School Committee Curriculum Subcommittee
Wednesday, March 13, 2019
8:30 AM-10:30 AM
5th Floor Conference Room, Town Hall

Curriculum Subcommittee Members Present: Barbara Scotto (Chairman), Susan Wolf Ditkoff, and Suzanne Federspiel.
Curriculum Subcommittee members Absent: Helen Charlupski (was representing the School Committee at another meeting).
Other School Committee Members Present: David A. Pearlman.
Staff Present: Meg Maccini, Mary Brown, Kathleen Hubbard, Brit Stevens, and Robin Coyne

<u>1) Review of Proposed Brookline High School (BHS) Robotics Courses for Course Catalog Inclusion</u>

Brit Stevens, Brookline High School Interim Coordinator of Career and Technical Education, presented a proposal for new 2019-2020 Brookline High School Courses: Robotics I and Robotics II (Attachment A). Autonomous Robotics I would be a project-based course where students develop computing and mechanical design skills and apply them to design and build autonomous robots that use sensors and actuators to perform simple tasks in response to their environment. Students would also explore ethical and aesthetic questions in robotics and computing as they apply to designing, building, and deploying their robots to solve real-world problems. Autonomous Robotics II would build upon the computing and mechanical design skills developed in Autonomous Robotics I. The courses were developed through collaboration between the Math and Career and Technical Education Departments and would be taught by math teachers. Each class would be an elective and would fulfill a .5 Career Technology requirement. The courses would be cost neutral.

Ms. Stevens stated that students at BHS from all backgrounds should be exposed to computing before they graduate. Robotics courses provide a pathway to further studies. This is an equity issue. Ms. Stevens discussed how concepts could potentially be embedded into other elements of the BHS curriculum. Subcommittee members expressed strong support for the courses.

On a motion of Ms. Scotto and seconded by Ms. Federspiel, the Curriculum Subcommittee voted unanimously to recommend that the School Committee vote to approve the proposed new 2019-2020 Brookline High School Courses: Robotics I and Robotics II, as shown in Attachment A.

<u>2) Math Program Review Update</u>

K-8 Math Curriculum Coordinator Kathleen Hubbard and Senior Director of Programs Meg Maccini provided an update on the Math Program Review (Attachment B). Phase I is in the final stages and the Interim Report is being finalized. Phase I included visioning (What do we want the Brookline math experience to be for our students?), data collection (Where are we now?), identifying strengths and areas for improvement, and developing areas of inquiry and making recommendations for Phase 2. Mr. Lummis is assisting with the process to communicate and get feedback on the vision statement for Prek-8 Math. The Subcommittee discussed the creation of a culture of numeracy and suggested providing concrete examples of how math can be embedded into all BHS classes.

Ms. Hubbard discussed the 6-8 pilot of Illustrative Math-Open Resources. Sixteen of 20 middle school teachers are piloting the materials for the full school year and the remaining teachers piloted at least one unit. Collaboration among the 6-8 team members and with the BHS teachers has grown. Feedback has been extremely positive and there will likely be a recommendation to the Superintendent and School Committee to move forward with the curriculum. Considerations if we move forward include: 1) Collaboration - more opportunities for collaboration and observing other classrooms with general education teachers, special educators, and math specialists; timing/packing of lessons-common plan (autonomy will be more in the delivery than the structure); more training and modeling of ways to structure discussions and group work, and 2) Materials – more challenge problems in addition to "are you ready for more," additional bank of shared assessment questions, station work/choice, and units that we make "our own" with added resources. Ms. Hubbard discussed the training provided to the 16 teachers for the pilot and the plan for future professional development. Finding time is a challenge.

Subcommittee members asked about the plan to make sure that the needs of students new to the district are addressed, e.g., working in groups may be new to some students. Ms. Hubbard provided examples of strategies. Subcommittee members suggested that the K-8 and BHS Math Curriculum Coordinators might want to include a joint statement in the Report on the importance of consistency in determining 9th grade placement recommendations, and why this is an equity issue.

