STEAM Program

A Proposed Innovation Academy
at the
Greater Lawrence Technical School

Innovation Plan

Submitted to Greater Lawrence Technical School - School Committee

February, 2017

Table of Contents

This Innovation Plan is submitted by a team of educators, parents, and STEM industry experts, who are collaborating with the Greater Lawrence Technical School to create an Innovation Academy called the **STEAM Program**.

What is an Innovation Academy?

Per CHAPTER 71 - Section 92 (Innovation Schools) of the General Laws of Massachusetts, an Innovation School is a public school operating within a public school district, or **an academy within an existing public school** [Section 92 (e)] **(e.g. Greater Lawrence Technical School),** that can be established to implement creative and inventive strategies and increase student achievement, through increased autonomy and flexibility. It receives the same per pupil allocation that a school receives, and is reviewed annually by the district superintendent to ensure that the school's goals and implementation plans are being met.

An Innovation Academy can have an advisory board, and have increased autonomy and flexibility in one or more of the following areas: curriculum, budget, school schedule and calendar, staffing policies and procedures, professional development, and school district policies. There are 40 Innovation schools/academies in operation throughout Massachusetts.

The Innovation Plan:

- Includes the academy's vision, learning environment, preliminary curriculum and instruction plan, anticipated schedule, preliminary staffing and budget (key elements required in a the Innovation [Implementation] Plan
- Follows the Massachusetts Department of Elementary & Secondary Education Innovation Schools guidelines, statute, and regulations http://www.doe.mass.edu/redesign/innovation/

The Innovation Plan will be reviewed by the Innovation Plan Committee (maximum of 11 members) that includes up to five STEAM Program team members; Superintendent Lavoie; principal Elizabeth Freedman; a school committee member; a parent who has one or more children in the district; and two GLTS teachers (one nominated by the teachers' union).

The Innovation Plan Committee's purpose: (i) develop the innovation plan; (ii) assure appropriate stakeholders are represented in the development of the proposed academy; and (iii) provide opportunities for stakeholders to contribute to the development of the school. The innovation plan will convey the areas of autonomy and flexibility required, and include student outcome goals and achievement data.

Once the innovation plan is completed by the Innovation Plan committee, two-thirds of votes cast by the Local 1707 Teachers' Union are required to approve the innovation plan. If approved, the plan then goes to the GLTS school committee for approval. If approved, the academy will be authorized as a district innovation academy for a period of up to 5 years, and can be reauthorized by the school committee at the end of each five (5) year term.

Information Sheet

Name of Proposed Innovation Academy: STEAM Program

School Location: If approved, the STEAM Program will operate within the Greater Lawrence Technical School – serving students in Lawrence, Methuen, Andover, and North Andover.

Primary Contact Person: John Lavoie
Superintendent, Greater Lawrence Technical School
jlavoie@glts.net

Anticipated school opening date: Fall of school year 2017.

School Year	Grades	Anticipated Student Enrollment
First Year	9	50 - 80
Second Year	9 + 10	100 - 160
Third Year	9 + 10 + 11	150- 240
Fourth Year	9 + 10 + 11 + 12	200 - 320

Grade span at full enrollment: Grades 9 - 12.

Anticipated student enrollment when fully expanded: 200 - 320.

School Year	Grades	Regular Ed Teachers	Action Learning Staff	SPED Teachers	EL Teachers	Admin-istrator	Total Headcount
First	9	5	3	Existing Staff	Existing Staff	Existing Staff	8
Second	9,10	11	6	TBD	TBD	TBD	17
Third	9,10,11	17	10	TBD	TBD	1	28
Fourth	9,10,11,12	22	13	TBD	TBD	1	36

Assumptions:

- Students begin foreign language in 10th grade
- SPED and EL staff are shared positions with the rest of GLTS for at least the first year
- Physical Education staff are shared positions with the rest of GLTS for at least the first year
- Administrative and teacher support staff are shared positions with the rest of GLTS

Student eligibility: The STEAM Program will follow the GLTS Admissions Policy and Shop Placement procedure. It will be open to all students, on a space available basis, and shall not discriminate on the basis of race, color, national origin, creed, sex, gender identity, ethnicity, sexual orientation, mental or physical disability, age, ancestry, athletic performance, special need, proficiency in the English language or a foreign language, or academic achievement (Mass. Gen. Laws c. 71, § 89(m)).

Components of the STEAM Program's Innovation Plan

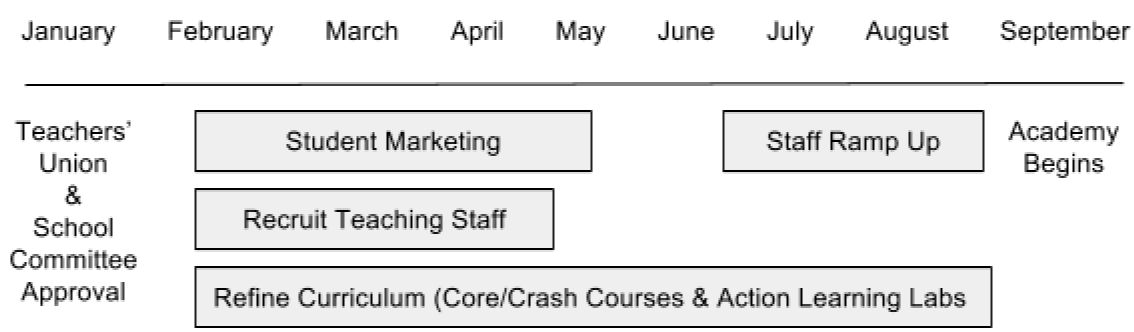
- Curriculum and Instruction
- School Schedule
- Staffing
- Advisory Board

The Innovation Plan Committee is responsible for:

- Developing the innovation plan (with the Prospectus serving as a draft)
- Assuring that the stakeholders are represented in the development of the Innovation Plan
- Conveying the areas of autonomy and flexibility required, and including student outcome goals and achievement data.

A majority vote of the Innovation Plan Committee is required for approval of the plan.

Timetable for Approval & Establishing the STEAM Program: January – September 2017



Executive Summary

The STEAM Program (grades 9-12) will offer students an exciting hands-on approach to learning. The curriculum blends the mind of a scientist or technologist with that of an artist or designer, enabling students to explore the captivating area where *STEM, the Arts, and the future intersect*.

The college and career-track program will operate within the Greater Lawrence Technical School, serving students from Lawrence, Methuen, Andover, and North Andover.

Our Focus


Emma Kelley, Andover, MA

- **Open students' eyes to a world of possibilities and interests**. We call this the “10,000 teachers” approach. We want to expose students to an expanding number of opportunities so they can make well-informed college and career decisions, while leading richer lives.
- **Create lifelong, independent learners** who are undaunted by the world around them, who can teach themselves new skills as needed, adapt to the changes they will face, and will flourish in a world that constantly creates new opportunities for employment and scientific and technology exploration.
- **Give students critical thinking habits, problem-solving skills,** and an interdisciplinary way of looking at the world that will enable them to be creative problem-solvers.
- **Enable students to put ideas into practice** by applying classroom learning to challenging, real-life projects.
- **Help students uncover aspects of intellectual life that excite them** and invite immersion.

The Curriculum

The college and career-ready curriculum includes a strong foundation in STEM, the Arts, and Humanities:

Interdisciplinary Core Courses (year-long) covering English, Math, Science, Performing Arts, History, World Language, and Health/Wellness. Examples: English & Digital Media Arts, Engineering America, Design through Algebra, Physics & Engineering, Math & Software Development, Technology of Biology

Crash Courses (2-10 weeks long) introduce a variety of short courses that give students the knowledge/skills needed to explore exciting fields (e.g. biological engineering, building mobile apps, electronics, creative writing, bio-inspired robotics, making wearables, architecture).

Action Learning Labs (2 weeks full-time at the end of each trimester). In addition to taking courses, student participate in three interdisciplinary labs, engaging in exciting explorations that provoke imagination, ignite passion, and improve their lives and the lives of others – in their communities and across the world.

The **Engineering** lab, where students leverage science and technology to engineer solutions that lead to better lives for our citizens and society.

The **Life Sciences** lab, where students tackle exciting projects in emerging areas, including biological engineering, new media medicine, wireless health, genetics, brain and cognitive sciences, and computational biology.

The **Computing** lab, where students take on the roles of software developers, data scientists, and game developers – and get immersed in projects that involve software creation, mobile app development, game design, and analytics.

How do Action Learning Labs work? We start with a question, an idea, or a technology. And, to make the experience as rich as possible for as many students as possible, **we aim for big questions, stimulating ideas, and unexplored technologies** that can lead students in many productive directions – within and across labs. Our approach is modeled after MIT's Edgerton Center and MIT Sloan School's Action Learning methodology.

The Learning Environment

The STEAM Program includes three integrated venues where every teaching space is a laboratory, a theater, and a playing field where ideas are born, tested, and realized.

The Classroom Environment is where teachers and students interact during most days. Over time, much of the content presentation that would ordinarily take place in a classroom will take place in an On-Demand Learning System, enabling teacher-student interaction time to be maximized in the classroom. Teachers will spend more time guiding and coaching students one-on-one, answering questions, and providing individual and small group tutoring.

The Studio Environment is modeled after Harvard's Innovation and Life Labs, and MIT's Center for Entrepreneurship. It is designed to facilitate collaboration between students and is where Action Learning Labs happen. Students work with teachers, other students, technology, and with industry experts in a design studio and lab environment. Studios are places of cross-fertilization where idea-sharing between students with different learning styles and different approaches to the creative process can lead to new ideas, new ways of perceiving the world, new artistic creations, and scientific discoveries.

The On-Demand Learning System will be implemented gradually. It will foster personalized learning and provide a place where content, resources, and lectures from staff and outside experts will be available 24x7 – on laptops and digital devices. Students will be able to draw from it to learn whenever and wherever they like, and add to it to build their portfolios, communicate with other students, and contribute to projects.

These venues enable students to focus the majority of their school day on active learning.

<u>Core Elements</u>

On-Demand Learning

The On-Demand Learning System will offer students the chance to personalize their learning experience. Because learning materials will be available digitally, rather than dispensed in the classroom, students will be able to accelerate their learning when they find a subject easy, and slow down when they need help from the teacher to understand a topic. This approach will enable students to take responsibility for their learning, setting their own goals and making their own plans for mastering subjects. The system will also provide teachers with a way to track student performance and provide more effective supervision, so no one falls through the cracks.

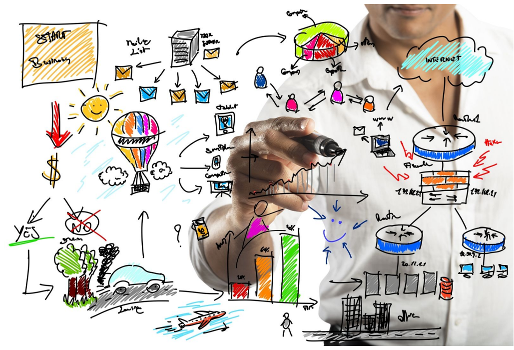
Crash Courses

Crash Courses introduce students to a large number of new ideas, concepts, and experiences in the form of short courses. They provide students with basic knowledge and skills that can then be applied in the Action Learning Labs, such as coding, electronics, biotechnology, and machine tools.

Crash courses also introduce students to various professions in science, technology, engineering, and the Arts.

Action Learning Labs

Modeled after MIT's Edgerton Center and MIT Sloan School's Action Learning methodology, students apply classroom learnings through real-life, interdisciplinary projects: deep-dives into current topics relevant to Engineering, Life Sciences, and Computing.



Labs are run like new ventures. Students use Design Thinking to imagine and discover breakthrough solutions, and apply the Scientific Investigation and Engineering Processes to guide their journey.

Students tackle projects that mix Science, Technology and Engineering with the Arts,and explore the convergence of scientific and artistic creativity. Action Learning Labs are where this convergence happens.

This hands-on environment helps students grow as creators, critical thinkers, and entrepreneurs – and prepares them to excel in higher education and careers in high-growth fields.

Performing Arts are core to our learning environment. Classes and workshops are offered throughout the year (five 90-minute classes every 10 school days), with a focus on both instrument instruction and performance, and electronic and computer-based composition.

The Spark Coding Initiative is part of the program's commitment to sparking an interest in the exciting world of computing. In the future, our students are likely to interact with computer programs (on the phone, in the car, at home, and at work) as often as they interact with people. So, we see coding as a useful employment skill, and take a different tack in teaching programming.

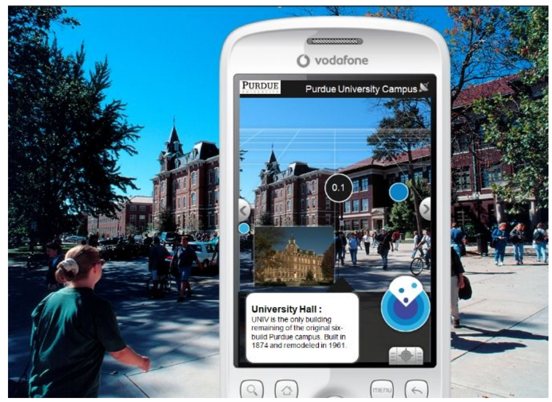
We approach the subject from the human viewpoint, not a mechanical/mathematical viewpoint. We introduce students to this world starting with areas they're already interested in - animation, biology, video games, the virtual world, and starting with key concepts they already know - list-making, sorting, question-asking, decision-making. We show programming to be fascinating and life-enhancing, where students aren't just consumers, but creators, of digital software and content.

