Developing a K-12 iSTEM Program

Overcoming the Challenges

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School District of the Chathams
Suburban School District in Morris County, New Jersey

Total Student Population: ~4,150
Total Teaching Staff: ~400

Six Schools
- High School (Grades 9-12): ~1,200 students
- Middle School (Grades 6-8): ~1,050 students
- Upper Elementary (Grades 4-5): ~650 students
- Lower Elementary (Grades K-3): ~1,250 students (3 schools combined)
1. Program Overview

An overview of our program
Program Overview

K-5 Level
- Weekly STEM Instruction (40 minute “special”)

Middle School Level (Grades 6-8)
- Required 6th Grade STEM Course
- Elective STEM Cycle Courses (students self select)
- Marking Period in Length (~40 days)
Program Overview

Design & Technology

K–5 Design & Technology

6th Grade
- iSTEM*
- Robotics

7th Grade
- Computer Aided Design
- Creativity & Design

8th Grade
- Grand Design Challenge
- Digital Game Design

* = required course

All other courses are electives.

Chatham Middle School
Program Overview

High School Level (Grades 9-12)

- Combination of Full Year and Half Year STEM Courses
  - Robotics & Computer Science
  - Architectural & Engineering Design
  - Video & Media Production
Program Overview

Video & Media Production

- Digital Media Design (Semester)
- Video Production (Semester)
- TV Production (Full Year)
- Short Films (Semester)

Architectural & Engineering Design

- Introduction to Design & Innovation (Semester)
- 3D Engineering Design (Full Year)
- Architectural Design (Full Year)
- Design Studio (Semester)

Robotics & Computer Science

- Animation & Movement (Semester)
- Robotics & Controls (Semester)
- Game Design w/ Python (Semester)
- Programming in Java (Semester)
- AP Computer Science Principles (Full Year)
- Advanced Robotics (Full Year)
- AP Computer Science A (Full Year)

Only Robotics & Controls and Game Design w/ Python can serve as a prerequisite for Advanced Robotics.
Program Overview

Design & Technology

- **Authentic Problem Solving**
- **Project-Based Learning**
- **Collaboration**
- **Innovation**
- **Critical Thinking**
- **Perseverance/Grit**

**ASK**
What is the problem?

**IMPROVE**
How can you make your solution better?

**IMAGINE**
What are possible solutions?

**CREATE**
Follow your plan and fabricate your solution.

**PLAN**
How will your solution work/look like?
2. **Developing Our Vision**

Where we started and where we wanted to go with regards to integrative-STEM education
Community Context | 2013-2014

- Vocal community group
- District desire to improve & expand STEM programming

**BUT**

- Growing enrollment
- Depressed state aid
- 2% property tax levy cap
K-5

- **Curriculum:**
  - No STEM-focused curriculum
  - Focus on computer technology & keyboarding

- **Facilities:**
  - Computer labs
  - Teachers rotated and/or signed up to utilize the space

6-8

- **Curriculum:**
  - No STEM-focused curriculum

- **Facilities:**
  - No dedicated computer lab
  - Teachers signed up for access to ChromeBook or laptop carts

9-12

- **Curriculum:**
  - Electives in robotics, technology education, and computer science
  - No AP Computer Science offerings

- **Facilities:**
  - One Technology Education lab
Developing our Vision

● **Analyzed Our Existing Program:**
  ○ We were excelling in the “S” and “M” in STEM (science and mathematics).
  ○ Shortcomings → Engineering & Computer Science

● **Developed a Plan:**
  ○ Develop elementary (K-5) and middle school (6-8) STEM programs.
  ○ Hire a computer science educator to develop and implement computer science offerings.
Developing our Vision

Design & Technology

- **Authentic Problem Solving**
- **Project-Based Learning**
- **Collaboration**
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Making Our Vision a Reality

Steps we took, funding we secured, curriculum we designed, and staff we hired to make our vision a reality.
Making Our Vision a Reality

