# SUPERCHARGE

## STEM-based University Pathway Encouraging Relationships with Chicago High schools in Automation, Robotics, and Green Energy

NSF ITEST Award # 2148429

*Primary objective: Create programmatic infrastructure that will increase the number of students from underrepresented and underserved groups who choose to pursue STEM fields at the postsecondary level.*

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1. Motivation
2. Goals
3. Program Structure
4. Outcomes and Conclusions (so far)
5. Partnership opportunities

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Primary objective: Create programmatic infrastructure that will increase the number of students from underrepresented and underserved groups who choose to pursue STEM fields at the postsecondary level.

**Motivation: Lack of representation in STEM fields among underrepresented racial groups**

### 1.1.3 Percentage of Bachelor's Degrees Awarded to Underrepresented Minorities by Discipline

Table 3: Percentage of Bachelor's Degrees Awarded to Underrepresented Minorities by Discipline 16.8 % of Total

| Discipline Name | Degrees Awarded |
|---|---|
| Civil | 22.7% |
| Electrical | 19.7% |
| Envr. Eng | 19.7% |
| Industrial/Manufacturing/Systems | 19.5% |
| Petroleum | 19.5% |
| Computer | 18.3% |
| Mechanical | 17.4% |
| Civil/Environmental | 17.3% |
| Architectural | 16.9% |
| Aerospace | 16.5% |
| Other | 16.3% |
| Chemical | 16.1% |
| Computer Sci. (inside Eng.) | 16% |
| Biomedical | 15.4% |
| Nuclear | 15% |
| Engineering (General) | 14.7% |
| Electrical/Computer | 14.3% |
| Computer Sci. (outside Engr.) | 13.3% |
| Engineering Management | 12.7% |
| Biological and Agricultural | 12.6% |
| Metallurgical and Matrls. | 12% |
| Engr. Science and Engr. Physics | 11.1% |
| Mining | 6.1% |

Source: ASEE By the Numbers, 2022

Table 1. Demographics of partnering high schools

| School | Farragut HS | Roosevelt HS | Simeon HS | Westinghouse HS | CPS District | State of Illinois |
|---|---|---|---|---|---|---|
| Enrollment / Attendance | 651 / 85% | 954 / 89% | 1338 / 88% | 1203 / 93% | 363,954 / 93% | 1,984,519 / 94% |
| School Demographics | 86.2% Hispanic, 12.9% Black, 8.2% Asian, 0.8% White, 0.2% Two or more races | 70.4% Hispanic, 12.8% Black, 8.2% Asian, 5.8% White, 1.3% Pacific Islander, 1% American Indian, 0.5% Two or more races | 1% Hispanic, 98.6% Black, 8.2% Asian, 0.1% Pacific Islander, 0.3% Two or more races | 39.4% Hispanic, 52.8% Black, 4.7% Asian, 2% White, 1.1% Two or more races | 46.6% Hispanic, 36.6% Black, 4.1% Asian, 10.5% White, 0.2% Pacific Islander, 0.3% American Indian, 1.6% Two or more races | 26.4% Hispanic, 16.7% Black, 5.1% Asian, 47.6% White, 0.1% Pacific Islander, 0.3% American Indian, 3.8% Two or more races |
| Low Income | 97.4% | 94.0% | 88.6% | 77.0% | 77.9% | 48.8% |
| English Language Learners | 28.4% | 34.1% | 0.1% | 3.0% | 19.4% | 12.1% |
| Graduation Rate | 57% | 70% | 92% | 94% | 77% | 86% |
| Post-Secondary Enrollment in 12 months | 48% | 60% | 68% | 87% | 68% | 73% |
| Science Proficient / Not Proficient (State Science Assessment) | 4% / 94% | 6% / 89% | 0% / 95% | 16% / 81% | 34% / 65% | 49% / 51% |
| SAT Math (% meeting standards) | 6% | 8% | 3% | 41% | 27% | 35% |