<u>**Future Planned Programs**</u>

The Global Schoolhouse program doesn't just recognize that we live in a global society. It embraces the idea. It rethinks the notion of globalization leading to greater competition, and sees the global society as a chance for greater global cooperation. The STEAM Program's *Embassy*, a room located in the physical school, will be linked by direct live feed to schools in other countries (step into the Embassy Room and you are in another country). Telepresent audio-video robots (built by students) roam the corridors controlled by students in a foreign high school (with our students controlling their robots) to act as virtual students in other cultures. *The goal is to prepare students for the future by making the constraints of physical geography irrelevant.* To do this **we create an environment where distance no longer limits interactions between students in different parts of the world.**

The College Research Collaborative is an association between the STEAM Program and area universities, including MIT's Experiential Learning Center (known as the Edgerton Center), MIT's Teaching Systems Lab, and University of Massachusetts-Lowell doing research in both education and technology. Through this program we plan to bring in:

- Guest speakers in areas that will inspire our students (women working in STEM fields, researchers working in the engineering, computing, and life sciences fields
- College students who will assist our teachers, be student mentors in our Action Learning Labs and introduce them to emerging technologies and the R&D process
- Visits to college labs to observe and participate in advanced learning opportunities.



The School of the Future is a program that turns the STEAM Program's physical space into more than just an environment in which classes take place. *The space itself becomes part of the learning adventure*, housing two different learning environments simultaneously: one physical – **The Programmable School** – and one virtual – **The Meta School**.

The idea behind a Programmable School is that it is a physical living laboratory infused with the spirit of invention and creativity, **where every physical component becomes a learning possibility**. It contains scientific and engineering experiments built into the structure of the school building itself, and students can (for example):

- Measure temperature gains with different kinds of thermal mass brought into the lobby for passive solar energy gain
- Determine optimal light levels for green walls of plants to minimize water needs
- Use sensors built into the school doorknobs to determine student traffic flow
- Cover a classroom window with carbon nanotube film to conduct energy generation experiments
- Create a rooftop Sky Farm using atmospheric energy generators, bee hives, and aeroponic vegetables (without the use of soil)

Initial efforts will focus on taking Ambient Computing (the Internet of Things), adding to it the idea of a Smart House, then mixing in the concept of a Makerspace. **The result is an entire physical school that is manipulable by students as part of their daily learning experience.**

The idea behind a Meta School is that **every blank space in the real school is filled with virtual environments, exhibits, experiments, and lessons** that students build and participate in through their mobile phones and laptops.

Imagine a walk-in videogame that houses a science museum built by a 3D animation studio. Every room, every piece of equipment, every empty space and hallway will have a virtual augment in the form of instructional and artistic material.

· Hold a cell phone up to the walls in the real hallway and see the water pipes and wiring of the virtual school behind the walls - giving the student the equivalent of x-ray vision.
· Step into the real biology classroom, hold up a laptop, and see the virtual DNA double helix floating above the floor with an audio track narrating its features.
· Hold up a phone to the real 3D printer and see a video tutorial on how to operate the machine.
· Hold up the phone to trigger films and animations describing the object being looked at.

Students can get explanations to things in the physical school. And it allows students and teachers vast leeway in creating instructional objects, films, experiments, models, and complex systems.

Initial efforts will focus on creating a virtual school within the physical school – that is revealed to students, faculty, and visitors through their mobile phones and laptops – and filled with engaging exhibits, lessons, and experiments. Think of it as ubiquitous augmented education.

All of its augments (links between the real and virtual worlds) can be created by students – animated characters, apps, instructional videos, audio narrations, interactive animations, and more. This National Geographic video highlights what's possible https://youtu.be/5QDB7CDD5aA .

Multiple Paths in Grade 12

In addition to the planned grade 12 curriculum geared to preparing students for college, we are exploring the potential to offer students two additional paths when they enter 12th grade:

- A "**Nano Degree**" where students gain practical skills in one of the program's concentrations (engineering, life sciences, computing). Upon graduation, students will be ready to immediately join the workforce - equipped with current, in-demand skills.

- A "**Micro Degree**" where students pursue an additional year of study beyond grade 12 (i.e. grade 13) and earn an accredited degree in engineering, life sciences, or computing through our planned collaboration with area colleges (e.g. UMass Lowell).

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Our Approach To Learning

There are three ideas at the center of the STEAM Program's approach to education.

The first idea is that **students should be exposed to as many concepts and fields of study as possible**. We call this the "10,000 teachers" approach. We want to open the students' eyes to a world of possibilities and interests. We want them to learn something about a large number of fields so they can make well-informed career decisions and lead richer lives.

It is a common experience for students to study Core subjects (Math, English, Science, History) with no idea of how or where the knowledge they're acquiring will ever be useful. It is also a common experience for people to discover much later in life a topic they love - a subject they could have embraced starting in high school, or might even have made a career of - if they had just known about it sooner. It is a common experience to have no idea what to major in in college. It is a common experience to discover an art form later in life that could have been a lifelong enriching experience.

These opportunities will be addressed by introducing students to a large number of different ideas through our interdisciplinary Core Courses and Crash Courses. These courses will:

- Show students how to apply subject-matter knowledge in different fields of study while providing a glimpse of different professions (apply English to the Digital Arts, apply Math to Architecture, apply Biology to Engineering)
- Teach students practical skills they can use throughout their academic and personal lives
- Introduce students to exciting new pursuits that may lead to lifelong enrichment

Core Courses are year-round and interdisciplinary. Sample courses include Changing Hearts and Minds: English and Digital Media Arts; Engineering America: US History and Engineering, The Technology of Biology; Geometry and Computer Visualization, Physics and Engineering: Motion by Design..

Crash courses are short in duration (generally 2-10 weeks long). They are frequent. And there will be a lot of them offered.

These courses work in a way that is similar to the Rotations system of medical schools. Possible future professions are introduced. Basic skills are introduced. Art forms are introduced. Students try out different fields of study to discover which ones they like and may want to pursue in the future. In the first year, most of these courses are not electives. We want all students to get a taste of all of these fields. However, students are welcome to choose electives in these fields in later years.

Some students will find Architecture instantly fascinating. Others will discover the thrill of Electronic Music for the first time. Others will embrace Animation Programming as soon as they learn it. Some students will find Law entrancing. Some will discover the joys of Music or Mobile App Development or Psychology. The Crash courses can be technical (e.g. Photoshop, Digital film-making, Coding) and artistic (Drawing, 3D Design, Architecture). But all of them have the same purpose - to provide the basic principles, skills, and knowledge for a field of human endeavor.

We want all students to learn how to play a musical instrument, design a house, diagnose an illness, use a spreadsheet, and build a web page. And if they become so intrigued with a particular topic that they pursue it on their own to become better at it we want to recognize their skills and knowledge by designating them "student masters" - students who can be guides and tutors to other students or can demonstrate their skills at a professional level.

The second central idea in the STEAM Program is the notion of "**taking responsibility for one's own learning.**" This means shifting the reason for learning from "because I have to" to "because I want to." It means students setting their own educational goals. ("I'd like to learn more about this subject because it interests me.") It means students making their own educational plans. ("I'd like to learn this field next and then branch into that field.")

The third central idea in the Academy is the notion of **putting ideas into practice**. "Practice" is a term borrowed from the professional world. Doctors have a practice. Lawyers have a practice. Architects and designers have a practice. In these fields, and in Design Colleges around the country, "practice" means taking what someone has learned in the classroom and applying it to Creation and Problem Solution. It is a way of making learning concrete and putting it to practical ends.

Students work collaboratively on real-life projects in action learning labs, tailored to three areas of practice: *Gears, Bits, and Cells*. Gears refers to Engineering. Bits refers to Computing. And Cells refers to Life Sciences.

In Gears, students might build a mechanical device, such as a rescue drone, using the knowledge they pick up in the studio itself and from their other courses.

In Bits, students might program a robot to walk up the steps of the school. None of the studios are devoted purely to one enterprise. A rescue drone requires an understanding of electricity and mechanics, but also programming. Converting algae to biofuel requires biology, but also math and mechanics. Robotic development requires programming, but also mechanics, electronics, math, and even some biology and physics.

In Cells, students would culture living organisms to, for example, grow algae that can be turned into biofuel.

These three approaches to learning - **exposure to many concepts, taking responsibility for one's own learning, and practice** - should provide students with a well-rounded education that gives them the basics, opens their eyes to the possibilities, and gives them the chance to translate their ideas into working forms.

Creativity and Discovery as Teachable Processes

Creativity manifests when a person with the right sets of skills and knowledge invents or finds an appropriate problem that cannot be solved using any existing approach, but which is amenable to solution by that person's unique set of experiences. Thus the Academy aims to teach a broad set of skills and apply them to problem-solving.

Students will be introduced to various types of creative expression and imaginative thinking. Students will gain an understanding of their own mental processes that lead to innovation, and then directly experience and practice creative thinking. This practicing of creativity is directed at both problem solving and the invention of novel forms of expression from scientific and an artistic perspectives. Students will examine methods of supporting, nurturing, and cultivating creativity such as the design school process, startup incubators, and artists and writers studios.

Culture

The STEAM Program emphasizes self-expression, discovery, exploration, invention, and deep learning based on active inquiry. This means that the program’s physical environment is likely to be a little messier than that of an ordinary school. Individual projects are part of the core curriculum. Group projects are part of the Action Learning structure. And Studios are physical areas set aside for active hands-on engagement. So, there is likely to be both work-in-progress and completed work in studios and classrooms, and on walls all over the academy. This includes the online environment because all students maintain an be both work-in-progress and completed work in studios and classrooms, and on walls throughout electronic portfolio of their best work throughout their stay at GLTS (successful projects; internship blogs; and creative output such as films, animations, stories, essays, schematics, and photos of working inventions or experiments).

The exhibition of student work will be a natural corollary of the program's culture of intellectual growth. Regular presentations of learning, including experimental products and designs, musical performances, videos , websites, and posters will serve to exhibit student work both to the Greater Lawrence community and to the wider world.

School Models That Have Influenced our Design

- Ben Franklin Academy of Philadelphia where practical subjects and invention are emphasized[1]
- Big Picture schools[2] and their use of coaches to guide students
- Coalition of Essential Schools[3] and their use of performance-based assessment
- Connecticut Academy of Digital Arts and Sciences[4] focus on engaging inquiry-based learning
- Early College schools[5] and their approach to accelerated learning
- High Tech High and New Tech Network schools[6] and their emphasis on project-based learning
- Khan Lab School in California[7] and its use of self-paced learning systems and a teaching approach that encourages student experimentation
- NYC iSchool in Manhattan[8] and its use of software in teaching languages
- Nueva School and their emphasis on integrated studies, creative arts, design thinking, and social-emotional learning[9]
- Quest to Learn[10] and their use of game-based problem-solving
- Studio schools in the UK[11] that regard "studios" as Da Vinci did, as places where both science and art take place
- Summit Public Schools' approach to personalized learning and daily, reading program[12]
- Sugata Mitra's SOLE (Self-Organizing Learning Environments) project[13] that focuses on peer-teaching and group scholarly exploration to answer big questions.

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[1] Ben Franklin's charter school prospectus: Paper on the Academy, Ben Franklin, 1750, University of Pennsylvania Archives:http://www.archives.upenn.edu/histy/features/1700s/bfacadpaper1750.html

[2] Big Picture Schools, http://www.bigpicture.org/schools/

[3] Coalition of Essential Schools, http://www.essentialschools.org/

[4] Academy of Digital Arts & Sciences, http://www.skills21.org/programs/the-academy-of-digital-arts-and-sciences/

[5] Early College High Schools, http://echs.salkeiz.k12.or.us/

[6] High Tech High and New Tech Network, http://www.hightechhigh.org/ http://www.newtechnetwork.org/

[7] Khan Lab School, http://khanlabschool.org/

[8] iSchool, http://www.nycischool.org/

[9] The Nueva School, http://www.nuevaschool.org/

[10] Quest to Learn, http://www.instituteofplay.org/work/projects/quest-schools/quest-to-learn/

[11] UK Studio schools, http://www.studioschoolstrust.org/welcome

[12] Summit Schools in CA: http://summitps.org/student-day?day=2

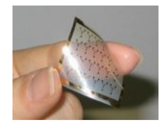
[13] SOLE, https://www.theschoolinthecloud.org/

Educating for Jobs of the Future

How do we plan to give students the knowledge and skills to work in jobs or create jobs that do not exist yet?

There are three approaches: a proactive curriculum, a focus on broadly applicable skills, and close ties to academic centers and the workplace.

1. Being proactive in teaching new ideas and technologies means that we have close ties with the workplace and keep an eye on trends so we can anticipate the jobs of the future. At the moment, drones and virtual reality/augmented reality are popular because they're new, and we'll have courses in both. There are other fields that are farther out, and we are likely to have courses that treat these subjects as well. Some examples:



- Carbon nanotube transistors can make light-emitting film that has a bright future. Place the transparent film on a window and light comes in during the day, but the film also captures photons and builds up a charge that allows it to emit light like a giant LED all night long. Daytime windows become nighttime lights for free.

- We want to wire some part of the school with Li-Fi to allow our students to study Li-Fi. (LED bulbs flicker at a rate faster than the human eye can perceive. With Li-Fi they do this to deliver the internet through visible light instead of cables or microwaves. The speeds are so fast that this may be the best way to provide all our students in a Studio with fast broadband.)

2. Instead of trying to anticipate future technologies, we will provide students with core concepts, skills, and practices that can be transferred to a range of future fields.

3. Students will be immersed in creating, not just consuming, the world around them.

What Qualities Will the STEAM Program Develop in Students?