The Subcommittee discussed options for K-8 students who may not feel challenged by their grade level math curriculum. Ms. Hubbard commented that the district is exploring options beyond sending students to afternoon math classes at the high school (not all students have had this option; are equity and cost implications). Subcommittee members had several comments: consider balance between what we can reasonably expect from teachers in terms of acceleration vs supplementing; what is the structure of supports; currently 6-7 students participate in the afternoon classes, but there are likely many more students in need of acceleration; providing differentiation for students two or more years ahead can be challenging; students in other subjects such as world language are grouped based on their understanding; have an alternative in place before eliminating the option of BHS classes.

The Subcommittee discussed the myth of mobility from standards to honors classes and how placement sometimes impacts students' sense of self. Many districts are waiting until 10th grade to make this decision. Members noted that this delays the issue, but does not address it. What is the best way to make the math material and concepts accessible to all students? Staff suggested a future discussion on this issue with input from the Headmaster and BHS Math Curriculum Coordinator.

Ms. Hubbard provided an update on the K-5 materials review process, which started in January. The initial list of ten programs was reduced to three. Illustrative Mathematics K-5 is under development. We will have the opportunity to participate in the piloting (super users, possibly the alpha pilot). The consensus is that the district should not make a decision on the other three without first looking at Illustrative Mathematics K-5.

Subcommittee members requested that a future Subcommittee meeting focus on the district's professional development structure (e.g., what are the strengths and challenges; which models in other comparable districts seem to work well; what is the data on teacher satisfaction; what are the budget implications; how much time is available and when; what is contractual; how does it map to essential curriculum).

The meeting adjourned at 10:30 AM.

Background

- Students at Brookline High School from all backgrounds should be exposed to computing before they graduate. After introductory computing courses, robotics courses provide a pathway to further studies.
- Autonomy in robotics (being self-directed) implies computing. All robotics courses should stress *autonomous* robotics, because that is the future of robotics — for example, self-driving cars. Therefore, robotics courses are also computing courses.
- A robot is anything with sensors and actuators. Robotics (and computing) courses should encompass all types of robots: driving robots, assistive robots, prosthetic robots, wearable robots, sculptural robots, walking robots, grasping robots, flying robots, *etc.*.
- Robotics (and computing) courses should include a consideration of ethics and the choices posed in the design, implementation, and deployment of robots and the software controlling them.
- Robotics (and computing) courses should incorporate creativity, one of the *7 Big Ideas of Computer Science* (http://j.mp/7-big-ideas). Making computational artifacts, including robots and software, is inherently a creative endeavor.
- The study of robotics is inherently project-based and the projects can be student-directed, once students master basic skills in computing and mechanics. In this approach, task-oriented projects can include autonomous driving (wayfinding, maze solving, mapping, tailing), prosthetic devices, wearables, kinetic sculptures, legged robots, aerial robots, and Botball.
- Botball® is an autonomous robotics program with both regional and global competitions. Competitions could be incorporated for two reasons: they establish deadlines and they provide a task to accomplish every year that incorporates important aspects of autonomous robotics (odometry & route planning, vision, mechanical design, contingency and error recovery, strategy, ...) While some students may be interested in competition, it need not be a required element of the study of robotics.

Notes

- Robotics I should be scheduled in the fall and Robotics II should be schedules in the spring.
- The budget for supplies (excluding one-time startup costs) could be funded through the Perkins grant awarded annually to the CTE department. The introduction of this course would not require additional FTEs.

Course catalog descriptions

<table>
<tr><td>CE4XXX</td><td>Autonomous Robotics I</td><td></td></tr>
<tr><td colspan="3">Autonomous Robotics I is a project-based course where students develop computing and mechanical design skills and apply them to design and build autonomous robots that use sensors and actuators to perform simple tasks in response to their environment.

Students also explore ethical and aesthetic questions in robotics and computing as they apply to designing, building, and deploying their robots to solve real-world problems.</td></tr>
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Skills developed in *Autonomous Robotics I* include: block- and text-based computing for embedded and robotics systems, mechanical design, autonomous goal planning & execution, sensor data acquisition & analysis, actuator control, error detection & recovery, *etc.*. Projects in *Autonomous Robotics I* include: maze solving, odometry, object identification & categorization, prosthetic & assistive technologies, wearables, kinetic sculpture & lighting, *etc.*. Students interested in pursuing robotics throughout high school can elect *Autonomous Robotics* more than once, with skills developed in one semester applied to projects in subsequent semesters.		
Level: N		Grade: 9-12
Prerequisite:	Exploring Computer Science or Introduction to Computer Science	Credit: 5