Source: Chicago Public Schools

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**Program Goals:**

1. SUPERCHARGE Scholars (high school student participants) will increase their knowledge of STEM domains and careers; specifically, those related to renewable and sustainable energy systems, robotics, and technology. Simultaneously, they will increase their understanding of the secondary and post-secondary pathways that lead to attainment of STEM careers.
2. SUPERCHARGE Scholars will increase their interest toward STEM careers and will demonstrate improved self-efficacy for career-related skills and for attainment of STEM careers.
3. SUPERCHARGE Designers (undergraduate STEM-related majors at the university) will increase their awareness of "societal and contextual factors [that] constrain the opportunities for students from underrepresented groups to develop identities as STEM learners and professionals, and to participate in activities that can stimulate those interests and identities." [5]
4. SUPERCHARGE Teachers (school-based teachers in after-school programming) will increase their knowledge of STEM domains and careers and will improve their knowledge of resources for students who are interested in pathways to STEM careers.

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**Program Structure:**

- Weekly after-school club at 4 CPS high schools, approx. 90 minutes per meeting
- Weekly after-school activities are led by 2-3 teachers at each school
  - Teachers are provided compensation and summer PD
  - Teachers are not expected to be subject-matter experts, but serve as mentors
- Weekly activities are on a public website, about.illinoisstate.edu/supercharge
  - Hands-on activities are developed by ISU undergraduate students and ISU faculty one year in advance
- Extra activities
  - Spring workshop in Chicago
  - Summer STEM workshop in Chicago
  - Fall on-campus visit to ISU
  - Support from local Community-Based Organizations (CBOs)

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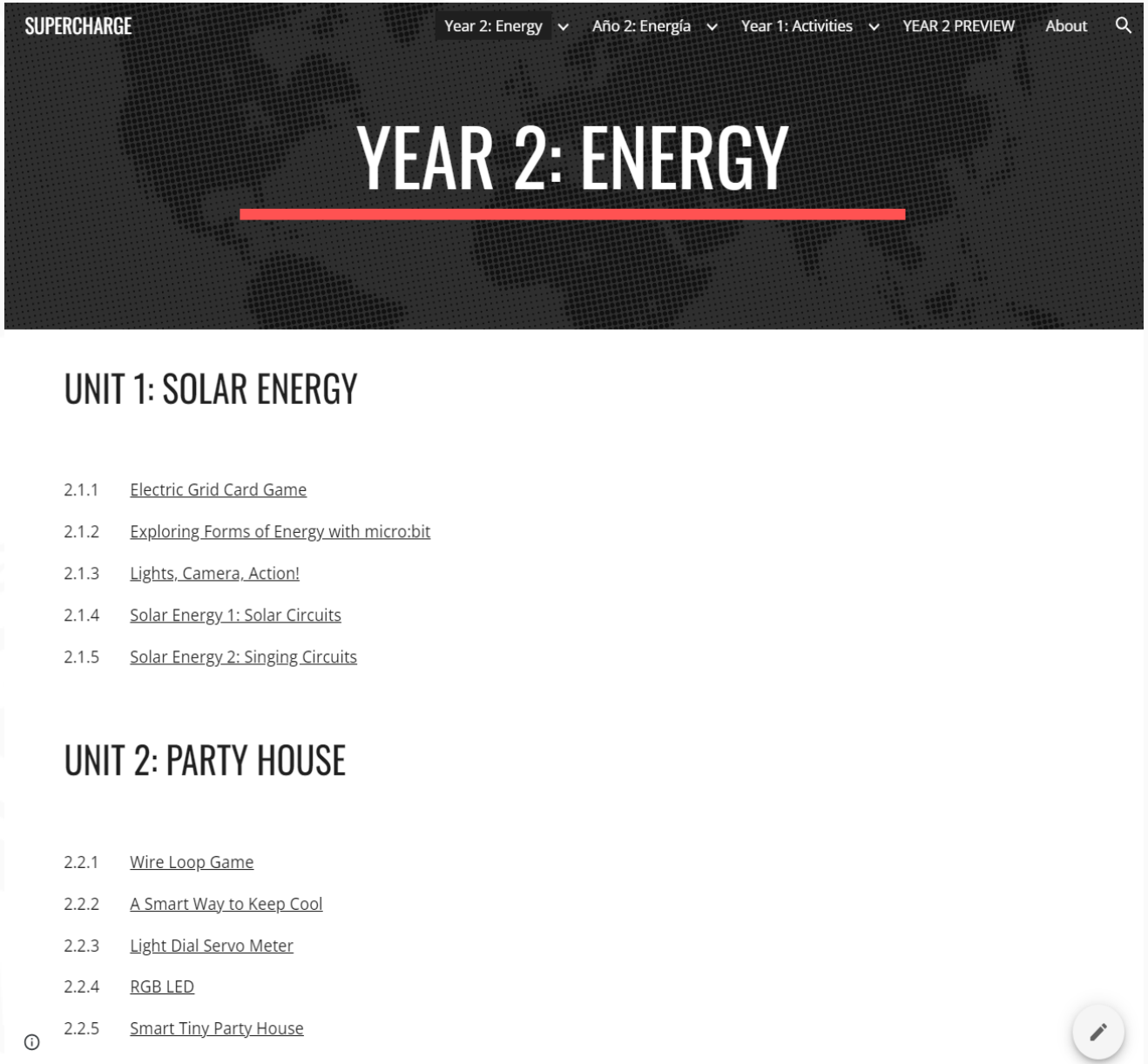
**Website:**