In addition to helping students become actively engaged learners with strong critical thinking and complex problem solving skills, the academic programs are focused on helping students develop these qualities:

- **Self-confidence** to effectively explain, demonstrate, and promote their original ideas - in writing and orally
- **Curiosity** to explore and learn in a variety of environments
- **Perseverance** to overcome difficult challenges despite inevitable roadblocks
- **Adaptability** to changing circumstances, different cultures, and new ways of thinking
- **Creative confidence** to approach new challenges fearlessly
- **Independence** and control of their own learning
- **Ability to work collaboratively** with diverse teams, and to treat others with kindness and respect
- **Ability to move seamlessly** between the physical and digital worlds

A Note on Focus and Implementation

It is recognized that the discussion of futuristic technology in this innovation plan might make it seem that we're distracted by technology. With all the talk of virtual this and electro that, it might seem that we've lost sight of the core goal of an education, which is to help students live fuller, happier, more productive lives by providing them with useful knowledge, skills, and habits of mind. And we also understand that readers might be concerned about over-reaching when confronted with new programs.

Addressing these points:

The emphasis on technology actually has two purposes. First, it is meant to give students areas of focus to get excited about, with the assumption that they will study harder and become better students if they see a wonderful purpose behind their study. For this reason, we tie all tech work in the academy to core subjects and crash courses, so students see the reasons for diligent study and even seek out new core knowledge on their own. Technology does not displace core subject work. It provides one possible reason for acquiring more core knowledge.

Second, the tech focus is meant to expose students to the world they will actually work in. If we aim to prepare students for future careers, we need to recognize what their working world will look like. The world our students will step into will be one of artificial intelligence, autonomous vehicles, global cooperation/competition, space flight, renewable energy, and virtual reality. (Even the most science-fiction-sounding technologies mentioned in this document are available right now and will provide high-paying jobs in the future.)

So, technology is used for two very practical purposes: it becomes a reason to study hard now and a source of employment in the future.

The number of new projects suggested in this document looks ambitious. But, in fact, **all the various programs tie into three simple concepts: explore the possibilities, take responsibility for your own learning, and practice what you learn**. Everything else supports these three ideas.

We have a clear development path to ensure that the most essential aspects of the academy are implemented first, including curating/developing the courses, outfitting the academy, and implementing the on demand system.

We are also actively focusing on the teacher experience and devising professional development to familiarize teachers with the new approaches.

Our implementation plans focus on the most important aspects first - the elements essential to the success of students on opening day.

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Curriculum

The planned courses are taught through an interdisciplinary lens and reflect the contributions of the Arts to STEM and vice versa, preparing students for a world where knowledge is integrated. Core courses are typically year-long, crash courses are 2-10 weeks long, and courses align with the MA State Curriculum and Career-Area Frameworks.

Interdisciplinary Core Courses (Year Long):

HUMANITIES	
English	• English & Media Arts • English thru Your Lens • Communication by Design • Changing Hearts & Minds Creative Writing will be emphasized each year, plus a dedicated 45-minute reading period 5 times every 10 days
History and Citizenship	• Engineering America: U.S. History + Engineering & Architectural Design • World History by Design • Big Ideas: The History and Future of Science & Technology • American Government & Public Services
World Language	• Spanish 1 • Spanish 2 • Spanish for the Entrepreneurial Mind • Native Speaker Spanish for Health Careers • Spanish for Patient Care • Other languages offered via online courses
MATH & SCIENCE	
Math	• Functional Design through Algebra • Geometry & Computer Visualization/Simulation • Applied Math & Engineering: Algebra 2/Trig for Engineers • Modeling Your World thru Math and Programming • Electives: Precalculus, Calculus, Statistics & Probability
Science	• Biology • Physics & Engineering • Chemistry & Engineering Design • Electives (e.g. Science of Music)
PERFORMING ARTS	
Music	• Instrumental Instruction (guitar, keyboard, drums, bass, vocal) * Themes: pop, rock, jazz, R&B, folk, blues • Electronic Music Production/Sound-Recording • Songwriting • Ensemble/Band Workshops • Master Classes
HEALTH & WELLNESS	
Phys. Ed / Health	• Progressions in Phys. Ed & Health • PE integrated with Computing, Life Sciences, Engineering Explorations

Crash Courses (2-10 Weeks Long):

SAMPLE			
STEAM Foundation	• STEAM Studio Essentials • Engineering by Design	• Creativity Tools & Techniques • Spark Coding	• Intro to Entrepreneurship • Foundations of Life Sciences
GEARS Engineering	• Introduction to Electronics • Designing Prosthetics	• Engineering of Structures • Redesigning Shelter	• Design It! Longboards • Redesigning Energy
BITS Computing	• Intro to Computer Science • Digital Game Design • Game Design & Development	• Mobile App Creation • Data Science & Analytics • Web Programming	• Cyber Security & Cryptography • Python Programming • Virtual Reality App Creation
CELLS Life Sciences	• BioBuilder (Biological Engineering) • Genetics	• Renewable Engineering of Tomorrow • Surgical Techniques	• Urban Farming • Biodiversity & Human Health
Design	• Art & Design Foundations	• Design Tools & Techniques	• Introduction to Architecture
Digital Arts	• Audio Production/Sound Editing • Motion Graphics and 2D Animation	• Film Making & Editing • 3D Modeling & Animation	• Computer Music Creation • Make Your Own Wearables
History & Citizenship	• Digital Citizenship	• Systems Thinking & the Pursuit of World Peace	• Innovation in Government
English	• Creative Writing • Digital Age Journalism	• Debate & Speech	• Writers Workshop: Essays to Screenplays
Entrepreneurship	• Technology Entrepreneurship	• Lean Startup Fundamentals	• Master Classes with Entrepreneurs

See Appendix A for Course Descriptions.

Interdisciplinary Core Courses

Each year, students will take year-long interdisciplinary core courses covering English, History and Citizenship, World Language, Math, Science, Performing Arts, and Phys. Ed/Wellness. Examples: English & Digital Media Arts, Engineering America, Design through Algebra, Physics & Engineering, Math & Software Development, Technology of Biology.

Over time, content for Core Courses will be available online in the On-Demand Learning System, enabling students to have access to everything they should learn and do to master disciplines.

Crash Courses

Crash Courses are 2-10 week long courses that serve three purposes. Some courses teach students the skills needed to present projects throughout their high school, college, and working careers. (These are called Foundation Courses.) Some courses present artistic skills and experiences. (These are called Arts + Design courses.). Intermingled among these two groups, are courses that introduce students to possible career paths, offering glimpses of various professions. These courses aim to link the content being presented in the core courses and action learning labs to various professions.

Crash courses can be either elective or required, but most will be required in the first 1-2 years because we want students to develop a basic set of 21st century skills in coding, electronics, mechanical design and media that can be applied to a broad range of projects.

Crash Courses expand the worldview and experience palette of students. They help students make connections between the professional world and their studies. And they provide students with tools that allow them to express themselves artistically, scientifically, and technologically. While core courses facilitate a student's entry into college or the workplace, and action learning labs focus on the real-world application of ideas in an interdisciplinary and collaborative way, crash courses allow students to acquire a large breadth of knowledge and skills that help them succeed in school and lead richer lives.

The Crash Courses called STEAM Foundation Courses - presented in the first year - are meant to provide students with the basic computational tools they will need to be productive in their other courses.

Some Crash Courses courses will be self-developed by the academy to address areas we feel are particularly important to our students. Other courses will be from organizations such as MIT's Edgerton Center, i2, Lynda.com, Khan Academy, Code.org, Codecademy, Pluralsight, Skills21, edX, and Stanford Online.

These courses enable individual students to master techniques to a degree that set them apart from their peers. One student might become adept enough at filmmaking, for example, that s/he becomes the student expert other students turn to when they have questions about this particular field. We want to encourage this ascent to mastery in areas of individual student interest by including "student masters" as part of the hierarchy of expertise that all students in the STEAM Program recognize. Most students are likely to turn to the student next to them for help in a mystifying area first. If they cannot find satisfaction there, we want them to turn to a student master. If the student master is stumped, the teacher is the next step (or, sometimes, the other way around). And if the teacher is stumped, crowd-sourcing in an expert forum (like Quora) or direct inquiry of an identified outside expert in the field would be next. One of the goals of the program is to have 10,000 teachers for each student. And student masters would eventually become part of the 10,000 teacher mix. (Classroom teachers become master guides and choreographers of student learning from all the branches of knowledge around them.)

Mastery Path

Crash courses are not long enough to teach everything one needs to know about a subject. Every student is likely to find a subject that intrigues them so much that they want to learn more on their own. For this reason, **a Mastery Path will be created for each Crash Course**. The Mastery Path allows the student to become self-propelled, and provides information to make further exploration of the topic easier. It details:

· websites to go to

· organizations to join

· books to read and movies to watch

· web courses and MOOCs to take

· software to use

· hardware to build or request

· experts to contact

· internships to apply for

· contests to enter and conferences to submit to

· teachers to talk to

· what a student should study in HS and college to enter this field

· colleges that specialize in this field

It is a path for those who want to become more immersed in a certain area and/or pursue in college.

Action Learning Labs: How Do They Work?

We start with a question, an idea, or a technology. To make the experience as rich as possible for as many students as possible, **we aim for big questions, stimulating ideas, and unexplored technologies** that can lead students in many productive directions – within and across labs.

In Cells, for example, we might study the idea of Biocouture - the act of growing clothing in a lab. The process of growing clothing is similar to that of making Kombucha (Asian fermented tea). To grow their clothing, students set up a heated insulated bathtub, called a bioreactor. (This means that they begin to learn about both engineering and biology right from the start of the project.) They fill the vat with tea, sugar, other ingredients, and what fermenters call the "mother" and biologists call the SCOBY (symbiotic culture of bacteria and yeast). These bacteria and yeast work together to grow a semi-solid mat that floats on top of the liquid growth medium. The floating mat is removed from the bioreactor after a couple weeks and formed around a mold to make a shoe, a jacket, a skirt, or pants. Different mats can be pressed together to make what is called "vegetable leather" without cutting or stitching. Once the material is dry, the clothing is ready to wear. However, vegetable leather may still absorb water after drying and may even dissolve in a heavy rain (the technology is still quite new), so experiments in hydrophobic additives (to make the leather shed water) are built into the exploration. In fact, the whole process of growing one's own clothing opens up hundreds of avenues for exploration and invention.

Spin-off experiments are waiting to be done. Algae can take the place of bacteria to grow different kinds of fabrics or other materials. Students whose artistic sense runs toward fashion can stretch their skills with new clothing designs. Students interested in Synthetic Biology (the creation of new biological organisms) may be intrigued by what else they can grow in a vat (medicine, metals, toxic-waste-consuming microbes). Students interested in tissue culture for medical uses (growing arteries, bladders, and skin grafts, or even, ew, a new form of cafeteria mystery meat) can use their new knowledge of bioreactors to experiment with medical applications.

Follow-on questions are inevitable. What else can the fabric (bacterial cellulose) be used for? Can students use the tissue culture techniques they learn from Biocouture to grow cartilage to replace damaged ears? Can they use them on a larger scale in biomimetic architecture to grow furniture and houses? Can they substitute electrogenic bacteria (bacteria that produce electricity) to make a system that runs the school's computers on human waste? Pond bacteria often contain geomagnetic sensors to distinguish up from down; since these bacteria act like the binary switches in a computer, can they be grown in a vat to create an organic computer? Can the hydrophobic coating invented for vat-grown clothing also be used in Art projects (sprayed on the sidewalk over a stencil) to create what is called "rain-activated art" (you don't see it on the sidewalk until it rains or someone pours water on it)? One Exploration in Biocouture can trigger a thousand other explorations and inventions.

Biocouture is a Cells project. But the same process can occur in a Bits or Gears project.

In Bits, for example, students build a One-Eyed Robot starting with a sensor to detect light and a controller to move an axle. They hook the sensor and controller together and write the code that recognizes a light signal and triggers the wheel to move:

If light-detected   Then turn axle   If no light-detected   Then stop axle

In one class period, students build a simple robot that moves when the light turns on. And what they've learned in that endeavor can be used to build much bigger projects and to write much more difficult code. Put a camera on the robot and it films as it moves. Put a sonic sensor on it and it comes when called. Add a speaker and a recorded sound effect, and it barks when called. After only a few sessions, an Artificial Dog begins to emerge. Everything from quadcopters flying in formation to mechas begin to be possible.

In Gears, students start with warm water and add cream of tartar (potassium bitartrate). Then they spoon in baking soda (sodium bicarbonate) that has been baked to create sodium carbonate. This mixture dries over a few days to form a crystal called a Rochelle salt. This crystal is piezoelectric. (When you squeeze it or strike it, it releases an electrical charge.) So, students can generate a small amount of electricity just by stepping on it. In the second part of the project, they engineer a panel that covers the crystal and wire the crystal to feed its electrical output to a light. Step on the panel and the light goes on. Change the light to a sound producer and a note sounds. Make eight panels in eight descending tones and that's an octave. Step on the panels to make music on a danceable piano. Or send the output to a switch and turn on the lights in a room by stepping on the panel. Send the output to a battery and store enough to power a cell phone or computer. Change the generator from a piezoelectric crystal to moss (ordinary moss generates electrical ions as it grows) and make a moss photovoltaic. Plant moss on the roof of the school and generate power in the summer. Start with a simple idea and branch out to anything in the world.

In the Action Learning Labs, we encourage students to manipulate the physical world, starting simply and building their confidence at each level, showing them that the basic processes are really simple and easy to learn. Then we give them the road maps and scaffolds to move from building a One-Eyed Robot to building an Artificial Dog, from growing vegetable leather to growing a human ear, from making sparks with foot pressure to growing an electricity farm on the roof.

