

BOARD OF HIGHER EDUCATION
REQUEST FOR COMMITTEE AND BOARD ACTION

COMMITTEE: Academic Affairs

NO.: AAC 12-49

COMMITTEE DATE: June 12, 2012

BOARD DATE: June 19, 2012

AMENDING SCIENCE REQUIREMENT OF ADMISSION STANDARDS

MOVED: The Board of Higher Education hereby adopts the following standard for approving admissions policies for four-year public institutions of higher education in the area of science effective upon adoption by the Board:

Science, 3 courses (drawn from Natural Science and/or Physical Science and/or Technology/ Engineering), including 2 courses with laboratory work. Technology/engineering courses must be designated as science courses (taken for science credit) by the high school.

The Board of Higher Education further adopts the following standard for approving admissions policies for four-year public institutions of higher education in the area of science effective for the freshman class entering fall 2017:

Science, 3 courses (drawn from Natural Science and/or Physical Science and/or Technology/ Engineering), including 3 courses with laboratory work. Technology/engineering courses must be designated as science courses (taken for science credit) by the high school.

Authority: Massachusetts General Laws Chapter 15A, §§ 9(c) and 9(h); and Chapter 75, §§ 1, 1A(h), and 2

Contact: Aundrea Kelley, Deputy Commissioner for P-16 Policy and Collaborative Initiatives

Background Summary

The current Board of Higher Education (BHE) standard for approving admissions policies for four-year public universities and colleges in the area of science requires three years of science, including two with a lab, with courses drawn from the natural or physical sciences. The Board of Elementary and Secondary Education’s (BESE) recommended course of study (MassCore) calls for three years of lab-based science, with courses drawn from the natural or physical sciences or technology/engineering.

Subjects	MassCore Standards	BHE Admissions Standards
English	4 years	4 years
Math	4 years	4 years (<i>eff. Fall '16</i>)
Science	3 years lab-based science <i>science and tech/engineering</i>	3 years, 2 with lab <i>natural/physical sciences</i>
History/ Social Science	3 years	2 years, <i>including 1 course in U.S. History</i>
Foreign Language	2 years <i>of the same language</i>	2 years <i>of the same language</i>
The Arts	1 year	--
Other	5 additional “core” courses <i>in business education, career and technical education, health, technology</i> Additional learning opportunities, <i>e.g., AP, dual enrollment, online, work-based learning, senior project</i>	2 electives <i>from the above subjects or from the Arts & Humanities or Computer Sciences</i>

College Participation Advisory Group Findings

The College Participation Advisory Group (CPAG) was jointly appointed in spring 2011 by the Commissioners of Elementary and Secondary Education and of Higher Education to advise them on programmatic interventions and state policies that will advance the goal of national leadership in college participation. Over the course of meetings held during the spring and fall of 2011 CPAG members heard presentations, reviewed materials and engaged in considerable discussion of a number of issues, including the need for better alignment between MassCore and Massachusetts four-year public university admissions standards. (See Appendix C for a list of CPAG members and participants.)

CPAG found that the disconnect between science standards for university admission and high school completion has caused significant confusion among students who in good faith complete the state-recommended MassCore course of study only to find that technology/engineering courses that are acceptable as a science under MassCore are not accepted as a science for admissions purposes.

Moreover, high schools have been reluctant to expand technology/engineering course offerings, particularly when aligned to the state’s Science and Technology/Engineering Curriculum Framework and offered as science credit, because students could be negatively impacted when applying to a state university. This disconnect has also significantly hampered the development of high school science and technology / engineering offerings and STEM opportunities for students.

CPAG found that university concerns about counting technology/engineering as a science have focused primarily on lack of clarity about educator qualifications and also about the definition and content of engineering/technology courses. BESE, however, has an approved technology/engineering specialization for educator licensure.

With respect to definition, the Massachusetts Curriculum Framework in science counts technology/engineering courses that are awarded science credit as part of the science framework and increasingly high schools are offering technology/engineering courses through the science department. Further, there is an end-of-course high school Technology/Engineering MCAS test that is offered along with Biology, Introductory Physics, and Chemistry.

Finally, since the time of the design of the classic model high school curriculum in the 18th century, there has been a convergence of science, technology and engineering that is reflected in the state’s science standards and acknowledged by scholars.