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## Typical Weekly Activity:

What to expect

Connections

Materials

Instructions

“Think about it” ?’s

Feedback

Next time - preview

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Year 2: Energy | Año 2: Energía | Year 1: Activities | YEAR 2 PREVIEW | About

2.1.3

Lights, Camera, Action!

**What to expect**

How much energy do you use in your daily life? When you flip on a light switch or use a hair dryer, how much does that increase your energy consumption? These are questions that we are going to answer today. During this activity, we will investigate our electrical energy consumption using a device that measures electrical power and energy.

**Connections**

In the previous activities, we have seen different forms of energy and electricity generation. In this activity, we will investigate the amount of electrical energy consumed by different kinds of devices. In the next few weeks after this, we will explore one type of renewable electricity generation in more detail: solar energy.

**Materials** (per group of about 3 students)

- 1 Electricity Meter and extension cord
- Light Bulb Socket with cord and on/off switch
- Phone to use as a stopwatch

**Test Devices** (shared between groups)

- Incandescent Light Bulb
- LED Light Bulb
- RGB remote-control LED Light Bulb
- Halogen Light
- Hair Dryer
- Plug-in electrical device of your own (optional)

**Instructions**

This activity contains two parts. First, we will use the  Electricity Meter to measure how much power different electrical devices consume, how much energy they use, and how much money they cost to operate. Second, we will use the micro:bit to measure the light output from each light bulb and compare their light output to their power consumption.