In the Cells project, incubating clothing teaches students how to grow cells - the basic building block of all biological lab work. **In the Bits projects**, writing the code to make a small autonomous dog teaches students the idea of an algorithm (a process followed by a computer) - the basis for all computational work. And **in the Gears project**, students developing their own touch-sensitive electrical systems learn the basics of chemical formulation (to make the crystal), mechanical application (to capture the steps), and electrical circuits (to store or use the generated electricity).

We start with the basics in the first year required explorations. But, in later years, exploration ideas come from students who use all their new hands-on knowledge to create Art, Engineering, Computing, and Biological products on their own - at, eventually, professional levels of sophistication. Part of the program's mission is to foster creativity and intellectual fearlessness, and explorations are one way to do that.

There is no shortage of interesting ideas and challenging questions to pursue.

· Could students turn the STEAM Program’s space into a learning environment by "augmenting" every poster, door, object, and classroom with instructional videos, so that students who had never used a certain piece of equipment or gone into a certain studio before could hold up their cell phones to the equipment or door and get a triggered narrated guided tour on how to use it?

· Could they use Arduino sensors and Raspberry Pi controllers to build a "smart school" that responds to student movements automatically?

· Could a drone explore the school grounds with an electroencephalographic connection alone (flying the drone using a helmet that reads brainwaves)?

Drones, medical simulators, soft robotics, ambient computing and the internet of things, virtual reality, moss photovoltaics, wearable technology, telepresence and remote sensing, autonomous vehicles, 3D printing at a large enough size to print a car, new educational technologies, ... The world is full of ideas waiting to be explored in the program’s action learning labs.

Physical Education / Health & Wellness

The STEAM Program takes a healthy mind in a healthy body approach to Physical Education and Health & Wellness. This means that students don't just practice ephemeral exercise drills or engage in sports during phys ed. They learn about how to monitor and maintain their own health over the course of a lifetime. Because we want students to apply the approaches, techniques, and facts that they learn in Science to the improvement of their own lives, we treat Physical Education/Health & Wellness (PE/H&W) as a way for students to gain knowledge about the optimal functioning of their own bodies by using Science to study it. PE/H&W, in this context, becomes both an experiment and a form of self-revelation that can stay with students for the rest of their lives.

We want students to understand the benefits of maintaining their own health, not through lectures, but through monitoring their own bodily functions and increasing their sense of self-awareness. We want to use technology to assist in this endeavor. So, we look for areas in which a person's health can be compromised and we address those areas in PE/H&W.

Stress, for example, is one of the areas that may become a lifetime concern, and an area in which some training during the teenage years can benefit a person during a lifetime. So, one program within PE/HW could be Meditation - a practice with thousands of years of history and dozens of years of scientific research behind it. In Meditation, students would learn various practices to regulate their own autonomic nervous systems, reduce stress, and put themselves in a frame of mind conducive to creative work. Hatha Yoga is likely to be another PE/HW program. The PE/HW program could be taught by currently GLTS PE teachers with additional training or STEAM program teachers. In this program , the asanas (postures) will be taught with an eye toward improving awareness of one's own body. Yoga's ability to lower blood pressure, treat depression, and aid in recovery from illness all make it a practical skill to learn, and its ability to relax a person accounts for its widespread popularity. So, it is a natural fit in a PE/HW program designed to provide lifelong skills that will benefit our students' health over the long term.

Aerobic exercise will be a part of the PE/HW program as well. We would like to distribute heart-rate monitoring wristbands to students to allow them to gauge their own daily exercise levels. Students would chart their pulse rates over time, correlate their activity levels with their pulse, and calculate calories burned during a typical day or activity. This would allow students to measure the activity of their physical bodies and do something productive with the data (and incorporate into the program's explorations.We're not ignoring traditional sports. Students will be able to sign up for sports teams as they are part of GLTS. The overarching goals in the PE/HW program, however, are to provide students with skills they can use to help maintain their own health over a lifetime, monitor their bodies for stress and dysfunction, and understand that they can use scientific knowledge and the scientific method to reach their own personal health goals.

Access to College Courses

Students in higher grades may develop interests in fields that we do not offer courses in or may reach levels of attainment that exceed those that our courses are directed at. As a result, we are pursuing partnerships with local colleges – (e.g. UMass Lowell, Merrimack College, Northern Essex Community College, and edX (an MIT-Harvard Consortium) – to offer our students college-level courses in either an online format or at the colleges themselves.

International Program

The International Program is designed to show our students that they are part of a planet-wide intellectual community, a world of fascinating ideas and interesting people, a realm that their education will allow them to flourish in. The International Program allows students to sample different cultures and modes of thinking, make friends with people of different backgrounds, and, in some cases, let them see that people on the other side of the world may be more like them than their nearest neighbors.

The program will consist of links to schools in other parts of the world designed to foster meaningful transcontinental relationships with a higher purpose. One international project, for example, will be with a school in Latin America - designed to show students how to tackle global environmental problems cooperatively. (South America is an easy link to make because the time zones are not far off.) Students on both sides of the equation will collect environmental data in their local area and compare notes through a Skype/Twitch/Livestream/Broadcam link. (A school in, say, Uruguay, is likely to have a lot of Spanish-English bilinguals, so common language experiences may act as a binding force for many students.)

Other international links may include a:

· SOLE project with another school that uses computers as part of their daily learning environment

· Simultaneous music production/jam with a school interested in the confluence of music and technology

· Planet-wide scientific Alternate Reality Game played through email, blogs, databases, webpages, reality augments, and phone messages

· Global film-production in which students in different schools make a Day In The Life video of their school and edit it together with films from other schools to illustrate student life around the globe

· Computational challenge with a school in the UK (where Computing standards have recently been adopted), and

· Other projects that emphasize the benefits of living in an increasingly geography-irrelevant world

While Core courses allow students to connect to their ancestors via centuries of accumulated knowledge, Explorations allow students to connect to the physical world via experiments and engineering, Crash courses allow students to connect to a realm of useful skills via the computer, and the Classroom allows students to connect to each other and to their teachers via daily interaction, the International Program allows students to connect to similar people on other parts of the earth via the global network.

Curriculum Review and Revision

The STEAM Program will have a system of continuous improvement that enables the curriculum to evolve over time based on teacher responses, student performance/growth, the results of assessments, and the educational goals of the school. This system will help build a culture of trust and collaborative inquiry among the staff in which we recognize the relationship between data and good teaching practices.

The goal is to have an electronic system in place that allows all teachers to record their observations on the effectiveness of their instruction, their lesson plans, or elements of curriculum, as well as share successes and suggested revisions in implementing the curriculum. This is not meant to be a standard electronic curriculum mapping system used to illuminate what a teacher is doing in the classroom. It is meant to be a system for collaboratively improving the curriculum and courses in practical ways through an open system that allows teachers to identify problems in curriculum or instruction that promote or interfere with learning or are missing, propose solutions, make observations, discuss, and implement changes – part of what we hope will be a larger continuous improvement system with live and electronic elements.

Instruction

The STEAM Program includes three integrated instructional environments:

The Classroom Learning Environment is where teachers and students interact during most school days. Over time, much of the content presentation that would ordinarily take place in a classroom will take place in an On-Demand Learning System, enabling teacher-student interaction time to be maximized in the classroom. Teachers will spend more time guiding and coaching students one-on-one, answering questions, and providing individual and small group tutoring when students have already reviewed some content materials electronically. The time freed up by the On-Demand Learning System, coupled with the insight it will provide on student interests, mental blocks, and intellectual strengths, will enable teachers to begin to tailor their interactions and interventions with individual students during classroom time.

The Studio Learning Environment is designed to facilitate collaboration between students and is the home for the Action Learning Labs. It is an environment where students work with teachers, other students, technology, and occasionally with experts in the field in a design studio or laboratory environment. Project explorations encourage the use of practical skills with the goal of creating products that demonstrate mastery in the fields students are working in. Studios are places of cross-fertilization where idea-sharing between students with different learning styles and different approaches to the creative process can lead to new ideas, new ways of perceiving the world, new artistic creations, and scientific discoveries.

Within these environments, we will focus on inquiry and challenge-based learning as the anchors. Generally, projects will feature open-ended socio-scientific problems as leading questions and may involve visualizations, simulations, spreadsheets, presentations, written or electronic document production, or physical model-building. These may mix studio teaching with cognitive emulation and Socratic learning. Throughout the program, we will use media to enhance teaching and learning. We will use a variety of methods to support and enhance these approaches. Likely pedagogical techniques include student peer-review within classrooms and studios, lecture tutorials, role-playing, jigsaw learning in which students achieve mastery in one area and teach the others in their group, invention and testing, and field and classroom laboratories.

Our On-Demand Learning System will be built on a secure industry-leading platform that provides safe use and interpretation of data – and serves two purposes. First, it will house all the content, resources, media, and applications that students can interact with according to their own schedule. A student waiting for a bus, for example, can take out a cell phone and watch a filmed demonstration in biology. A student at home can add illustrations to a design portfolio and create graphs for a chemistry project in this environment. The On-Demand Learning System will be always on and work in both directions. Students can draw from it to learn whenever and wherever they like, or they can add to it to build their portfolios, communicate with other students, or contribute to projects.

Second, the On-Demand Learning System will serve as a capture and notification system for struggling students. It will collect data from students as they take tests, turn in homework, read online books, research projects, and interact with others. This data will be displayed in the form of a dashboard – a set of graphs on a single page – that will allow teachers to see which forms of learning the students were engaged in before their performance dropped off. For example, a student who did poorly on a Biology test after reading a scientific article (textual learning) might do better with content that is presented in a more graphical/auditory form such as an animation. The teacher will be shown these types of correlations in order to modify the forms of instruction given to the student. The system will give teachers a new set of eyes when looking at student performance. The same information will be presented to the individual students themselves, so they can draw connections between events in their lives and school performance as well. The data will help students “learn how to learn” - a component of the STEAM Program’s philosophy. It will enable teachers to recognize needs and address learning issues as they happen.

The three instructional environments overlap. A typical student's homework might involve reading an e-book chapter and inputting experimental results into a spreadsheet in the online environment at night, then pulling up the spreadsheet on a laptop to show the classroom teacher the next day. The teacher might then answer the student's questions in class and point to a set of articles or documentaries for the student to view online to fill in missing information. This could be followed by an in-class demonstration on a new topic linked to a studio project and then a quick pop assessment taken online in class. The results of the quiz would be revealed to the teacher immediately, and the teacher, perhaps recognizing that most of the class had misunderstood a certain topic, would modify the next day's lesson plan to re-teach that problematic area using a different approach. During the next day's class, the teacher might spend time with an EL student working through a sheltered English version of a lesson posted online, talking with a dyslexic student to make sure his font and text-to-speech converters are having the desired effect, and doing a front-line intervention with a General Ed student needing help staying on track in a long project.

During the advisory session later that day, the teacher might speak with a student who had missed three homework assignments in a row, as flagged by the online data-tracking system. In class, the teacher would work with that student to catch up or would arrange the appropriate method of external support. The student would return home, watch a documentary for History, answer a set of questions for Biology, and compose an essay for English, all online. The teacher would spend the next day's prep period revising a lesson plan online, posting it so that the other teachers and could see it, adding a new website link to the resources of a course, and then viewing the online data dashboard of recent student performance, looking for problems or opportunities.

All teachers will also be coaches/advisors for students. Coaching will take the form of both academic advising and social-emotional advising. Students will also be assigned a guidance counselor. Teachers will be provided with content, pedagogy, and technology professional development to prepare them for academic advising, and with professional development in social-emotional learning to prepare them for the social aspects of advising.

Coaching will be done in groups of roughly one staff member to 10-15 students. These advisory cohorts will move through the program years together after some initial adjustment and should form a bond that acts as a fundamental social-emotional experience. Advisory groups will also act as a feedback loop on student sentiment so school officials can gauge the effects of program policies and modify them accordingly while problems are still incipient. Coaching sessions will also act as a source of insight for teachers, as they will be able to see and hear firsthand how their students are faring under different forms of instruction and under different social circumstances (in project groups, working alone, in classroom settings, at home, and in the electronic environment).

Differentiation for students based on needs, interests, and abilities **takes place in three realms**: (1**) the content and materials**, (2) **the instructional processes and techniques**, and (3) **the products used to demonstrate learning**. The On-Demand Learning System will facilitate all three forms of differentiation. This environment facilitates access to different materials when students in class are not all working on the same task at the same time. It allows students with needs in particular areas to access additional instructional materials either created by others (e.g., Khan Academy) or by the teachers themselves. It allows teachers to record and share with other teachers techniques used for particular pedagogic purposes. Additionally, it allows different forms of assessment to be tracked and explained to other teachers and noted in student records.

The goal is to move toward a system in which all courses are modularized according to similar criteria that will make them easier for us to track and to update electronically. Criteria might include Common Core standards, scope/sequence/pace, lesson plans, content materials, electronic and physical resources used, course descriptions, big ideas and leading questions, accommodations for special needs/below grade/advanced, instructional techniques, and assessment strategies.

The goal is to make this type of system available to teachers in order to allow them to make changes, add observations on student performance and progress, mention problems, propose projects, contribute lesson or project plans, record the results of formative assessments, and pass on suggestions for the future. In this way, the STEAM Program will gradually build up a pool of resources and alternative teaching techniques that have been found valuable in the school environment.