● **Finances**
  ○ **2014 → Second Question** (separate ballot for specific programs that would exceed the 2% tax cap)
    - Enhance and augment our district Technology Education/STEM program with the addition of staff, materials, and updated facilities.
      - Added one (1) STEM teacher to each elementary school
      - Added three (3) STEM teachers to Chatham Middle School
      - Added two (2) additional STEM teachers to Chatham High School
  ○ Utilized breakage to hire a district supervisor to oversee the STEM program.
Making Our Vision a Reality

Hiring Staff

- **Qualifications:**
  - Background in integrative STEM
  - Knowledge of technology (and not just using it)
  - Understanding of the engineering design process
  - Background in computer programming (if possible)

- Almost all staff members are Technology Education certified.
  - Graduates from The College of New Jersey’s Technology Education/iSTEM Program.
Making Our Vision a Reality

- Hiring Staff

**Chatham High School**
- 4 Teachers
  - Computer Science
  - Engineering/Architecture
  - Video/Multimedia
  - Robotics/Engineering

**Chatham Middle School**
- 4 Teachers
  - Each teacher teaches one Design & Technology course in each grade level (6, 7 & 8)

**Lafayette School**
- 1 Teacher
  - 4th & 5th Grade Design & Technology

**Milton Ave. School**
- 1 Teacher
  - K through 3 Design & Technology

**Washington Ave. School**
- 1 Teacher
  - K through 3 Design & Technology

**Southern Blvd. School**
- 1 Teacher
  - K through 3 Design & Technology
Making Our Vision a Reality

- Developing Curriculum - Elementary School

<table>
<thead>
<tr>
<th>Grade</th>
<th>Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>A Home for all Seasons</td>
</tr>
<tr>
<td>First Grade</td>
<td>Agriculture Around Us</td>
</tr>
<tr>
<td>Second Grade</td>
<td>Our Environment, Our Health</td>
</tr>
<tr>
<td>Third Grade</td>
<td>Every Drop Matters</td>
</tr>
<tr>
<td>Fourth Grade</td>
<td>The Power of Solar</td>
</tr>
<tr>
<td>Fifth Grade</td>
<td>Community Connections &amp; Transportation</td>
</tr>
</tbody>
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Elementary Schools
Making Our Vision a Reality

- **Kindergarten (Introduction to the Process)**
  - Ask
  - Improve
  - Create
  - Plan

- **First Grade (Focus: ASK & IMAGINE)**
  - Ask
  - Improve
  - Create
  - Plan

- **Second Grade (Focus: PLAN & CREATE)**
  - Ask
  - Improve
  - Create
  - Plan

- **Third Grade (Focus: IMPROVE)**
  - Ask
  - Improve
  - Create
  - Plan
Making Our Vision a Reality

- Developing Curriculum - Middle School

**2013-2014**

**Web 2.0**
- **Teacher:** German Certification

**Individual vs. Technology**
- **Teacher:** ELA Certification

**Music Technology**
- **Teacher:** Music Certification

**2019-2020**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Subject</th>
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<tbody>
<tr>
<td>6th</td>
<td>iSTEM*</td>
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Chatham Middle School

**Teacher:** Technology Education Certification
4. Overcoming Obstacles

The various obstacles we needed to overcome over these past five years and how we did so
Overcoming Obstacles

● Finances Necessary to Get Program Off the Ground
  ○ Second Question & Breakage

● Lack of STEM Educational Facilities at Middle School & High School Levels
Step 1: Purchase Whiteboard Tables & Storage
Overcoming Obstacles

- **Step 2: Referendum**

  **2016 Referendum Proposal**
  - $3.8 million addition
  - Three STEM Labs
  - Shared Storage Space
  - Prototyping Lab
Overcoming Obstacles

- **Step 2:** Referendum - Broke Ground November 2017
Overcoming Obstacles

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Overcoming Obstacles

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Overcoming Obstacles

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Overcoming Obstacles

- **Step 2:** Referendum - Broke Ground November 2017
Step 2: Referendum - Broke Ground November 2017
Overcoming Obstacles

