

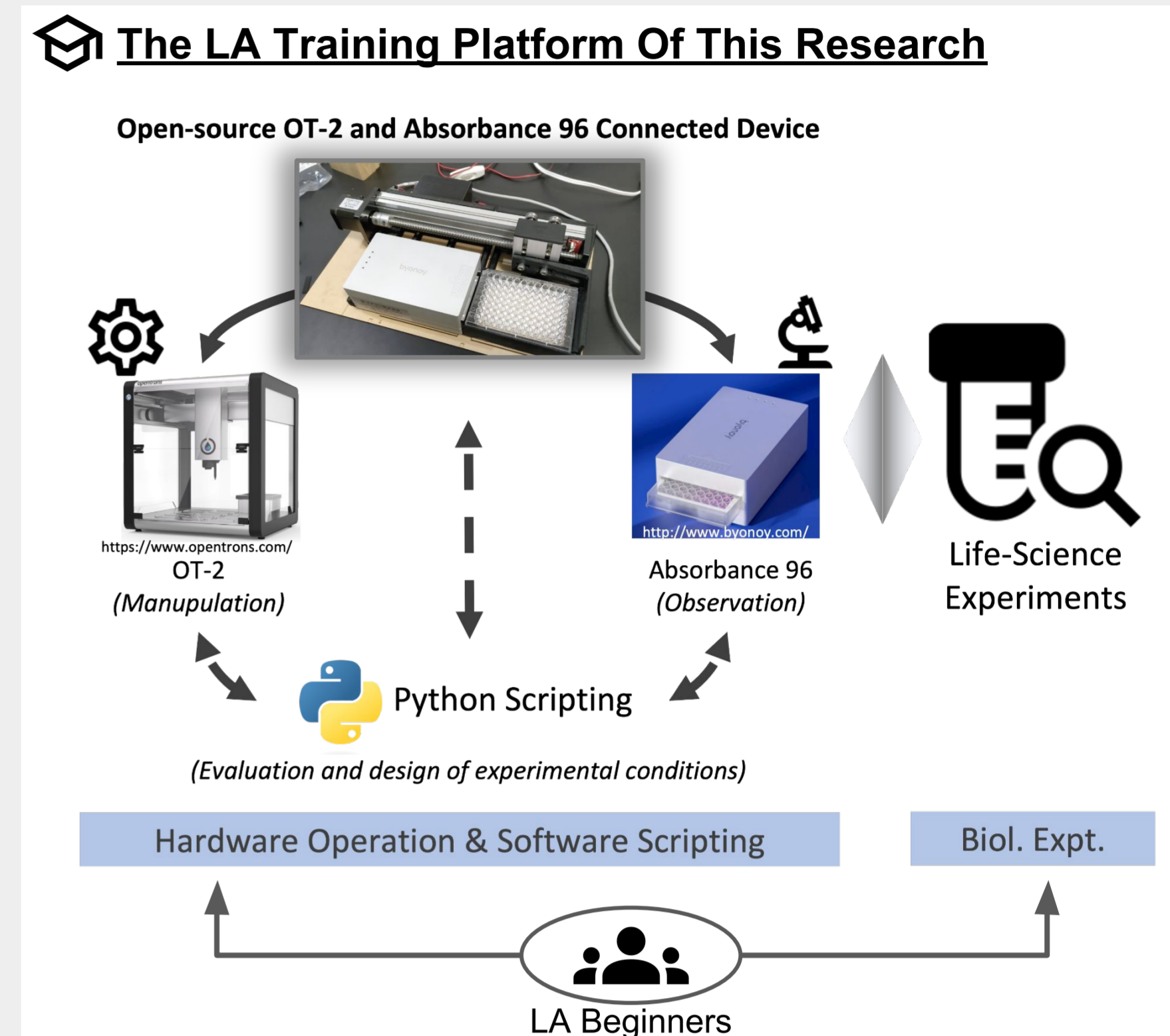
# A Minimal Open-Access Platform for Laboratory Automation Training