Ancillary Badging Systems

Electronic badging systems will be set up to reward and encourage behaviors we hope to make widespread in the STEAM Program. Reading for pleasure is an obvious area of interest given the decades of research correlating minutes spent reading outside school with vocabulary growth. And English language reading will be particularly important for second language learners. So, the Reading Badging System will allow students to earn "credits" for reading by merely writing into the computer system a one paragraph summary of a book they've read, a one paragraph exhortation to others on why they should read the book, a rating, and, perhaps, the definition of one new word they learned in reading the book.

The reading recording badging system, open to all students in the program can be replicated and shared with the whole GLTS community. It will act as a recommendation engine, allowing group favorites to bubble to the top of the list for other students to peruse. (Since this is a gamification system, higher level badges are given for greater amounts of reading. And students will be encouraged to only read books they like - we want students to feel pleasure in reading. "Credits/badges" may be virtual items given as part of a school-wide game-style treasure system or they may eventually be redeemable for physical objects (possibilities include trinkets worn as jewelry and meaningful only within the school context, or social rewards like attention, objects such as trophies or letters sent home to parents, or privileges within the school).

Other badging systems may focus on: Artistic expression (an electronic or physical museum of art); Community engagement (recognition for public service endeavors); Good health, and; the habits of mind the school hopes to instill.

Additionally, students will set up their own badging systems for club activities and outside interests, firstly, to connect people who already have an interest in an arcane topic (let students see they are not the only bibliophile, philatelist, or junior ichthyologist around), and, secondly, to interest students in areas they may never have heard of before.

Student Achievement Goals

· The 10th grade MCAS scores in Math, Science, and ELA for individual students will exceed previous scores for those students. School improvement plans will change over time to reflect improvements in student and school performance.

· At the end of each year, Students will demonstrate proficiency and growing mastery in at least one action learning area (engineering, life sciences, computing) – through their multi-media portfolios of prior work, oral and media presentations, demonstrations and exhibitions. Proficiency will be assessed by teams comprised of teachers and industry experts (using pre-built rubrics).

· Students will successfully complete at least one online course offered by an accredited academic institution (such as edX or Khan Academy's new K12 course initiative with Phillips Academy), as measured by the students obtained a certificate from the granting institution, demonstrating that they have successfully fulfilled the course requirements.

· College attendance and graduation rates will exceed the national average.

School Schedule

Students (grades 10-12) will have the same academic year as the rest of GLTS (180 days) over three trimesters. The day begins at 7:43 am and ends at 2:30 pm – to coincide with the GLTS school day. During grade 9, the program will align with the current GLTS 8 Period schedule during the first semester, then switch to its own 6 Period schedule for the second semester.
Students will follow a rotating "A" and "B" schedule over 2 school days. The planned school day

includes the following daily components: six 55-minute class periods and a 30-minute lunch break. With a daily 'structured learning time' of 372 or 367 minutes, annual learning time = 6.2 hours (1,116), which exceeds the 990-hour requirement for Massachusetts high schools.

Two Week Rotation: Classes meet 5x over 10 days. Core & Crash Courses: 55 Min. Action Learning Labs: 115 minutes

WEEK 1					
	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
7:43 - 8:38	Phys Ed / Wellness	Performing Arts	Phys Ed / Wellness	Performing Arts	Phys Ed / Wellness
8:38 - 8:43	5 minutes to get to next class				
8:43 - 9:38	Foreign Language	Social Studies	Foreign Language	Social Studies	Foreign Language
9:38 - 9:43					
9:43 - 10:38	Science	Math	Science	Math	Science
10:38 - 10:43					
10:43 - 11:38	Crash Course #1	Crash Course #2	Crash Course #1	Crash Course #2	Crash Course #1
11:38 - 11:43					
11:43 - 12:30	Lunch/Indep Learning	Lunch/Indep Learning	Lunch/Indep Learning	Lunch/Indep Learning	Lunch/Indep Learning
12:30 - 12:35					
12:35 - 1:30	Reading for Pleasure/ Coaching/Advising	Action Learning Labs (115 Minutes)	Reading for Pleasure/ Coaching/Advising	Action Learning Labs (115 Minutes)	Reading for Pleasure/ Coaching/Advising
1:30 - 1:35					
1:35 - 2:30	English		English		English
After School	Athletics, Community Service, Optional Studio / Learning Lab Time				

WEEK 2					
	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
7:43 - 8:38	Performing Arts	Phys Ed / Wellness	Performing Arts	Phys Ed / Wellness	Performing Arts
8:38 - 8:43	5 minutes to get to next class				
8:43 - 9:38	Social Studies	Foreign Language	Social Studies	Foreign Language	Social Studies
9:38 - 9:43					
9:43 - 10:38	Math	Science	Math	Science	Math
10:38 - 10:43					
10:43 - 11:38	Crash Course #2	Crash Course #1	Crash Course #2	Crash Course #1	Crash Course #2
11:38 - 11:43					
11:43 - 12:30	Lunch/Indep Learning	Lunch/Indep Learning	Lunch/Indep Learning	Lunch/Indep Learning	Lunch/Indep Learning
12:30 - 12:35					
12:35 - 1:30	Action Learning Labs (115 Minutes)	Reading for Pleasure/ Coaching/Advising	Action Learning Labs (115 Minutes)	Reading for Pleasure/ Coaching/Advising	Action Learning Labs (115 Minutes)
1:30 - 1:35					
1:35 - 2:30		English		English	
After School	Athletics, Community Service, Optional Studio / Learning Lab Time				

- Schedule aligns with GLTS school day: 7:43am - 2:30pm
- Lunch Block: 30 minutes for lunch + 17 minutes independent study
- Reading for Pleasure time for 55 minutes, five times every ten school days
- Performing Arts (with a focus on Music) 55 minutes, five times every ten days
- Phys Ed / Wellness: 55 minutes, five times every ten days
- Student Advisory Time integrated during Reading for Pleasure Time
- Core Courses are Year Round. Crash Courses are 2 weeks to 2 months long
- M, W, F, each teacher teaches (3) 55-min blocks; Tues + Thurs, (2) blocks, plus (1) Action Learning period
- Students are on two week rotations, with 5 core courses over 10 days
- Total Learning Time per day: 372 Min = 6.2 hours = 1,116 hours in 180 day school year

Typical Student Two Week Rotation:

- (7) year-long core subjects (e.g. English, Math, Science, Performing Arts, History, World Language, Phys Ed). These courses meet for 55 minutes - five times every ten school days.
- Crash courses that run two weeks through two months. These two courses each meet for 55 minutes (5x every 10 school days)
- Reading for Pleasure time for 55 minutes, five times every ten school days.
- Action Learning Labs. Students work on project explorations five out of every ten school days (115 minutes long). Each Exploration is typically 12-13 weeks long.

Typical Student Two Day Schedule

On the first day, a typical student would arrive at 7:43 to begin Wellness. During the 55 minutes of Wellness, the student would engage in activities that integrate mind and body.

A student might then go to English class (55 minutes) to discuss the latest book, writing skills, or literary ideas. This would be followed by Science (55 minutes of Biology in the first year) where topics dealing with living systems are part of the online lectures and classroom projects.

This would be followed by a 30-minute Lunch period in the cafeteria followed by 55 minutes of Reading for Pleasure in a classroom (students can read any book they'd like, with staff approval).

Afternoon classes would start with a 55-minute crash course. These courses are short (two weeks to two months long).

The second half of the afternoon would be spent in Foreign Language class (55 minutes). Depending on the language being studied, Foreign Language class would either involve meeting with a teacher or engaging with a computer program. Students studying Spanish would meet with a teacher. Students studying other languages would have a teacher in the room with them who might not know the language the student was studying, so the student would learn the new language mostly through software.

The school day would then end at 2:30.

On the second day, a typical student would arrive at 7:43 to begin a 55-minute Performing Arts class focused on instrumental instruction in guitar, keyboard, bass, drums, vocals.

A student might then go to Social Studies class for 55 minutes to discuss Democracy, Scientific Progress, Culture, history or similar big idea. This would be followed by 55 minutes of Math where topics dealing with the world of numbers were explored. This class if followed by a Lunch period (30 minutes).

Afternoon classes would start with a 55-minute Crash course (e.g. STEAM Foundation Course.) Foundation Courses teach the skills necessary to create a webpage, but others allow students to expand their knowledge in other fields. Crash courses aim to provide students with the basics of useful subjects/ideas/technologies/approaches, so students can discover their calling, and use the skills they acquire in all their subsequent work.

The second half of the afternoon would be spent in a 2-hour Action Learning Lab. A lab is done in a studio room set up for a particular purpose, rather than in a classroom. A studio room is equipped either as a wet lab for doing biological projects, a computer room for doing programming projects, or a Makerspace for doing engineering projects. Projects can involve anything from growing living organisms to building robots to writing the code to create a mobile app.

Once the official school day ends, after-school activities like sports and band are possible. Activities like Language Exchange or clubs are also possible. And Atoms, Cells, and Bits studios may be open for students who want to continue building, growing, or coding.

Educational time spent at home, nights and weekends, is likely to be spent watching course lectures on the computer, doing assignments and tests in the online system, reading books, and working on individual projects.

A Teacher's Typical 2-Day Rotation:

Core teachers will typically teach three (3) periods per day in their core area

Core teachers will typically supervise or advise students for one (1) period per day during Foreign Language online class or Reading/Advising class.

Core teachers will typically have two periods for preparation each day.

Chap. 74 teachers will typically teach two (2) periods per day in Explorations/Action learning.

Chap. 74 teachers will typically facilitate/supervise two (2) periods of Crash Courses per day.

Chap. 74 teachers will typically have two periods for preparation each day.

Typical Teacher Day Schedule

Teachers will work 7:40am - 2:55pm Mondays, Tuesday, Thursdays; 7:40am - 3:15pm Wednesdays; and 7:40am - 2:30pm Fridays - which follows current GLTS teaching hours.

Beginning at 7:43, teachers are likely to spend the first (55 minute) period of the day, with preparation time for daily planning. For the next two 55 minute periods most teachers would teach their subject matter in the classroom. Then a teacher would eat lunch for 30 minutes.

In the afternoon, there would be one class (55 minutes) of Reading Coaching/Advising session (5x over 10 days) in which students read to themselves. Teachers would check to see that what the students were reading was appropriate/edifying.

This might involve working individually with one student on academic concerns brought by the student. Or it might involve sitting with a group of students to go over their plans. goals, and progress. (Students are assigned to a coach and stay with that coach all year long.) Teachers, in their role as coaches, have access to digital performance and progress data for each of their charges: including grades, current work, interests, and goals in all subjects. These are available so the coach can help the student make steady progress on Core Courses and investigate areas of interest that could lead to further study, career plans, or lifelong enrichment pursuits.

Then a teacher would teach their own subject once again for 55 minutes. When the day ended at 2:30, teachers would be available up to three (3) hours per week (in addition to their current day) for after-school discussions in which students may ask questions about difficult problems or get help with a particular project. Teachers would set up any weekly after-school office hours according to their own schedules. Additionally, during the summer, teachers would work 3 weeks the first year and 2 weeks each year after, on curriculum development and professional development activities.

Collaborating with Area Organizations

The focus on expanding horizons for students includes collaborating with area organizations, to provide students with co-op, internship, job shadowing, and mentoring opportunities. Area researchers, artists, innovators, engineers, scientists, and practitioners will be invited to assist with the STEAM explorations, speak to student groups, deliver master classes, demonstrate, mentor, and serve as judges in competitions.

Involving Parents/Guardians as Partners in Education

We will strive to have a system of open communication between parents and the program and plan to adopt GLTS' current system that allows parents to see student progress.

Enrollment, Recruitment, and Retention

School Year	Grade Levels	Student Enrollment
First Year	9	50-80
Second Year	9 + 10	100-160
Third Year	9 + 10 + 11	150-240
Fourth Year	9 + 10 + 11 + 12	200-320

Anticipated total student enrollment when fully expanded: 200-320. The maximum number of students who can attend the STEAM Program will be capped at 320.

Retention Goals and Strategies

+ Ensure academic success

Dedicate time each week during the school day, where students engage in proactive small-group academic conferences and coaching sessions.

+ Provide social and emotional support

Provide time every week during the school day, when students can engage in proactive small group social support advising.

+ Early identification of at-risk students (e.g. SPED, EL, & students trending below grade level)

When students enroll, we plan to contact their middle schools to learn about support services that are being provided at we do for all students at GLTS.

Support Structure

Inclusion Model: The STEAM Program - as part of GLTS - plans to have an inclusion model to deliver services to students with special needs. This inclusion model will provide students with disabilities a free and appropriate public education in the school's regular education classrooms and studios – or in a setting that most closely resembles the school's regular classrooms and studios.

Students will be supported in the inclusion environment whenever possible with trained staff. Example modifications may include tailoring instructional plans and assessments. Students will also be offered a range of services (based on their IEPs), provided by certified Special Education Teachers.

Given the varied district percentages of students with IEPs - Lawrence 17%; Methuen 15.5%; North Andover 15.2%; Andover 17.4%; and GLTS 21.1%, the STEAM Program will plan for the percentage of students with IEPs to be approximately equivalent to that of the state average – 17.3%. Based on this number, the number of SPED students in the program is estimated to be between 8-14, 17-28, 26-42, 34-56 for years 1 through 4 respectively.

Support Services:

The STEAM Program's On-Demand Learning System can help teachers identify students who are falling behind in a subject – recording what form the struggle is taking (subject areas, projects, tests, essays, homework) and which types of learning (lectures, films, simulations, reading, podcasts, projects, worksheets/drills, etc.) preceded the student's drop in performance. This should be of particular help in working with SPED and ELL students.