“Exponential advances in knowledge, instrumentation, communication, and computational capabilities have created mind-boggling possibilities, and students are cutting across traditional disciplinary boundaries in unprecedented ways. **Indeed, the distinction between science and engineering in some domains has been blurred to extinction.**”

—Charles Vest, 2006

Scientific Inquiry	Engineering Design
Ask a question	Define a problem
Obtain, evaluate and communicate technical information	Obtain, evaluate and communicate technical information
Plan investigations	Plan designs and tests
Develop and use models	Develop and use models
Design and conduct tests of experiments or models	Design and conduct tests of prototypes or models
Analyze and interpret data	Analyze and interpret data
Use mathematics and computational thinking	Use mathematics and computational thinking
Construct explanations using evidence	Design solutions using evidence
Engage in argument using evidence	Engage in argument using evidence

Based on these considerations, CPAG recommended in its November 2011 memo to the Commissioners that the science standards for admissions and MassCore be aligned in a way that holds harmless students who have taken technology/engineering (as a science) under MassCore. This recommendation provided the background for a presentation to the BHE on this topic by Aundrea Kelley, DHE’s Deputy Commissioner for P-16 Policy and Collaborative Initiatives, and Jacob Foster, Ph.D., Director of Science and Technology/Engineering, Massachusetts Department of Elementary and Secondary Education at the December 6, 2011 Board meeting.

Survey Results¹

In March 2012, DHE distributed a survey on the proposed science recommendations among Massachusetts K-12 and higher education stakeholders. The DHE received 605 responses—20% from higher education and 80% from the K-12 sectors. Survey results indicated strong support for the proposed recommendations.

- When asked if they agreed that “better alignment between college admissions requirements and the state’s K-12 recommended college preparatory course of study (MassCore) will **send clearer signals to students** about the courses they need in high school to get ready for college,” the following responded that they agreed or strongly agreed:

K-12		Higher Education	
All responders	94.6%	All responders	95.1%
Superintendents and principals	91.7%	Chief academic officers and other administrators	95.8%
Guidance counselors and faculty	95.3%	Faculty	96.2%

- When asked if they agreed that “science and technology/engineering courses that have been designated as a science course (taken for science credit) by the high school **should be acceptable** under higher education’s science admissions standard,” the following responded that they agreed or strongly agreed:

K-12		Higher Education	
All responders	88.1%	All responders	63.8%
Superintendents and principals	88.9%	Chief academic officers and other administrators	75.0%
Guidance counselors and faculty	87.8%	Faculty	67.0%

- When asked if they agreed that a two-phased approach that **opens the acceptance of technology/engineering as a science** for admissions purposes for the 2012-12 academic year while **delaying the requirement that all three science courses be lab-based** until 2016 will best hold students harmless while considering the needs of high schools that may need extra time to accommodate access to lab-based courses, the following responded that they agreed or strongly agreed:

K-12		Higher Education	
All responders	75.6%	All responders	75.3%
Superintendents and principals	50.0%	Chief academic officers and other administrators	87.0%
Guidance counselors and faculty	78.4%	Faculty	68.2%

¹ Survey questions below are abbreviated in this section. Full texts of questions are listed in the appendix.

- When asked if they supported an approach to providing future quality assurance through the **convening of a working group** to review next-generation science standards and consider criteria for rigorous science and technology/engineering courses, including criteria for what constitutes a lab-based course, the following responded that they agreed or strongly agreed:

K-12		Higher Education	
All responders	81.3%	All responders	80.5%
Superintendents and principals	75.8%	Chief academic officers and other administrators	87.0%
Guidance counselors and faculty	82.9%	Faculty	76.7%

Responders also had the option to comment on the possible impact of such a change for themselves or their schools:

- Many comments from K-12 leaders expressed strong support and readiness to pursue a change in requirements, while some did express concern about being able to hire enough teachers or provide enough laboratory space to meet the higher demands. Other specific concerns included the need for more special education and ELL teachers to avoid higher dropout rates as high school curricula become more demanding; the complexity of the science teacher certification process, which could offer schools much more flexibility in hiring if it allowed teachers to become certified in all physical and life sciences instead of one specific science; and the need for more resources in the schools for students who do not have the resources at home to complete technology-based homework.
- Comments from higher education leaders were very supportive overall and expressed enthusiasm about the potential to improve college readiness and retention rates of all students, and particularly those in STEM majors. A few concerns were raised, including the potential impact on out-of-state students whose home states may not have made the same curriculum changes.