CE4YYY	**Autonomous Robotics II**	
Autonomous Robotics II is a project-based course where students build upon computing and mechanical design skills developed in *Autonomous Robotics I* and apply them to design and build autonomous robots that use sensors and actuators to perform tasks in response to their environment. Students also explore ethical and aesthetic questions in robotics and computing as they apply to designing, building, and deploying their robots to solve real-world problems. In *Autonomous Robotics II* students apply skills developed in previous *Autonomous Robotics* semesters to projects in robotics, including autonomous driving (wayfinding, maze solving, mapping, tailing), prosthetic devices, wearables, legged robots, aerial robots, and the potential to participate in Botball®. Students interested in the Botball autonomous robotics challenge will prepare robots for the New England regional competition in May. Students interested in pursuing robotics throughout high school can elect *Autonomous Robotics* more than once, with skills developed in one semester applied to projects in subsequent semesters.		
Level: N		Grade: 9-12
Prerequisite:	Autonomous Robotics I	Credit: 5

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Course syllabus

Students will be able to independently use their learning to…

use sensors	• touch sensors • distance sensors • reflectance sensors • cameras	design robots	• design rolling, walking, assistive, wearable, sculptural, flying robots
use actuators	• LEDs • drive motors • servo motors	create artifacts	• create conceptual artifacts (specifications, designs, evaluations) • create computational artifacts (code) • create physical artifacts (robots)
write code	• use block-based languages (Snap!, MIT App Inventor) • use text-based languages (Python, Robot-C, Forth) • error recovery	complete tasks	• basic mobility • line following and maze solving • object retrieval and sorting • grasping and manipulating • real-world interaction
consider ethics	• articulate technological impact • make ethical design choices • cite sources for remixed work	apply strategy	• plan task completion • use feedback to adjust strategy • respond to real-world failures
communicate	• reflect on work of self and others • review work of self and others	explore advances	• use artificial intelligence • use multi-robot swarms

Optional: compete in Botball	https://www.kipr.org/botball/what-is-botball/aligned-standards-national-impact — critical thinking, analytical skills, adaptive learning / flexibility, decision making, computational thinking, creativity / innovation, collaboration, problem solving, communication.

Student practices will include...

From PBL:
- solve challenging & authentic problems
- sustain inquiry in their problem-solving
- direct their own problem-solving process
- iteratively critique & revise their design & implementation (imagine - design - build - test)
- create artifacts for their authentic audience
- reflect on their designs & artifacts and on the process

From DLCS:
- creating
- connecting
- abstracting
- analyzing
- communicating
- collaborating
- researching

Student subject matter knowledge will include...

Computing and Society
- Understand safety and security concepts, security and recovery strategies, and how to deal with cyberbullying and peer pressure in a social computing setting. (9-12.CAS.a – Safety and Security)
- Understand, analyze impact and intent of, and apply technology laws, license agreements and permissions. (9-12.CAS.b – Ethics and Laws)
- Recognize, analyze, and evaluate the impact of technology, assistive technology, technology proficiencies, and cybercrime in people's lives, commerce, and society. (9-12.CAS.c – Interpersonal and Societal Impact)

Digital Tools and Collaboration
- Selection and use of digital tools or resources and computing devices to create an artifact, solve a problem, communicate, publish online or accomplish a real-world task. (9-12.DTC.a – Digital Tools, 9-12.DTC.b – Collaboration and Communication, 9-12.CS.a – Computing Devices)
- Use of advance research skills including advanced searches, digital source evaluation, synthesis of information and appropriate digital citation. (9-12.DTC.c – Research)
- Understand how computing device components work. Use of troubleshooting strategies to solve routine hardware and software problems. (9-12.CS.a – Computing Devices, 9-12.CS.b – Human and Computer Partnerships)
- Understand how networks communicate, their vulnerabilities and issues that may impact their functionality. Evaluate the benefits of using a service with respect to function and quality. (9-12.CS.c – Networks, 9-12.CS.d – Services)