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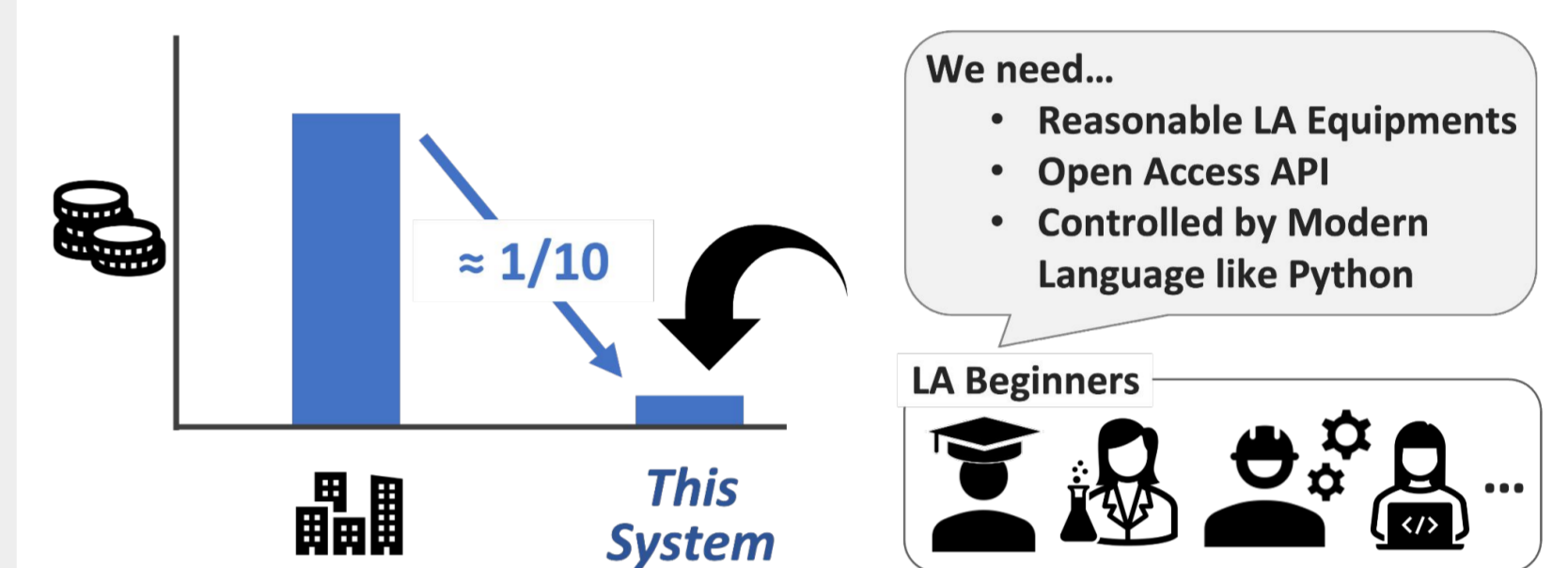
## Overview

- **Purpose:**
  - It is developing an accessible and cost-effective training platform for laboratory automation (LA) by the novel open-source device.
- **Methods:**
  - **Hardware design:** The device was designed by 3D CAD (Fusion360). The main body of the device was constructed of parts modelled on digital fabrication equipment and cost-effective components.
  - **Electronic design:** The actuator was controlled using the open-source G-CODE firmware grbl, which runs on CNS-Shild/Arduino.
  - **Software design:** The platform was controlled by Python.
- **Results:**
  - The novel open-source device connecting an OT-2 liquid dispenser (Opentron) to an Absorbance-98 plate reader (Byonoy) was developed.
  - The novel LA training platform was developed and enables manipulation (liquid handling), observation (absorbance measurement), and the evaluation and design of experimental conditions.
  - The LA training platform was used to train undergraduate students at Keio University in Japan. The focus of the training was optimizing solutions using Bayesian estimation.