See Appendix A for more detailed survey results and Appendix B for the full text of the substantive questions.

Additional Information on BHE Admissions Standards

The Board of Higher Education (BHE) has relied on admission policy as the primary means for articulation of the standards that applicants need to meet to demonstrate their readiness for college-level work. This policy takes on additional importance from the fact that the Board of Elementary and Secondary Education cannot mandate course requirements for local high schools. In effect higher education admissions policy is the only vehicle available to educational policymakers to mandate rigorous course-taking by high school students planning to attend college.

Current admissions standards for the state universities and UMass do indeed emphasize a strong academic high school background that focuses on the completion of rigorous college preparatory coursework so that students enter college ready to learn. In fact, students who enroll in the four-year institutions demonstrate significantly less need for remediation than students enrolling in the community colleges, which have open admissions.

The minimum academic course requirements under the admission standards now in effect include four years in English, three in Mathematics (Algebra I & II and Geometry or Trigonometry, or comparable coursework), three in the Sciences (including two with laboratory work), two in the Social Sciences (including one in U.S. History), two in a Foreign language and two in electives.

In March 2011 BHE amended the mathematics admission standard to require four years of college preparatory mathematics, including mathematics in the senior year, effective for new students entering in fall 2016.

The recommended science standard does not impact other existing admissions standards. BHE's admissions standards will continue to offer the flexibility for admission of up to ten percent of new students who may not meet the core course distribution requirement.

DHE Recommendation

The DHE recommends that the Board accept as a science for admissions purposes technology/engineering courses taken for science credit along with courses drawn from the natural or physical sciences. The proposed science standard does not require that students take a technology/engineering course in lieu of courses in the natural or physical sciences. Rather, the recommended standard provides greater flexibility to students and thus should be effective upon adoption by the BHE.

Upon adoption of the recommended standard by the BHE, the DHE will update its Admissions Standards *Guide for High School Counselors* to include the following information in the *Guide's* section on college preparatory coursework.

Technology/Engineering Courses

In order to be accepted as meeting the science admission requirement, a technology/engineering course must be:

1. Significantly aligned to the Massachusetts curriculum frameworks and employ mathematics and scientific content;
2. Academic and not vocational in nature;
3. Offered for science credit after review by the district as meeting district guidelines for science courses; and
4. Equivalent to a full year of learning.

The DHE also recommends that effective in 2017, the science admissions standard shall require three years of lab-based science (drawn from technology/engineering or natural or physical science). This recommendation will help bring the MassCore science requirement and the current BHE admissions standard of three science courses, including only two with laboratory work into full alignment.

The 2017 recommended timeframe for the lab requirement is consistent with the timeframe provided for implementation of the new mathematics admissions standard, which was approved by the Board of Higher Education in March 2011 and goes into effect for fall 2016. The survey of K-12 and higher education leaders asked about the potential impact of a 2016 implementation date, and while many indicated that they were already offering or could feasibly begin offering an adequate number of lab-based courses in that timeframe, enough respondents expressed resource concerns that the DHE is recommending a 2017 implementation date. The Advisory Group recognized that even with this lead time small rural districts may have difficulty—financially and due to student class size—in offering three lab-based courses. In such cases alternative approaches (dual enrollment, virtual high school, and online courses) may help.

Appendix A: K-12 and Higher Education Leaders Survey Results

1. Better alignment between college admissions requirements and the state's K-12 recommended college preparatory course of study (MassCore) will send clearer signals to students about the courses they need in high school to get ready for college.

	K-12 Responses						Higher Ed Responses					
	Superintendent	Principal	Guidance Counselor	Faculty	Other	Response Totals	President	Chief Academic Officer	Other Administrator	Faculty	Other	Response Totals
Strongly agree	75.0% (6)	67.9% (19)	66.7% (6)	57.0% (166)	69.4% (50)	60.5% (247)	0.0% (0)	75.0% (3)	60.0% (12)	61.5% (32)	66.7% (4)	62.2% (51)
Agree	12.5% (1)	25.0% (7)	11.1% (1)	38.8% (113)	23.6% (17)	34.1% (139)	0.0% (0)	25.0% (1)	35.0% (7)	34.6% (18)	16.7% (1)	32.9% (27)
Neither agree nor disagree	12.5% (1)	7.1% (2)	22.2% (2)	2.7% (8)	4.2% (3)	3.9% (16)	0.0% (0)	0.0% (0)	5.0% (1)	1.9% (1)	16.7% (1)	3.7% (3)
Disagree	0.0% (0)	0.0% (0)	0.0% (0)	1.4% (4)	2.8% (2)	1.5% (6)	0.0% (0)	0.0% (0)	0.0% (0)	1.9% (1)	0.0% (0)	1.2% (1)
Strongly Disagree	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
answered question	8	28	9	291	72	408	0	4	20	52	6	82
skipped question						3						2

