robot on five volunteer kindergarten students in a laboratory setting and evaluate their level of engagement and how well our product matches their capabilities. The end goal is to introduce a pilot program with our product in a class of kindergartners at a local school.

## 4 Expected Results

The boat will be made of paper (<$1), a NodeMCU board and motorshield (<$10), servos (<$10), and a power bank (<$20), bringing the total cost to under $50 per boat. This is a reduction of an order of magnitude from existing robotics kits. Students will also have greater flexibility in designing their own robots, fostering a sense of ownership over their project and resulting in a more engaged and open-ended learning experience. Specifically the students will be introduced to engineering, robotics, and physics, but will also develop their critical thinking and problem-solving skills.

## 5 Project Timeline

- Week 2: Have prototypes of mechanically-powered boat design. Decide on materials and general structure of boat.
- Week 3: Motorize boat and integrate electronics into design.
- Week 4: Interview kindergartners. Evaluate their motor and reasoning skills to determine age-appropriate controls over the final design of robot.
- Week 5: Design robot on RoCo. Decide on the parameters students will be able to modify.
- Week 7: Adding remote controls by creating app interface to control boat.
- Week 9: Test run robot on kindergartners. Evaluate their level of engagement and overall experience.

## References


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