The STEAM Program's Electronic Environment (when deployed) can make certain SPED/ELL accommodations easier. Dyslexic students, for example, will be able to switch their online reading assignments into Dyslexia font to facilitate reading. They will be able to use their computing devices to shorten the reading width of documents to reduce the comprehension problems inherent in longer lines of text. And they will be able to convert written content into spoken content by a text-to-speech synthesizer. ELL students will be able to click-translate English text into most other languages.

Students will also have the ability to access digital voice recorded textbooks, novels, and research material via online sites such as Learning Ally which maintains a big library of accessible audiobooks and is available on computers, tablets and hand-held devices.

Teachers' Qualifications: Special Education staff will hold appropriate qualifications, according to federal and state law. The Special Education staff will conduct annual professional development for our classroom teachers.

SPED Staff: The number of special education students in the STEAM Program is estimated to be between 8-14, 17-28, 26-42, 34-56 for years 1 through 4 respectively. However, the number of Special Education teachers will ultimately be based on student need and IEP guidelines.

The STEAM Program will coordinate services with GLTS, such as occupational therapy, physical therapy, and speech therapy.

English Learners (EL):

The STEAM Program will follow GLTS' process for identifying students who are English learners, Limited English proficient and Former English Learners.

Staffing: Teachers will be Sheltered English Instruction (SEI) endorsed. The number of EL students in the STEAM Program is estimated to be 9.6% of the total number of STEAM Program students (Year 1: 5-8; Year 2: 10-16; Year 3: 15-24; Year 4: 20-32). 9.6% is the same percentage of EL students in GLTS currently - as reported in the 2015-16 MA Department of Elementary and Secondary Education Selected Populations Report.

Annual Program Evaluation: The STEAM Program will conduct yearly self-evaluation surveys of parents and staff on the effectiveness of services provided and their satisfaction with the quality of support provided. Staff will analyze WiDA assessments, MCAS scores, classroom performance, student portfolios, and team project results to (1) determine if inclusive practices are being effectively implemented and (2) identify ways to improve the effectiveness of the program.

Staffing Plan

The staffing plan reflects anticipated resources needed to implement the academic programs and serve the forecasted number of students (50-80 year 1; 100-160 year 2; 150-240 year 3; 200-320 year 4).

School Year	Grades	Regular Ed Teachers	Career Area Teachers	SPED Teachers	ELL Teachers	Admin-istrator	Total Headcount
First	9	5	3	Existing Staff	Existing Staff	1	9
Second	9,10	11	6	TBD	TBD	1	18
Third	9,10,11	17	10	TBD	TBD	1	28
Fourth	9,10,11,12	22	13	TBD	TBD	1	36

Assumptions:

- Students begin foreign language in 10th grade
- SPED and EL staff are shared positions with the rest of GLTS
- Physical Education staff are shared positions with the rest of GLTS
- Administrative and teacher support staff are shared positions with the rest of GLTS

Staff Recruitment, Advancement, and Retention Plans

Staff recruitment will remain consistent with the current GLTS recruitment, and will recruit qualified candidates through a variety of avenues starting with internal postings to SchoolSpring, including the advisory board and advisors' networks; meeting with area education school and university career offices; recruitment services; and LinkedIn education groups.

The STEAM Program will strive to retain staff by creating a working environment where teachers and staff are excited and engaged by their work, and feel they are actively contributing to the program's success – and that their voices and opinions count.

Working Conditions and Compensation

The STEAM Program will foster a working environment that (1) Encourages teachers and staff to be entrepreneurial; *(2)* Empowers them to think outside the box; and (3) Promotes a professional learning network within the school that transcends to neighboring school districts and schools throughout the world.

How faculty will be evaluated and by whom

The STEAM Program as part of GLTS will use the negotiated Appendix F in the teacher contract.

Professional Development

In the summer before its first year of operation - and every summer – the STEAM Program would like to run a teachers' institute in which faculty would devote 2-4 weeks to topics related to the school's goals, techniques, curriculum, and environment. The gathering would feature teachers, program developers, outside experts, and administrators brought together to exchange ideas and explore the culture of the school. This gathering would serve as an introduction to the people who work at the school and to the unique philosophy, known challenges, common practices, curriculum emphases, and ubiquitous technology of the school.

Discussions, often including outside speakers from academia and industry, would revolve around:

- Curriculum enhancement
- The integration of the arts and sciences
- Multimodal assessment
- Best practices in a student-centered classroom
- Pedagogical approaches to personalized and competency-based learning
- Guidance and coaching techniques
- Strategies for project/explorations-based teaching
- The creation of online and classroom educational content, and

Navigation of the STEAM Program's various computer systems, especially:

- The on-demand learning system that holds course content and tests
- The student academic monitoring system that holds information on student progress
- The coaching system that holds social and emotional learning data on student idiosyncrasies, interests, and goals:
- The electronic portfolios for students and Teachers' Forum for teachers, and
- The ancillary badging systems for encouraging reading, artistic expression, community engagement, good health, and the habits of mind the school hopes to instill

During this gathering, teachers would gain:

- Practical knowledge on how to use the STEAM Program's electronic environment
- Practical advice on how to teach in a student-centric competency-based often-project-based classroom, and
- Practical guidance on how to flourish in an environment that emphasizes student ownership of learning, experimentation, action-based education, and creativity

Professional Development (PD) during the school year would take three forms:

- Occasional outside activities that may include conferences, lectures, and demonstrations by visitors; leadership seminars held at university schools of education and management; and visitors from, or visits to, innovative schools in the Commonwealth and throughout the country - to observe their approaches and learn from their best practices

- Regular peer-centered collaborative program development sessions between colleagues where teachers discuss the improvement of the curriculum, the online system, the Coaching approach, the Explorations, integration of new ideas, and teaching methods.
- An online Teacher's Forum, a place where teachers can place written, photographed, or filmed successes that were achieved in their classrooms after trying new pedagogical approaches. These documents and images would be shared with other teachers and staff at the school - so everyone could learn from any one teacher's approaches. (We're exploring linking this Teachers' Forum to a PDP credit system so teachers could use it to work toward Recertification.)

As part of professional development, teachers will have the opportunity to modify or create online content for their courses whenever they find students missing a key point in the recorded content or not understanding an explanation in the recorded content. Teachers are not stuck with the recorded content, assignments, or tests that often take the place of classroom lectures. They can experiment with creating and substituting new content in any form, or can document student difficulties with existing content for later developers.

The observations and input of teachers in improving the STEAM Program are not only welcomed, but are, in fact, seen as key factors in the program's growth and evolution over time.

Note: The STEAM Studio Education Foundation has developed working relationships with several educational organizations. Representatives from these organizations are likely to participate in PD experiences for our teachers. Institutions include MIT, the new Woodrow Wilson Graduate School of Education (a collaboration with MIT's Digital Learning Center), BioBuilder, High Tech High, UMass Lowell, Lawrence General Hospital, Boston Children's Hospital, and area colleges.

STEAM Program Evaluation

Annual Review by GLTS Superintendent

When the GLTS Superintendent and team visit the STEAM Program for their annual review, a team of students gives them a tour, where they see first-hand the learning communities in action. Team members engage in ad-hoc discussions with students in the engineering, life sciences, and computing studios, where students are working individually and in teams – on explorations that foster critical thinking, creativity, analysis, and reflection. Students also speak about the entrepreneurial spirit throughout the school and it's engaging, active environment.

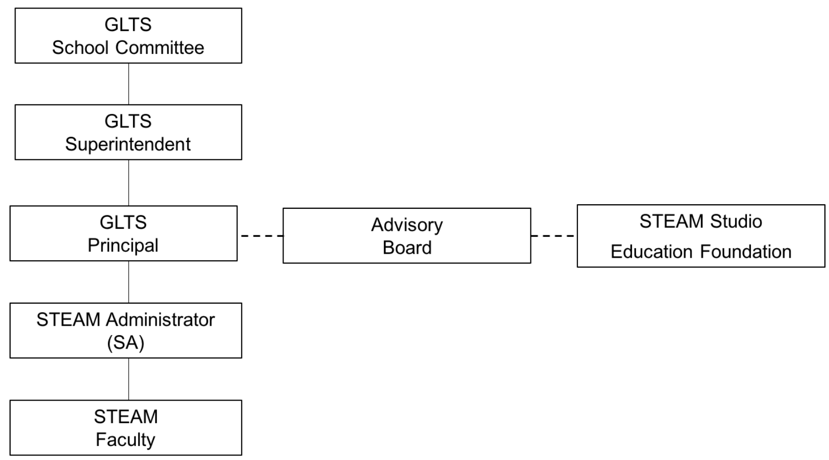
When the team visits the classrooms, they see a blend of face-to-face classroom instruction with online learning, based on the MA State Frameworks. Students who are struggling with a particular topic get the time and attention they need to master that area, while those who are ready to learn more can take on greater challenges.

Facilities

The STEAM Program will reside within the Greater Lawrence Technical School. The planning team will determine the necessary revisions/build-out required to meet the school's short and long-term needs and identify the necessary local building approvals needed. The program will be

ADA compliant and all students, staff, parents, and the general public who are physically challenged will have full access to the STEAM Program.

Proposed Organization Structure



The following is a summary of a potential organization structure. The structure is subject to change based on discussions with GLTS leadership.

The STEAM Administrator (SA) reports to the GLTS principal. The Advisory Board acts as a sounding board (providing advice and guidance) to the GLTS superintendent and STEAM Administrator. Teaching staff report to the STEAM Administrator.

In the areas of curriculum and instruction, student achievement, and teaching staff decisions, the STEAM Administrator, under the direction of the principal, will be the primary decision-maker. In the areas of fiscal planning, partnerships with industry and universities, and community outreach, the STEAM Administrator will be the primary decision-maker, with input from the GLTS principal and Advisory Board. The STEAM Administrator will monitor academic performance, and ensure sound financial decision-making.

Roles and Responsibilities

The STEAM Administrator (SA) has overall responsibility to ensure that the day-to-day operations of the STEAM Program move smoothly – and oversees development and implementation of the curriculum, assessment, and professional development. The SA plans and evaluates academic and career programs and tracks student performance and progress. The SA is responsible for leading teacher and staff hiring process, and maintaining programs and policies under the direction of the principal and Superintendent.

The STEAM Administrator is responsible for the teaching staff, curriculum, and instruction. They coach and mentor the faculty, ensuring that teaching is engaging and rigorous. They provide instructional leadership to the regular, special education, and english language (EL) teaching staff oversee the implementation of the curriculum, coordinate assessments, and monitor students' academic performance. The SA ensures the academic success of all students; recommends necessary actions and strategies; oversees effective implementation of curriculum and instruction; and coordinates the administration of assessments.

The STEAM Administrator will be evaluated annually using the MA DESE Administrator Evaluation Process.

STEAM Administrator attributes include:

Serves as the academic and career area leader of the STEAM Program; creates a safe environment for learning and an innovative environment for teaching; provides leadership and direction to the staff; supervises and observes instruction practices, including coaching and mentoring directly or through other staff; builds and fosters a vibrant school culture; evaluates staff; administers scheduling and oversees the curriculum.

STEAM Program Finances

The fiscal management will be led by the GLTS superintendent.

Operating Budget

The STEAM Program's Operating Budget falls under the GLTS school budget. Below are estimated costs:

	FY18 Proposed Budget
Staff/Instruction	800,000
Stipends	40,000
Curriculum and Development	15,000
Materials and Supplies	40,000
Renovations	20,000
Equipment	100,000
Total:	$1,015,000

Preliminary assessment of the autonomy and flexibility the school will seek

In the Massachusetts Innovation School legislation, Innovation schools and academies can seek autonomy and flexibility in numerous areas, including curriculum, budget, school schedule and calendar, staffing policies and procedures, professional development, and school district policies.

The Innovation Plan planning committee will considering whether it is appropriate/necessary to apply for autonomies in the following areas:

Curriculum: The STEAM Program's curriculum is divided into six categories: Humanities, Math & Science, STEAM Foundation, Performing Arts, Health & Wellness, and Crash Courses.

- We have some non-standard courses (e.g. Crash Courses and Action Learning Labs) that last two weeks to three months, and are in non-standard areas like Architecture, Medicine, and Computer Programming - so we may not be able to hire certified teachers for such short, one-off courses
- Some of our language courses will be primarily online, so no teachers, or alternative kinds of teachers (language exchange) will be required
- Action Learning Labs and Crash Courses may be overseen by graduate students who are doing research in a particular field, or by outside experts, instead of by teachers because we may not

be able to find a union teacher for a 4 week course in the design of, say, flying jellyfish robots. So, a university group working in Soft Robotics would become our teachers

Staffing Policies: The STEAM Program may seek the ability to hire industry practitioners to teach STEAM Foundation, Performing Arts/Design, Health & Wellness, Action Learning Labs, and Crash courses (hiring could be for less than a year – e.g. for a single course). Additionally, if the STEAM Administrator and GLTS leadership team believe there are no qualified certified teacher candidates in a given curriculum category, the STEAM Program may be able to hire non certified candidates to fill available teaching positions.

The program's crash courses are shorter than typical high school classes (2 weeks through 2 months), and are likely graded pass/fail. This may require autonomy in school district policies.

The program's Mastery approach to learning, Explorations, Physical Education/Wellness, Language Exchange, Performing Arts, International Program, and Personalized Learning System may require autonomies.

School Schedule: The STEAM Program is planning to have the same school day (start/end time) as GLTS. The program may also be open in the afternoon (and possibly weekends) for student studio use.

Professional Development: The STEAM Program will incorporate new computer systems, new methods of teaching and learning, and new curriculum, so professional development (PD) will be required of our teachers.