K-12 Summary: Agree/Strongly Agree		Higher Ed Summary: Agree/Strongly Agree	
Superintendent	87.5%	President	No responses
Principal	92.9%	Chief Academic Officer	100%
Guidance Counselor	77.8%	Other Administrator	95.0%
Faculty	95.9%	Faculty	96.2%
Other	93.1%	Other	83.3%
Total	94.6%	Total	95.1%

2. Science and technology/engineering courses that have been designated as a science course (taken for science credit) by the high school should be acceptable under higher education's science admissions standard.

	K-12 Responses						Higher Ed Responses					
	Superintendent	Principal	Counselor	Administrator/ Teacher	Other	Response Totals	President	Chief Academic Officer	Other Administrator	Faculty	Other	Response Totals
Strongly agree	75.0% (6)	46.4% (13)	44.4% (4)	55.2% (158)	64.3% (45)	56.4% (226)	0.0% (0)	0.0% (0)	30.0% (6)	22.0% (11)	50.0% (3)	25.0% (20)
Agree	12.5% (1)	42.9% (12)	33.3% (3)	32.9% (94)	24.3% (17)	31.7% (127)	0.0% (0)	75.0% (3)	45.0% (9)	38.0% (19)	0.0% (0)	38.8% (31)
Neither agree nor disagree	12.5% (1)	7.1% (2)	0.0% (0)	7.0% (20)	2.9% (2)	6.2% (25)	0.0% (0)	0.0% (0)	5.0% (1)	22.0% (11)	16.7% (1)	16.3% (13)
Disagree	0.0% (0)	0.0% (0)	22.2% (2)	3.8% (11)	5.7% (4)	4.2% (17)	0.0% (0)	25.0% (1)	20.0% (4)	12.0% (6)	16.7% (1)	15.0% (12)
Strongly Disagree	0.0% (0)	3.6% (1)	0.0% (0)	1.0% (3)	2.9% (2)	1.5% (6)	0.0% (0)	0.0% (0)	0.0% (0)	6.0% (3)	16.7% (1)	5.0% (4)
answered question	8	28	9	286	70	401	0	4	28	69	6	80
skipped question						10						4

K-12 Summary: Agree/Strongly Agree		Higher Ed Summary: Agree/Strongly Agree	
Superintendent	87.5%	President	No responses
Principal	89.3%	Chief Academic Officer	75.0%
Counselor	77.8%	Other Administrator	75.0%
Administrator/Teacher	88.1%	Faculty	60.0%
Other	88.6%	Other	50.0%
Total	88.1%	Total	63.8%

3. A two phased approach best holds current students harmless while taking into account the needs of high schools that may need extra time to determine alternative approaches to offering lab-based courses.

	K-12 Responses						Higher Ed Responses					
	Superintendent	Principal	Guidance Counselor	Faculty	Other	Response Totals	President	Chief Academic Officer	Other Administrator	Faculty	Other	Response Totals
Strongly agree	25.0% (2)	15.4% (4)	0.0% (0)	31.9% (90)	39.7% (27)	31.3% (123)	0.0% (0)	25.0% (1)	21.1% (4)	13.6% (6)	33.3% (2)	17.8% (13)
Agree	25.0% (2)	34.6% (9)	66.7% (6)	46.8% (132)	36.8% (25)	44.3% (174)	0.0% (0)	75.0% (3)	63.2% (12)	54.5% (24)	50.0% (3)	57.5% (42)
Neither agree nor disagree	25.0% (2)	30.8% (8)	22.2% (2)	13.8% (39)	5.9% (4)	14.0% (55)	0.0% (0)	0.0% (0)	5.3% (1)	27.3% (12)	0.0% (0)	17.8% (13)
Disagree	0.0% (0)	7.7% (2)	11.1% (1)	5.3% (15)	8.8% (6)	6.1% (24)	0.0% (0)	0.0% (0)	10.5% (2)	2.3% (1)	0.0% (0)	4.1% (3)
Strongly Disagree	25.0% (2)	11.5% (3)	0.0% (0)	2.1% (6)	8.8% (6)	4.3% (17)	0.0% (0)	0.0% (0)	0.0% (0)	2.3% (1)	16.7% (1)	2.7% (2)
answered question	8	26	9	282	68	393	0	4	19	44	6	73
<i>skipped question</i>						18						11