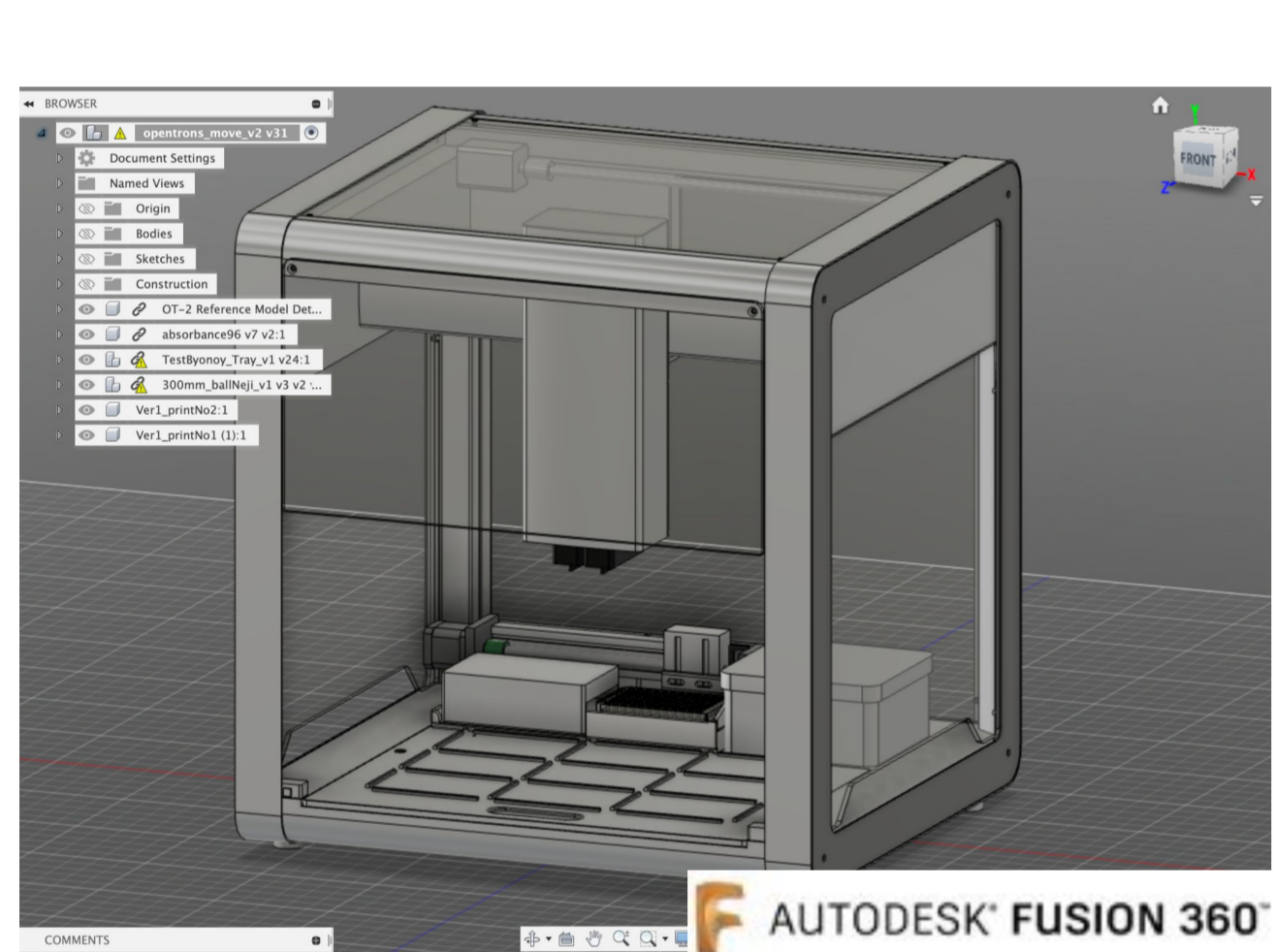


## Introduction

Laboratory automation (LA) in experimental biology contributes to the advancement of basic research, biotechnology, and medicine by enabling experiments beyond human capabilities. The demand for LA professionals is growing, but effective training platforms are still scarce. Closed and often proprietary programming environments and the high cost of LA equipment hinder the widespread implementation of efficient training in educational institutions. Currently, affordable LA devices like the OT-2 (Opentron) and Absorbance96 (Byonoy) exist, yet no device integrates them to develop a cost-effective LA training platform. This study aims to fill this gap by developing novel open-source equipment.