The STEAM Program plans to have full-school teacher Professional Development each summer - 3 weeks the first year and 2 weeks each year after, where teachers will be engaged in curriculum planning/development and professional development activities.

This will add 2-3 weeks to the teacher year, and may require autonomy from existing staff policies and procedures. Additionally, the program plans to hold weekly all staff collaboration meetings during the school year and deploy Teachers' Forum contributory software which may require autonomies.These dates will be determined and communicated by January 1st for teacher planning purposes. Any time over the contracted school day that is required as part of the STEAM program will be compensated. Any Professional Development that is required as part of the job in the summer will be at the per diem rate.

Teachers will be asked to be coaches/advisors in addition to teaching, which will entail more PD.

The PD during the school year would be for the STEAM program faculty.

Teacher Community: A collaborative professional atmosphere where teachers regularly collaborate with each other, curriculum designers, software developers, and staff/administrators. (We're exploring ways of getting teachers PDP credits for recertification for this kind of PD)**.**

Hire teachers who are eager to engage in high levels of collaboration with each other and with other STEAM Program participants (e.g. graduate students, universities, industry, and international high schools).

The GLTS superintendent will work with union leadership to reach consensus RE what autonomy and flexibility will be required. Any exceptions are subject to collective bargaining.

Why such flexibility is desirable to carry out the STEAM Program's objectives

The above autonomy areas may be required to deliver planned academic programming and fulfill the goals of the program.

STEAM Program Concept Team - and Potential Advisory Board Participants:

- John Arnold, a software entrepreneur with extensive experience in the software industry. Served 12 years as a member of the Massachusetts Board of Library Commissioners. Current Town Moderator in Westborough, MA and former Chair of their Finance Committee.
- JoAnn Gantz Bendetson, a child development expert, with special education expertise.
- David Birnbach, director of the STEAM Studio Education Foundation. He is an educator at MIT's School School of Management - on the teaching team for several Action Learning courses.
- Joseph Browne, Assistant Director, Action Learning at MIT. Prior to joining MIT Joseph was program coordinator for the New Scientist Program at Brown University, where he led a STEM transition initiative for incoming students and oversaw a mentoring initiative for STEM students.
- Jonathan Dietz, who leads curriculum planning for the STEAM Studio Education Foundation. A graduate of MIT, with degrees in Life Sciences and Electrical Engineering, and a former biomedical engineer, Jonathan has been a teacher of K12 science and engineering since 2001.
- Mary Kelleher, who heads an innovative education advisory service that guides high school students and their families through the college search and application process.
- Howard Lurie, an expert in online learning, with 18 years of leadership and management experience in digital education. He was managing director for PBS LearningMedia, a nationally recognized digital learning platform produced by the Public Broadcasting System.
- Karen Postal Ph.D., a noted neuropsychologist and instructor at Harvard Medical School. She served as president of the American Academy of Clinical Neuropsychology, the Massachusetts Neuropsychological Society, and the Massachusetts Psychological Association.
- Matthew Taylor, a software engineer at the MIT Media Lab, focused on learning technology. He is a member of the Media Lab's Lifelong Kindergarten Group - where he works on Scratch, a visual programming language for teaching computational thinking.

Our Advisors and Potential Advisory Board Participants:

- Heather Abbott, Senior Vice President, Technology Solutions at NASDAQ. A leading Boston-area technology leader and advocate for helping girls to pursue careers in STEM fields.
- Andrea Brennen, Former artist and designer at MIT Lincoln Lab. She is an expert in the intersection between science and design, and helps scientists and designers collaborate to push the boundaries of both disciplines.
- Ann Koufman-Frederick Ph.D., Director, Education Initiatives at LearnLaunch, an education technology incubator. Former Deputy Superintendent for Teaching & Learning in Newton (MA) Public Schools and Superintendent in Watertown, MA.
- Natalie Kuldell Ph.D., Instructor, MIT Department of Biological Engineering and Founder/President of the BioBuilder Education Foundation, that converts cutting-edge science and engineering into teachable modules aimed at high school students. http://biobuilder.org/
- Ron Lasser Ph.D., Professor of the Practice, Department of Electrical and Computer Engineering, Tufts University. Prior committee chair of Tufts' Engineering Leadership Program.
- DJ Poet /Jaime Munson, Grammy award winning producer, songwriter and DJ with The Black Eyed Peas. He is one of the most innovative artists in the music industry.
- David Stephen, a noted school designer and educator who helps districts, schools and teachers develop student-centered and inquiry-based curricula and programs. His design projects include the highly acclaimed High Tech High network of schools (CA) and Da Vinci Schools (CA).
- Jack M. Wilson Ph.D., President Emeritus, The University of Massachusetts system (2003-11) and Founding CEO, UMassOnline. Now a Professor of Higher Education, Emerging Technologies, and Innovation at UMass Lowell.

Appendix A: Planned Course Descriptions

Core Courses:

<u>English Courses</u>

Changing Hearts and Minds: English and Digital Media Arts is a yearlong course that teaches students to act as purveyors of change in the world at large. Throughout the course, students will analyze a variety of print and digital texts in order to identify and interpret an author's, artist's, and/or designer's message, and to determine how a specific audience drives a creator's decision making process. Students will evaluate and use visual design principles and elements to enhance, distribute and increase visibility of a message or cause. This process will lead students to use writing and the principles of design to create texts and visuals that tell stories and convey effective messages for the purposes of effecting change; this also leads students to be critical thinkers and active receivers of messages. Students will read fiction and nonfiction as sources of inspiration and discovery and then write to learn with an emphasis on how choices of diction and syntax shape a message. Throughout the course, students will use collaboration processes, oral communication, presentation and creative problem solving to strengthen and apply their knowledge of written and visual messaging.

(Source: University of California Curriculum Integration Center:
http://ucci.ucop.edu/integrated-courses/changing-hearts-and-minds.html)

"Get Reel: English Through Your Lens" challenges students through the analysis of text, including media, informational writing, and fiction. Students develop the abilities and skills to effectively produce powerful video messages, oral presentations, and writing to critically examine and deconstruct ideological and social influences and understand how these influences impact both individual and group identity.

Students in this engaging English class learn to recognize themselves as both products and members of society as they study and create a variety of text, including narrative and analytical writing, constructed argument, visual mapping, multimedia, and video messages. They understand that language is a powerful medium when read, written, spoken, and performed with purpose. While students explore the universal themes of identity, power, and freedom, with extensive focus on the novel, poetry, informational text, and film, they acquire important technical skills needed to use digital media tools for filming and editing. They gain the necessary abilities for digital media production, while participating in a rigorous, integrated creative English and media course that provides real-world connections through extensive career and technical content.

(Source: University of California Curriculum Integration Center:
http://ucci.ucop.edu/integrated-courses/get-reel-english-through-your-lens.html)

Communication by Design: English and Media Design integrates English with Visual Design and Media Arts by giving students the ability to communicate to different audiences in a variety of text formats as it applies to analog media, digital media, and real-world digital representations. Through repeated assignments and strategies, students develop and reinforce academic and industry-related foundational concepts and skills such as website construction, document specific formatting, career connections, analytical and informative writing and collaboration. Using effective speaking and listening skills, students convey a variety of messages both informative and persuasive, demonstrate mastery of visual representation of information, and conduct interviews with community and industry professionals as well as prepare for career based interviews. Analytical essays incorporate rhetorical strategies to develop persuasive/arguments and claims in both written and visual representations. Students deliver clear, organized presentation specific to the concept of each unit and leading to the Culminating Project at the end of the year. Students end the course with a choice of projects which expand on the performance task of one of the units. They begin with the basic product of the unit performance task; increase its sophistication, depth, and professionalism.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/communication-by-design.html)

Changing Hearts and Minds: English and Digital Media is a year-long course that teaches students to act as purveyors of change in the world-at-large. Throughout the course students will analyze a variety of print and digital texts in order to identify and interpret an author's, artist's, and/or designer's message, and to determine how a specific audience drives a creator's decision-making process. Students will evaluate and successfully use visual design principles and elements to enhance, distribute and increase visibility of a message or cause. This process will lead students to use writing and the principles of design to create texts and visuals that tell stories and convey effective messages for the purposes of effecting change; this also leads students to be critical thinkers and active receivers of messages. Students will read fiction and nonfiction as sources of inspiration and discovery and then write to learn with an emphasis on how choices of diction and syntax shape a message. Throughout the course, students will use collaboration processes, oral communication, presentation and creative problem solving to strengthen and apply their knowledge of written and visual messaging.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/changing-hearts-and-minds.html)

History & Citizenship Courses

Engineering America: U.S. History + Engineering & Architectural Design. This course serves to help students make connections between U.S. History and the engineering innovations that helped form our nation. Students will not only use the engineering design process as they attempt to solve the historical challenges presented to them, but they will also look at the Code of Ethics that governs decisions in the world of engineering; they will examine how decisions made by powerful people had an impact on the landscape and forever altered the way things are done in the US. This course seeks to explain the political, social, economic, and technological factors that prompted the need for engineering innovation in US History. Upon completion of the course, students will think and act like historians, understanding that source, contextualizing, and corroborating historical sources are used to analyze and address present day issues. Their understanding will be demonstrated in a culminating project in which small student teams design/build a scale model of a modern "ideal" US city informed by their understanding of history. Upon completion of this course, students will understand the design process, logistical thinking, and relevance of engineering in American life. This course provides a foundation that could serve as an opportunity for further study in engineering as a career.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/engineering-america.html)

World History by Design is a course in which students will analyze significant periods in world history from the development of government systems through to modern times while building the basic skills of graphic design elements and principles. Students will use major world events such as revolutions, wars and globalization as the inspiration for design projects to synthesize the knowledge into cohesive assignments that are both content driven and conceptual. Students have the opportunity in this course to demonstrate their knowledge of historical content through the creating art, using the elements and principles of design. Students will produce a series of artistic products that reflect their comprehension of both historical content and relevant design skills; from the years of the ancient Greeks and Romans through the modern post Cold War world. Students will integrate the reading and viewing of traditional texts, primary source resources, technology manuals, digital media sources, appropriate era artwork and tutorials to demonstrate their knowledge of design and world history. Upon completion of this course, students will have completed their world history requirement and be prepared to take additional design courses.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/world-history-by-design.html)

Big Ideas: History and Future of Science and Technology Based on National Geographic's "*The Big Idea*" series – this course takes students on an exciting voyage through time, exploring the biggest STEM innovations of today – by moving back through history to uncover the foundations for these groundbreaking science, technology, and engineering concepts. Students will explore the history of 24 big ideas – life-changing innovations across technology, medicine, physics, chemistry, biology, and transportation.

(Source: To be Developed using National Geographic's "The Big Idea Series)

Journey for Justice in America: American Government & Public Services provides students with the necessary skills and content knowledge in a standard American Government course, while also allowing them to understand how this knowledge is applied in careers in government services and legal sectors. The foundational American Government concepts students learn in the course also allow them to become informed, active citizens in their respective communities. In this course, students come to understand the principles on which the United States government was founded, the structure of government at the federal, state and local levels, the individual and civil liberties needed to maintain a democratic society, and the way in which order is maintained through law enforcement and the judiciary.

(Source: University of California Curriculum Integration Center (http://ucci.ucop.edu/integrated-courses/journey-for-justice.html)

Science Courses

The Technology of Biology: This one-year course serves to introduce the principles of biology through a biotechnological perspective. A general high school biology class focuses on the study of life ranging from the atoms that build up the macromolecules that serve as the foundation of life to how different ecosystems interact within a biosphere. Biotechnology aims to help improve our lives and the health of our planet by harnessing cellular and biomolecular processes. Students will use an integrated approach to study the principles that govern life while constantly referring to how these applications of biotechnology are attempting to improve life on earth. For example, modern biotechnology provides ground breaking products and technologies to combat diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner, and more efficient industrial manufacturing. This course challenges students to honestly evaluate the current problems faced in the 21st century and apply their knowledge of foundational biology to propose possible solutions using biotechnological techniques. Upon completion of the course, students will identify a medical or environmental problem, research possible products of biotech companies that are attempting to address that problem, prepare an advertisement campaign to educate the public of the identified problem, and justify why their product is the answer. Upon successful completion of the course, students will have a better understanding of current biological concepts and biotechnological applications.

(Source: University of California Curriculum Integration Center (http://ucci.ucop.edu/integrated-courses/the-technology-of-biology.html)

Physics and Engineering: Motion by Design: Students apply principles of physics and engineering to an iterative cycle of product design. In this year-long, integrated, course, students will develop an understanding of fundamental physics concepts in kinematics, mechanics, mechanical and electromagnetic waves, and electricity/electromagnetism while exploring robotics, computer programming, computer aided design (CAD) and rapid product development. Working individually and in teams, students complete a series of design challenges to develop key skills in computer programming, 3D modeling software, engineering technology, and physics concepts. The course culminates with competition-ready, semi-autonomous devices presented as marketable products designed to serve a specific purpose in the local community. These projects promote critical thinking, communication, collaboration, creativity and provide a foundation for data collection, analysis, reflection, presentations and technical writing skills. By successfully completing the course, students will be prepared for success in college science and engineering as well as in high-demand careers like automation and advanced manufacturing.