K-12 Summary: Agree/Strongly Agree		Higher Ed Summary: Agree/Strongly Agree	
Superintendent	50.0%	President	No responses
Principal	50.0%	Chief Academic Officer	100.0%
Counselor	66.7%	Other Administrator	84.2%
Administrator/Teacher	78.7%	Faculty	68.2%
Other	76.5%	Other	83.3%
Total	75.6%	Total	75.3%

4. I support the convening of a P-12/higher education working group to consider criteria for rigorous science and technology/engineering courses (including criteria for what constitutes a lab-based course). This should include a review of any next generation P-12 science standards. This approach will provide quality assurance to future students, schools and admissions officers.

	K-12 Responses						Higher Ed Responses					
	Superintendent	Principal	Guidance Counselor	Faculty	Other	Response Totals	President	Chief Academic Officer	Other Administrator	Faculty	Other	Response Totals
Strongly agree	12.5% (1)	28.0% (7)	0.0% (0)	40.1% (111)	50.7% (34)	39.6% (153)	0.0% (0)	50.0% (2)	47.4% (9)	27.9% (12)	16.7% (1)	33.3% (24)
Agree	75.0% (6)	44.0% (11)	66.7% (6)	43.3% (120)	26.9% (18)	41.7% (161)	0.0% (0)	25.0% (1)	42.1% (8)	48.8% (21)	66.7% (4)	47.2% (34)
Neither agree nor disagree	12.5% (1)	16.0% (4)	22.2% (2)	13.7% (38)	7.5% (5)	13.0% (50)	0.0% (0)	25.0% (1)	0.0% (0)	14.0% (6)	16.7% (1)	11.1% (8)
Disagree	0.0% (0)	12.0% (3)	11.1% (1)	2.5% (7)	11.9% (8)	4.9% (19)	0.0% (0)	0.0% (0)	10.5% (2)	7.0% (3)	0.0% (0)	6.9% (5)
Strongly Disagree	0.0% (0)	0.0% (0)	0.0% (0)	0.4% (1)	3.0% (2)	0.8% (3)	0.0% (0)	0.0% (0)	0.0% (0)	2.3% (1)	0.0% (0)	1.4% (1)
answered question	8	25	9	277	67	386	0	4	19	43	6	72
skipped question						25						12

K-12 Summary: Agree/Strongly Agree		Higher Ed Summary: Agree/Strongly Agree	
Superintendent	87.5%	President	No responses
Principal	72.0%	Chief Academic Officer	75.0%
Counselor	66.7%	Other Administrator	89.5%
Administrator/Teacher	83.4%	Faculty	76.7%
Other	77.6%	Other	83.3%
Total	81.3%	Total	80.5%

Respondents also provided multiple narrative comments on the preceding questions as well as on the final survey question which solicited commentary on how respondents felt that the proposed DHE recommendation would impact their institution. Following are representative comments.