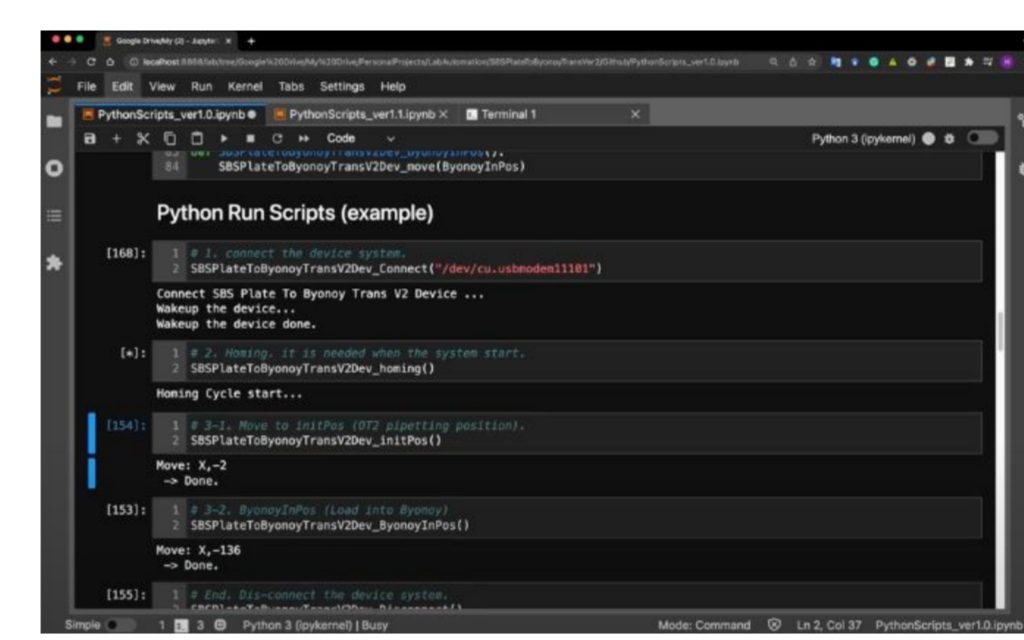
## The Novel Device Development: Integrating the Opentrons OT-2 and the Byonoy Absorbance-98