Part 1: Measuring Power, Energy, and Cost

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**Program Structure:**

Fall on-campus visit to ISU

Oct. 30th, 2024

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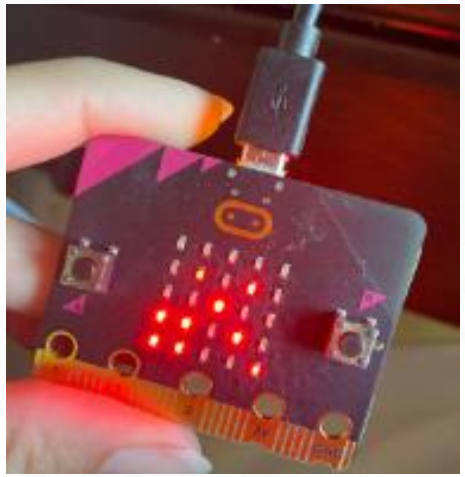
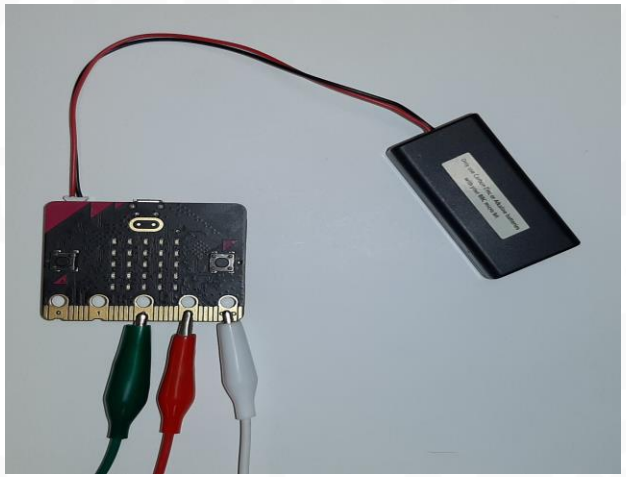
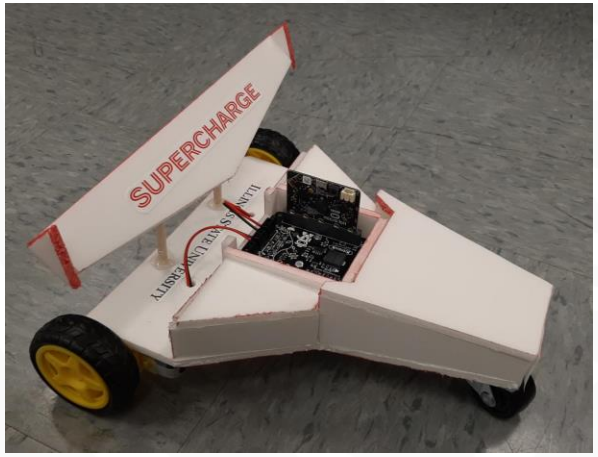
Activities/Projects:





Every student receives a micro:bit, which is the foundation for most other projects




Student projects: RC car, dual-axis solar tracker, & “Smart Weather Station”

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Teacher Professional Development Workshops: Summer 2023


Introduction to micro:bit at the summer PD workshop for teachers

Teachers build RC cars at the summer PD workshop

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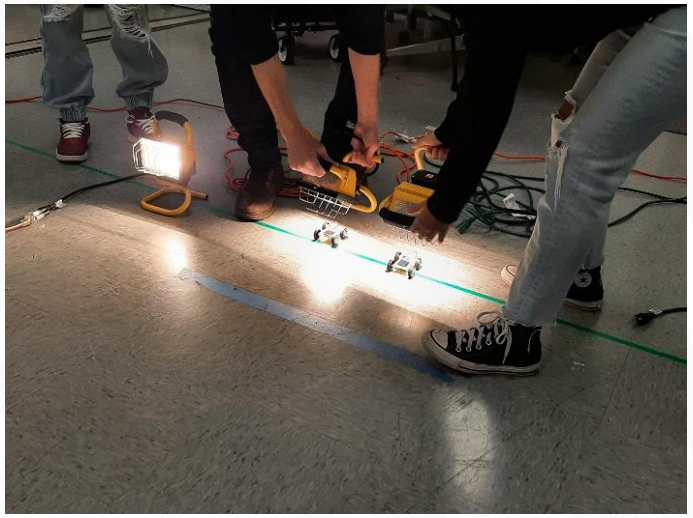
Campus visit to ISU:
October 2023



High school students build solar cars in the ISU Renewable Energy Lab

High school students learn about robotics in the ISU Manufacturing Lab

Visiting ISU Admissions

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Spring 2024 workshop at Farragut High School:
Students build their own electric grid, and program a Smart Home

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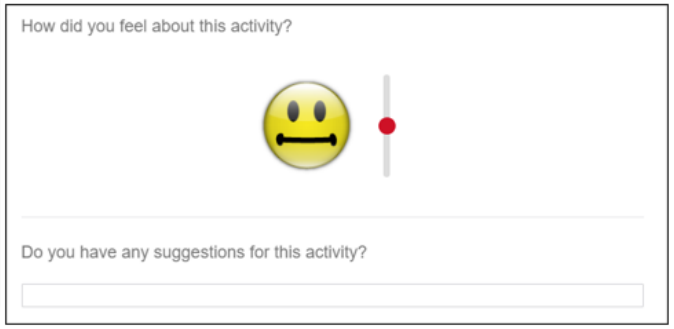
**Outcomes:**