Computational Thinking
- Creation of new representations, through generalization and decomposition. Write and debug algorithms in a structured language. (9-12.CT.a – Abstraction, 9-12.CT.b – Algorithms)
- Understand how different data representation affects storage and quality. Create, modify, and manipulate data structures, data sets, and data visualizations. (9-12.CT.c – Data)
- Decompose tasks/problems into sub-problems to plan solutions. (9-12.CT.d – Programming and Development)

- Creation of programs using an iterative design process to create an artifact or solve a problem. (9-12.CT.d – Programming and Development)
- Creation of models and simulations to formulate, test, analyze, and refine a hypothesis. (9-12.CT.e – Modeling and Simulation)

This subject matter knowledge is from the *2016 Massachusetts Digital Literacy and Computer Science (DLCS) Curriculum Framework*. Additional subject matter knowledge will include strands and topics from the *2016 Massachusetts Science and Technology / Engineering Curriculum Framework* (including HS-ETS-1 – engineering design, HS-ETS-2 – materials, tools, and manufacturing, and HS-ETS-3 – technological systems).

Math Program Review Update

3/12/19

Presented to Curriculum Subcommittee

What has taken place since our last update to Curriculum Subcommittee...

Program Review - Wrapping up Phase 1

Materials Pilot in Grades 6-8

Materials Review in Grades K-5

Overview of the Program Review Process

Phase 1 : Study

Paints the “big picture” of how the program is currently functioning.

- Visioning - What do we want the Brookline math experience to be for our students?
- Data Collection - Where are we now?
- Identifying Strengths and Areas for improvement
- Developing areas of inquiry and making recommendations for Phase 2

PROGRAM REVIEW

- Completing Phase 1 - Study and Vision
- Finalizing report for review including committee work and findings from CCE
- Transitioning to recommendations for Phase II - Planning

6-8 Pilot of Illustrative Math - Open Up Resources

- 16 of 20 Middle School Teachers are piloting materials for the full school year
- Remaining teachers piloted at least 1 unit.
- Collaboration among the 6-8 team members has grown.
- Collaboration with BHS teachers

Feedback from Teachers

Gathered through:

- Survey conducted in October
- Department meeting in December - What do we need to consider if me move forward with a full implementation of IM - Open Up as our primary curricular resource?
- Informal - teacher check-ins, monthly department meetings

What is working for students?

“Students gaining deeper understanding, practice explaining their thinking.”

“Material seems ‘fresh,’ or new, for most students. There is always something to learn, something to realize, or a connection to make…. (even those with hours of math outside school). So, in some ways, the variation on traditional topics opens the door to more authentic, whole-class conversations.”

“Being able to work in pairs and groups.”

“Engaging tasks, students love team work, and after a survey students feel challenged but not too much to think to give up.”

“Students have been engaged in really deep thinking and have been challenged to prove their thinking using strong reasoning.”

“It does a good job building understandings instead of teaching students to memorize things. It is accessible to almost all students and still provides some challenges to those who need them.”

“I think it offers a lot of "high ceiling/low floor" tasks that many students can access. The visual curriculum offers entry points for ELs and students with learning-based disabilities. I think it encourages rigorous discourse and discussion.”

What is working for teachers?

“Helping me to use formative assessment in a more meaningful way.” (Canvas)

“I can almost always use the lessons as designed with only small modifications.”

“Out of the 5 curricula I have used over my teaching career, this is the only one I can use 80% out of the box.”

“Structure of the lessons. Having the lesson synthesis to use at the end of lessons.”

“I see lots of strengths: a set curriculum, a compelling mathematical "story" over three years, online resources, great vocabulary, a focus on conversation and teamwork in class.”

What should we consider if we move forward?

Collaboration:

- More opportunities for collaboration and observing other classrooms with general education teachers, special educators, and math specialists
- Timing/Pacing of lessons - common plan
- “More training and modeling of ways to structure discussions and group work. Continued support of the collaboration we have already begun. I feel like there are many ways we are supporting each other already.”

Materials:

- More challenge problems in addition to "are you ready for more”
- Additional bank of shared assessment questions, station work/choice
- Units that we make “our own” with added resources

K-5 Materials Review Process

- Started in January
- Committee of teachers and specialists
- Initial list of 10 programs; shortened to 3:
  - Investigations 3
  - Eureka Math
  - SFUSD
- Now being developed - Illustrative Mathematics K-5