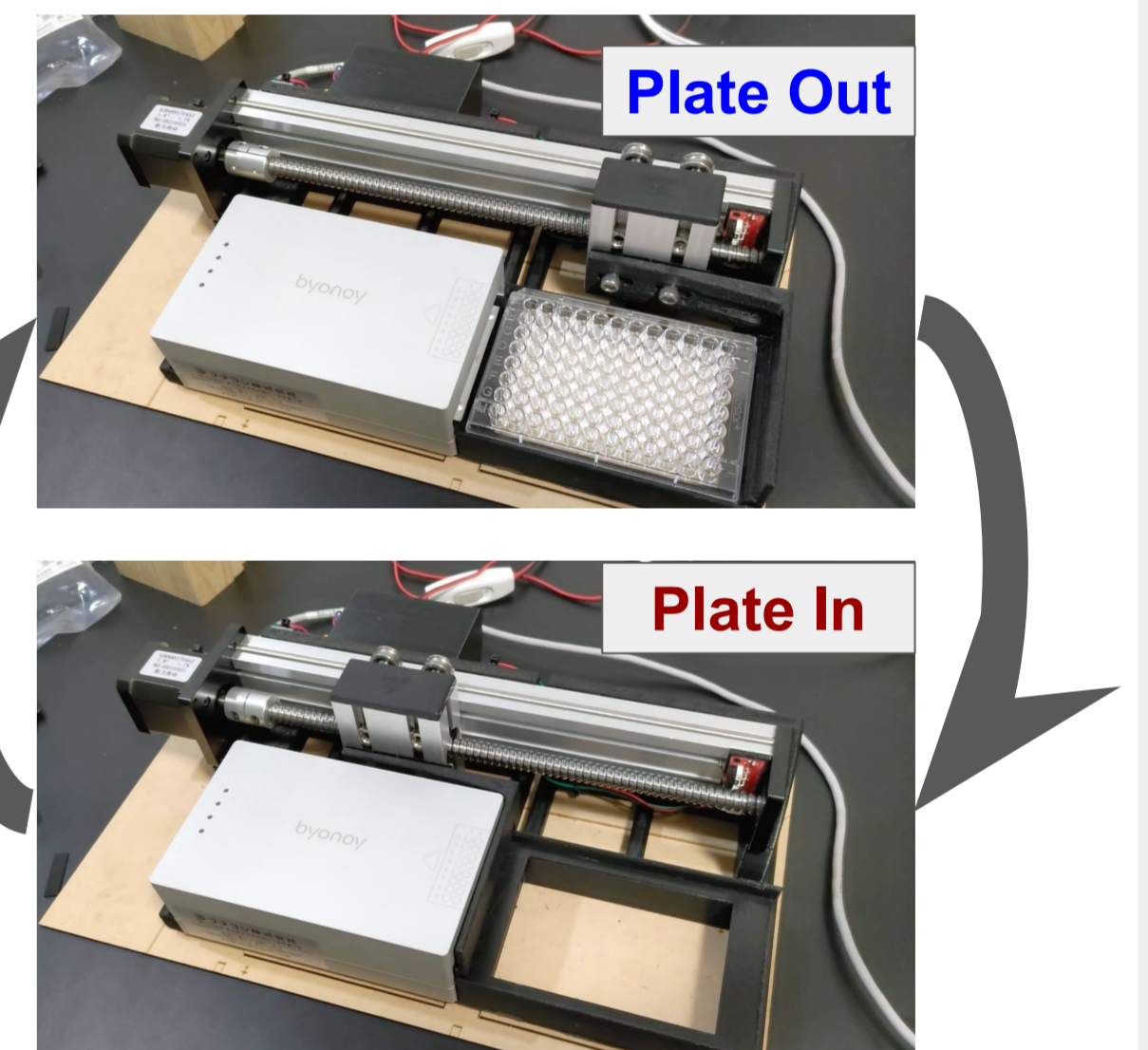
Designing



Creating parts with digital fabrication equipment, and purchasing electronic parts and others.



Python programming for machine control using G-CODE.



Operation check

We designed a simple, robust device using the OT-2 open-source hardware design (<https://github.com/Opentrons/ot2>) and Fusion360 (Autodesk). Following DIY-LA principles, we used a 3D printer and laser cutter to fabricate parts, with other components purchased. We controlled the stepping motor through the grbl firmware (<https://github.com/gnea/grbl>) on a CNC-Shield, utilizing Python classes developed for G-CODE command transmission. After final operational verification, the device construction was completed.