Feedback after every weekly activity




a. Feeling=5 b. Feeling =4 c. Feeling =3 d. Feeling =2 e. Feeling =1

Table 3. Survey question 1 for Unit 1.1: Introduction and first micro:bit challenge

| Feeling value | Count |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 2 |
| 5 | 9 |

Table 4. Survey question 1 for Unit 1.2: Calculating your carbon footprint

| Feeling value | Count |
|---|---|
| 1 | 0 |
| 2 | 1 |
| 3 | 2 |
| 4 | 12 |
| 5 | 3 |

Table 5. Survey question 1 for Unit 1.4: Investigating thermal properties of materials

| Feeling value | Count |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 2 |
| 4 | 1 |
| 5 | 5 |

Table 6. Survey question 1 for Unit 1.5: Community Connection – Green Infrastructure

| Feeling value | Count |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 1 |
| 5 | 2 |

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**Outcomes:**

Surveys with Undergraduate student curriculum designers and CPS teacher-mentors

Table 1. Undergraduate Student Activity Designers' and Teachers' Perceptions of ease of using specific STEM engagement practices from very hard (1) to very easy (4)

| STEM Activity Engagement Practices | Role | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| Choosing activities that allow for hands-on exploration of STEM content | Designer | 2.60 | 0.55 | 2.00 | 3.00 |
| | Teacher | 2.57 | 0.79 | 2.00 | 4.00 |
| Leading activities that allow youth to engage cognitively with STEM content | Designer | 2.20 | 1.10 | 1.00 | 4.00 |
| | Teacher | 2.57 | 0.79 | 2.00 | 4.00 |
| Ensuring activities are inclusive of students of all backgrounds | Designer | 3.00 | 1.23 | 1.00 | 4.00 |
| | Teacher | 3.14 | 0.90 | 2.00 | 4.00 |
| Delivering activities that build toward meaningful STEM learning goals | Designer | 3.60 | 0.55 | 3.00 | 4.00 |
| | Teacher | 2.57 | 0.79 | 2.00 | 4.00 |
| Ensuring all students actively participate in STEM activities | Designer | 3.20 | 0.84 | 2.00 | 4.00 |
| | Teacher | 2.86 | 0.90 | 2.00 | 4.00 |
| Supporting students to share their ideas and opinions | Designer | 3.20 | 0.84 | 2.00 | 4.00 |
| | Teacher | 3.29 | 0.76 | 2.00 | 4.00 |
| Helping students to connect STEM activities to the real world | Designer | 2.00 | 1.41 | 1.00 | 4.00 |
| | Teacher | 3.14 | 0.69 | 2.00 | 4.00 |
| Allowing students to make decisions that impact their STEM learning experience | Designer | 2.80 | 0.84 | 2.00 | 4.00 |
| | Teacher | 3.43 | 0.54 | 3.00 | 4.00 |

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**Conclusions:**

1. Micro:bit is a capable, budget-friendly technology upon which to build beginner- and intermediate-level programming and robotics curriculum.
2. Teachers perceived more difficulty around delivering meaningful STEM activities and ensuring all students participate in the activities. Undergraduate student activity designers , meanwhile, perceived more difficulty around connecting STEM activities to the real world and allowing students control over their own STEM learning experience.
3. In Year 1, program recruitment was successful at three of the four target high schools. Interviews with the teacher-mentor at the fourth high school yielded insights including i. students are only interested in attending the club if their friends are attending, ii. the program should start as early as possible in the school year so that it becomes part of students' routines. Another high school will be added in fall 2024 to bring the program back to four high schools.
4. The preferred method of communication varied among team members, particularly between undergraduate students and faculty.

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**Partnership opportunities:**

We are always looking for guest speakers and field trip opportunities, especially in the Chicago area!

- After school club (~ 1 hr), spring workshop (~2-3 hrs), or summer workshop (~2 days)

# Thank you.

# Questions?

The authors wish to gratefully acknowledge funding support from the National Science Foundation ITEST Program, Award # 2148429.