(Source: University of California Curriculum Integration Center (http://ucci.ucop.edu/integrated-courses/physics-and-engineering-motion-by-design.html)

Chemistry and Engineering Design: Solving Local and Global Challenges: Students will examine, explore, and experiment with a variety of Chemistry concepts in order to better understand how such knowledge can be used to engineer tools, products, or systems for using energy to meet human needs–such as water purification, energy needs for a community, and ways to store energy. Students will tackle challenges framed around creating sustainability related to water, food, or energy consumption in a hypothetical small village. The culminating project of the course requires students to present a report that includes CAD models or prototypes, bill of materials, and Gantt chart to achieve their selected goal. They will also present their project to an authentic audience and receive feedback. In order to demonstrate and integrate student learning of both Chemistry and Engineering design, students will be prompted to collect work samples for a portfolio that will also support them with completing their culminating project.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/chemistry-and-engineering-design-solving-local-global-challenges.html)

Mathematics Courses

Functional Design Through Algebra: In this engaging, hands-on course, students will discover the power of mathematical modeling with Algebraic functions. Through a variety of Engineering Design projects, students must utilize functions to optimize the outcome of each challenge.

Students will see parallels between the mathematical modeling cycle (top image at right) and the engineering design process (bottom image at right) in each unit. Students will design parachutes, bungee jumps, boats, balloon rockets, a variety of water fountains, and, as a capstone project, a thermally resistant beverage container along with product proposal and pitch. Students will document calculations, graphical relationships, sketches of prototypes and final designs in an engineering notebook that includes summaries of each project and ideas for future redesigns. By building understanding of functions, graphs, equations, and algebraic relationships, students will see how mathematical understanding can verify optimal performance and design in a variety of applications.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/functional-design-through-algebra.html)

Geometry + Computer Visualization/Simulation: This course seeks to introduce students to a range of careers - including software development, computer programming, game design, digital fabrication - and methods that use computers to visualize geometric information necessary for product design. Using applied geometry, students create a final 3D-printed product that demonstrates the key role that geometry plays in a particular industry. Throughout the course, students will integrate geometric principles with computer-based programs and designs while learning to create and work in a technical environment that facilitates workplace efficiency and online communication. Students use information and communication technology (ICT) practices to share their geometry-based findings and projects with each other, their teachers, family and others. Upon completion of this course, students will be familiar with the many ways that computers can be used to simulate and model geometric concepts using computer programming and modeling, simulations and interactions, and three-dimensional printing.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/geometry-computer-visualization-simulation.html)

Applied Math and Engineering: Algebra 2 and Trig for Engineers: This course allows students to apply Advanced Algebra and Geometry skills contained in the traditional Algebra 2/Trig course to the Engineering Design Process: Requirements, Analysis, Design, Build, Validation. Student groups will represent civil engineering firms who receive a Request For Proposal (RFP) from a school district in need of a new 21st Century state-of-the-art high school. Students employ the engineering process to design this high school, considering the parameters and requirements of the district while using math (linear equations and functions, quadratic equations and functions, polynomials, rational and radical functions, exponential and logarithmic functions, statistics and probability, and trigonometry) as a tool to make engineering decisions and complete the projects. Throughout the course, teams will keep an engineering notebook which documents all mathematical calculations, assumptions, notes, preliminary sketches, etc. to provide a “roadmap” of their final design assignment. Project Teams will continuously update their Know/Need To Know Lists Re: the RFP to include new information learned. These revised lists will be used by the teacher as a formative assessment on a recurring basis. The teacher will look for understanding of mathematical concepts as applied to the current engineering process. Upon completion of the course, students will be able to integrate the math topics and concepts with the

Engineering Design Process to create a final report and presentation of their high school design aimed at an audience of school board members.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/applied-math-and-engineering-algebra-and-trig-for-engineers.html)

Modeling Your World #math #programming is an Integrated Mathematics and Software Development course that explores the world of computer programming through the mathematical modeling of concepts such as polynomials, logarithms, exponentials, functions, statistics, trigonometry, and rational expressions. Through linking the real-world applicability of project-based learning, such as exponential models based on population growth, students see patterns, test hypotheses, and solve problems. Mathematical modeling is built into the course throughout and reinforced through creating and coding algorithms, teaching students the importance of clarity and precision of language whether they choose to pursue college and career goals in the field of mathematics or computer science. Students will leave this course with not only higher level math skills, but experience in software development. This project-based course features topics ranging from the world of social media to data visualization for disaster planning.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/modeling-your-world.html)

Precalculus, AP Calculus AB, and AP Statistics

(Source: Summit Public Schools, CA: Students will use Summit Public School's curriculum for Precalculus, Calculus, and Statistics. http://summitbasecamp.org/

World Language Courses

The STEAM Program will serve the Greater Lawrence region, which has a substantial bilingual population. Many of our students are likely to be at various levels of fluency in their first and second languages, and language education, in one form or another. For students whose first language is Spanish we'd like to offer innovative native speaker Spanish courses.

Spanish 1, Spanish 2.

(Source: Summit Public Schools, CA: Students will use Summit Public School's Spanish curriculum. http://summitbasecamp.org/)

Spanish 3 for the Entrepreneurial Mind: Within the context of a third year high school Spanish class, students will explore how their interests and talents fit into the marketing, sales and service sector, come to understand, develop and implement workplace norms that meet safety and comportment standards, decide upon a product or service to sell, develop that product or service in a simulated market environment, create a marketing campaign to vend the product or service, hire a staff, and present their product or service for sale. Students will use situationally appropriate and culturally sensitive Spanish as the means of communication and instruction as they learn the concepts and principles of sales and marketing inherent in completing these tasks and in demonstrating their ability to apply them appropriately.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/spanish-3-for-the-entrepreneurial%20mind.html)

Spanish 4 for Patient Care: ¡Soccoro!: Medical caregivers must be able to communicate with the Spanish-speaking patient on a medically and linguistically appropriate level. Students will build a framework for practice with management of health-related situations such as an infectious disease outbreak, treatment of injuries, cardiopulmonary complications, and diabetes. From this established foundation of common scenarios encountered in medical settings, students will incorporate standard medical terminology, knowledge of anatomy and physiology, and patient assessment with clear, accurate Spanish communication in an effort to fuse the medical responder with the medical communicator. This hybrid Spanish-Healthcare provider responder represents the future of accurate, responsible healthcare, paving a road to uncompromised medical services for the Spanish-speaking patient.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/spanish-4-for-patient-care.html)

Native Speaker Spanish for Health Careers: This course meets the standards of a Native Speaker Spanish course while incorporating Health Science and Medical Technology (HSMT) themes, with a focus on the Public and Community Health Pathway. Taught exclusively in the target language, this course begins with a focus on personal health, then broadens the context and scope to include family, community and public health, and health careers. Students acquire knowledge of a range of public health issues including physical, mental and social. They apply their understanding of public policies to promote health-positive behaviors among individuals, families and the community. Through a range of real-world situations, students demonstrate understanding of culturally appropriate Spanish and the nuances of language across the Spanish-speaking world, as they engage in advanced listening, speaking, reading and writing activities. Students use a full range of academic Spanish vocabulary, with emphasis on health terminology, in present, past, future, subjunctive and perfect tenses.

(Source: University of California Curriculum Integration Center: http://ucci.ucop.edu/integrated-courses/native-speaker-spanish-for-health-careers.html)

Crash Courses - Sample

Gears: Engineering Crash Courses

Design It! Longboards: Based on summer workshops at Dartmouth and the Girls Garage – Berkeley, CA, students will design, hand-press, laser-etch, and construct custom skateboards.

Design & Build Musical Instruments, based on Dartmouth's Lasercut Ukelele Project.

Design Thinking Shelter Course: *An Integrated Design Thinking/STEM Curriculum* is a four-week program, in which students explore shelter-based design thinking challenges and STEM activities related to shelter. The curriculum focuses on the intersection between design thinking, STEM, and shelter. The foundation of the curriculum is an enduring understanding:

students will develop the creative confidence to fail forward by building successful shelters using both STEM concepts and the empathy-driven design thinking process.

Materials World: Based on materials science and nanotechnology principles, this interdisciplinary approach engages students in making sense of the rich tapestry of materials that surround them and to provide an opportunity to create new materials or fabrics for our world. Students engage in an environment of scientific inquiry within a design context involving material objects; students ponder design problems that scientists and engineers encounter every day in the workplace. Incorporating inquiry within a materials design context helps to provide purpose and structure in the learning of underlying scientific concepts. Students engage in explorations involving biodegradable materials, ceramics, biosensors, sports materials, and solar cells.

Introduction to Electronics: Students will learn basics of DC circuits, and be introduced to the technology of building electronic devices through hands-on projects (e.g. creating LED circuits, smartphone speakers, insect robots).

Redesigning Energy: An Integrated Design Thinking/STEM Curriculum is a four-week program, in which students explore energy-based design thinking challenges and STEM activities related to energy production and conservation.

Designing Prosthetics: Created by the ‘Enabling the Future’ organization, students design and build prosthetics using 3D printers to create 3D printed hands and arms for those in need of an upper limb assistive device.

Build an Interactive Monster: Developed by MIT’s Media Lab, students will learn fundamentals of electronics and programming as they create their own interactive stuffed monster. Using a small computer called a LilyPad Arduino, conductive thread, and some simple programming, students combine sewing and circuitry in the form of a friendly monster that can light up, make noise, and respond to touch. No prior knowledge of programming or working with electronics is required.

The Engineering of Structures, based on Vicki May’s Dartmouth/edX course.

BITS - Computing Crash Courses

Fun Intro to Computer Science: Based on Code.org’s approach, students gain a hands-on introduction that covers core computer science and programming concepts.

Computing, Apps, and the Web: Software affects almost everything we do. This course helps students become software creators, not just consumers. Students explore the world of software engineering by creating smartphone and tablet apps. The course uses App Inventor, an innovative tool to teach students the latest concepts. Co-developed at Google and MIT, App Inventor is a visual software development environment that is transforming computer science education by appealing to students across the educational spectrum, including students who typically fear math and science.

Make Your Own Wearables: This course introduces students to computer science, electrical and mechanical engineering through wearable technology. Developed by MIT Lincoln Laboratory, the course consists of two hands-on projects in manufacturing and wearable electronics. These include 3D printing jewelry and laser cutting a purse, as well as programming LEDs to light up when walking. Participants learn the design process, 3D computer modeling, and machine shop tools, in addition to writing code and building a circuit.

Cyber Security Skills for the Real World: Based on the Hacker High School curriculum, students learn cyber security and critical Internet skills. Projects challenge students to be as resourceful and creative as hackers with topics like safe Internet use, web privacy, online research techniques, network security, and even dealing with cyber-bullies.

Game Design and Development: The improvement of digital technologies has transformed the video game industry into one of the most exciting forms of modern day entertainment. This field has unlimited growth and limitless creative advances. This course challenges students to produce a 3D video game while developing foundational skills common to other forms of digital media.

Vector Graphics for Making Things: Vector graphics is the creation of digital images through a sequence of commands or mathematical statements that place lines and shapes in a given two-dimensional or three-dimensional space. Students will be introduced to basics of vector graphics for both laser cutting and commercial graphics, using Adobe Illustrator

CELLS – Life Sciences Crash Courses

Urban Farming: Food is a basic human need and nutritious food is critical for a healthy life. As our population grows and our available farm lands shrinks, how do we ensure that all people, even those in urban areas, have access to high quality, fresh food? In this course, students will learn about the urban farming revolution, how plants can be grown in cities, and the impacts urban farms can have on their communities.

Green Engineering Design Challenge: Students will learn the Design Thinking methodology through series of projects centered around Green Engineering. Based on curriculum from Newton North High School's Green Engineering program.

Surgical Techniques 101: What is it really like to be a physician or surgeon? In this course (developed by the New York Hall of Science), students will investigate how the body works by participating in a range of hands-on activities, such as dissections and construction of life-sized physiological system maps (skeletal, nervous, circulatory, immune). Students will conduct simulated surgeries, perform biopsies, and learn how to suture. They will also learn about important medical and surgical breakthroughs and practice the type of problem-based learning taught in medical school.

Wrestlebrainia: Developed by the National Science Foundation Engineering Research Center for Sensorimotor Neural Engineering, students engage in a simulated arm-wrestling game in which students compete – using to pin their opponents by generating stronger electrical signals from their muscles, captured by electrodes, and controlled motors in two mechanical arms.

Bioinformatics: Students will use introductory DNA techniques to study human populations.

Appendix B: STEAM Program Teacher Job Description

STEAM Program teacher candidates should be:

- Pedagogically agile; able to model learning
- Reflective and enthusiastic about exploring new approaches to pedagogy
- Flexible and able to be comfortable in a non-traditional school environment
- Collaborative with fellow teachers and staff to continually improve programs and services

Teachers should be comfortable with technology as, over time, the STEAM Program will integrate technology into a teacher's daily life to a degree that most schools have not yet attempted. Over time, technology (e.g. On-Demand Learning System) will be a major and integral part of the teaching and learning environment.

Over time, course materials will be provided to students online. Recorded "lectures" that explore course concepts, facts, and ideas will be available online. Students and teachers will maintain their own electronic portfolios.

Project-based learning and the encouragement of creativity will also be large parts of teacher life. So, teachers should be comfortable in a project-based learning environment.

Student projects will be embedded in courses, and teachers will conduct Design School-style "pin-ups" in class in which students display and explain their creative approach and defend their work to the class. Group projects occur every other day in action learning labs - periods set aside for students to work together solving problems and developing solutions that put to use the ideas and concepts they learn in core/crash courses.

Teachers will also be coaches. Each teacher will mentor, guide, and advise a group of 20-25 students throughout the school year, and perhaps through all four years. This will include parent-teacher contact.

Time during the week will be set aside to allow teachers to share the results of their teaching and coaching endeavors with other teachers and staff. We are studying ways for teachers to receive PD CE credit for contributing to a Teachers' Forum that features ideas, past successes, current trials of new pedagogical approaches, and interesting future projects that relate to their teaching. This Teachers' Forum would be available for all teachers to share.

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