## Results

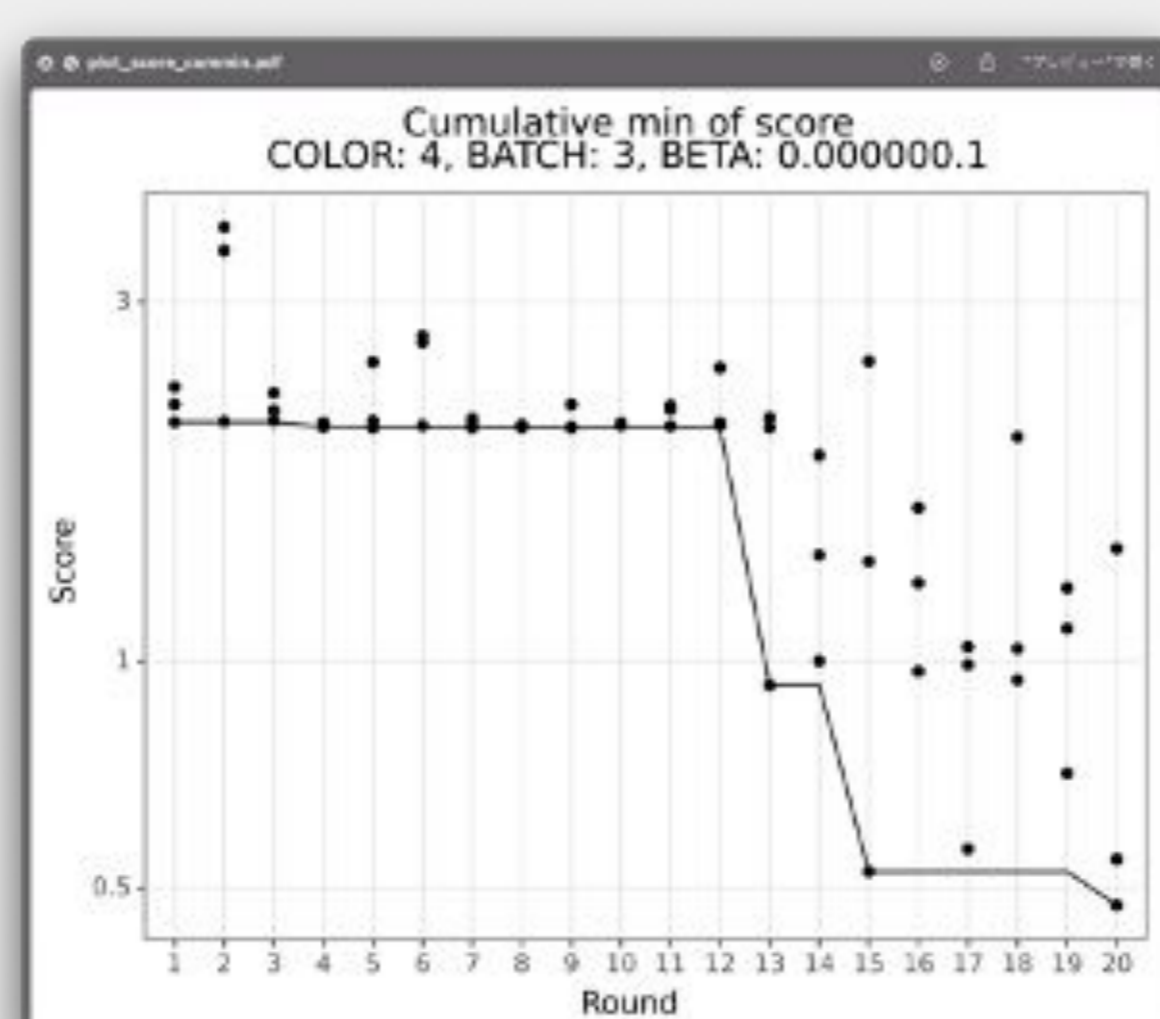


### ● Device Evaluation

- We experienced challenges with aligning the device and Absorbance-96 (Byonoy), requiring multiple design revisions.
- Finally, we were able to establish an open access system that is both robust and highly maintainable.

### ● Evaluation as This LA Training Platform

- Undergraduate students at Keio University learned the fundamentals of LA using the developed system.
- The students created a Python script for colour water adjustment, controlling the OT-2 (Opentron), observing with Absorbance-96 (Byonoy), and evaluating and designing experimental conditions using Bayesian optimization, successfully achieving automatic adjustment to a specified colour.
- Including both hardware and software issues encountered during the exercises, the system demonstrated a high level of educational effectiveness.



## Conclusions

The use of open source technology removes the cost barrier associated with developing specialised equipment. This platform would make LA training more accessible in educational institutions, enabling coherent learning of hardware, software and biology.

## Acknowledgements

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