Step 3: Requesting Furniture Donations from Ed. Foundation

Chatham Education Foundation

VIDEO/MEDIA PRODUCTION
CLASSROOM & STUDIO
Overcoming Obstacles

- **Step 3:** Requesting Furniture Donations from PTOs
Overcoming Obstacles

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Overcoming Obstacles

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Breaking Down Barriers

How we increased access to special education students and females through our scheduling and course design
Breaking Down Barriers

- Major programmatic goal → ensure STEM access to **ALL** students.
  - K-6 required courses ensured all students experienced STEM at an early age.
  - Our high school computer science classes were opened to freshmen with mathematics prerequisites removed.
Breaking Down Barriers

- Created a basic and introductory computer science course entitled "Animation & Movement" designed for students who want to dip their toe in the water of computer science without getting bogged down with syntax.
  - Computer Science Special Education Enrollment: 20.09% (at school average)
  - Design & Technology Special Education Enrollment: 26.7% (6 percentage points higher than school average)
Breaking Down Barriers

- Major programmatic goal → ensure STEM access to **ALL** students.
  - Saw our enrollment in 8th grade **Coding** course was low.
  - We polled the students and renamed the course **Digital Game Design**.
  - Enrollment increased by 55%!
High School Computer Science Enrollment

- **2013-2014**: 0 AP Computer Science Sections
  - Total CS Enrollment: 45
- **2014-2015**: 1 AP Computer Science Sections
  - Total CS Enrollment: 207
- **2015-2016**: 2 AP Computer Science Sections
  - Total CS Enrollment: 211
- **2016-2017**: 2 AP Computer Science Sections
  - Total CS Enrollment: 210
- **2017-2018**: 2 AP Computer Science Sections
  - Total CS Enrollment: 196
- **2018-2019**: 3 AP Computer Science Sections
  - Total CS Enrollment: 214

375% increase!
Breaking Down Barriers

- **Animation & Movement Enrollment Statistics:**
  - 56% male; 44% female
  - 32% of students are classified as special education students [having an Individualized Education Programs (IEP)]
Evening Out Our Female Enrollment:

- Early access to STEM.
  - Starting in Kindergarten.

- Ensure our project themes and course names are gender neutral and/or provide student choice.
  - Females have a desire to make a difference in the world and want to use STEM to change other people’s lives for the better (climate change, poverty, homelessness, environmental issues, medical improvements).

- Have female role models/teachers.
  - Teaching staff:
    - 55% female
    - 45% male
Breaking Down Barriers

Evening Out Our Female Enrollment:

- High School Level → Combined our CAD course with our introductory machines/tools course.
  - Named the new course **Introduction to Design & Innovation** and emphasized the design process over product creation.
  - Within 2 years, the course was 54% female and 46% male.

**Previous Year:**

- **Males:** 71%
- **Females:** 29%
Breaking Down Barriers

Results:

- **2013-2014**: Male: 71%    Female: 29%
- **2014-2015**: Male: 63%    Female: 37%
- **2018-2019**: Male: 58%    Female: 42%

After 1st Year

After 5th Year
Breaking Down Barriers

Results:

- Awarded the AP Computer Science Principles Female Diversity Award for having higher than 50% female enrollment in AP Computer Science.
  - 56% male; 44% female
  - Previously: 86% male; 14% female
● Develop a well articulated program spanning as many grade levels as possible. *(early access to STEM is key!)*

● Make your courses are accessible to **all** students.
  ○ Review any prerequisites *(Are they necessary? Are they blocking access to any specific student groups?)*.
  ○ Making sure your course titles are inviting.
  ○ Ensure course topics/themes/projects permit student choice.
  ○ Develop some entry level courses that allow students to try out STEM in an inviting and developmentally appropriate manner.

● In terms of facilities updates, be patient.
  ○ Work with what you have.
  ○ Slowly make upgrades/changes.
  ○ Visit other schools.
  ○ Investigate the possibility of a second question or referendum.
THANK YOU!

Disclaimer:
What works for our district may not work for yours. Each of our districts have distinct differences that make us unique and curriculum should be reflective of the needs of our students and programmatic goals as a whole.

One size does not fit all.