Representative K-12 Comments	Representative Higher Education Comments
<ol style="list-style-type: none"> 1. <i>I am in favor of rigorous courses in science, technology and engineering but my concern is the lack of lab space and equipment to offer such a rigorous course. I am hoping to add 5 science labs to my school with a new addition but what if I don't get approval of my ten towns for this addition?</i> 2. <i>If you include technology and engineering the impact would be limited.</i> 3. <i>We could include more technology/engineering in our curricula.</i> 4. <i>We currently are in the process of implementing a four year course sequence in technology/engineering. We are affiliated with Project Lead The Way. We chose PLTW because of the high standards and rigor that is an integral part of the curriculum. Instructors are required to attend a 10 day training session for each course they teach and all students must take a test after completing each course. This testing provides feedback to the district on whether the students have mastered the skills and concepts presented during the school year. PLTW dovetails well with the skills and interest of our students and this amendment of the science admissions standards would validate the hard work of those students that choose the technology/engineering path.</i> 5. <i>This is a tough one. We have poured so much resource into moving our students toward being on par with the rest of the state in Mathematics and ELA. A new push toward science requirements will draw resources from some other part of our organization. It makes sense to me, but funding is a topic that really needs to be discussed at ESE.</i> 6. <i>We would have to add additional laboratory science courses to our curriculum. Our current requirement is that students must complete three years of science, including one unit of biology and chemistry.</i> 7. <i>We already require rigorous courses in science, technology and engineering, so there would be no impact on our school.</i> 8. <i>We do not currently have the staff to provide all students engineering courses if it were a graduation requirement. Our school does offer engineering courses but only as a Project Lead the Way elective program</i> 9. <i>Positive impact. This would support our efforts in moving toward including rigorous college and career STEM pathways in our high school that include tech/engineering science courses (that should qualify for both Mass Core</i> 	<ol style="list-style-type: none"> 1. <i>Minimal (impact). Students' lack of success in our science courses is primarily due to lack of college readiness (understanding and retention of math through advanced algebra, reading and writing skills, and ability and willingness to put in the necessary amount of time to studying), not science specifically.</i> 2. <i>As long as the students were properly advised and understand that different programs/majors have different expectations regarding background in the sciences it should not be a problem.</i> 3. <i>I can only hope that students will be better prepared and more interested in STEM majors. I would encourage the development of strong engineering courses but am hesitant to have them replace a basic science course. The physical sciences are woefully under-represented in our K-12 curriculum (e.g. No geology requirement) and I would hate to see students elect an engineering course over chemistry or physics. I'd prefer the engineering requirement augment the foundation disciplines and make MA students the best prepared students in the US.</i> 4. <i>As the community colleges are open admission it would probably not have an effect on admissions. However, it would provide students with the background to successfully complete STEM transfer programs. In many instances it would also shorten the time it would take a student to meet the transfer requirements.</i> 5. <i>A number of current incoming students lack the foundations for tackling the more rigorous STEM disciplines, many of which have been nationally identified for targeted strategies for expanded enrollment. Even among aspirants, this lack of adequate preparation leads, at the very least, to extended time for graduation or, worse, lower retention especially in the early years. Raising minimum science admissions standards to reasonably challenging levels would, I believe, help grow both the numbers and the success rate of students in our programs.</i> 6. <i>Without jeopardizing access to Massachusetts residents, MCLA has seen an increase of interest from students outside of the Commonwealth. The out of state applicants are highly qualified yet may not necessarily meet the Mass Core Curriculum requirements. We would maintain our interest in</i>

and college admissions) and offering the Tech/Eng MCAS as a option for demonstrating proficiency on high stakes science assessment for graduation.

10. Our pupil progression plan currently requires all students in our district to earn 3 science credits. As the MCAS is currently in the areas of Biology and Intro to Physics there is some concern that very few students will take Chemistry as they will take technology/engineering courses instead. This raises some concern for us in the Springfield Public Schools.
11. Staffing would have to change 2. Course scheduling would need to change 3. A student who may not have originally considered attending a Massachusetts Higher Education School and took 3 years or even more of a lab sciences, but did not include one in tech/eng would be ineligible for admission to the Mass University or College. This student may be academically extremely capable regardless of whether or not they took a tech/eng course. 4. Special education would be impacted - are these students exempt from the requirement? 5. Cost of equipment and facility space would be an issue.
12. My school district already requires all students to take and pass three lab-based sciences for graduation. Biology and chemistry are required; physics is recommended. A mini course in introductory engineering is offered but few students elect the course.
13. At vocational schools, we are consistently at a disadvantage when the Board of High Education makes protocols for us to follow. The admission standards need to be flexible because the life experience that vocational students are exposed to could definitely contribute to success in higher education. Our school is at a great disadvantage because we are restrained by a district that does not understand the needs and pace of a vocational school. If we are held to a strict pupil progression plan, our students are not given the science courses that would be appropriate for their vocational studies.
14. The biggest concern in terms of enrollment in certain science courses is a space consideration. We do not have many laboratory spaces. I think the secondary alignment between frameworks of these lab sciences and the high school curricula will be important, since the high school teachers in my building, by and large, act on their own standards, not necessarily those articulated by the frameworks
15. It would support NCTL's commitment to offering rigorous STEM courses for all Pk-12 students that is inclusive of the "T" and "E" in STEM. This change would also strengthen the state STEM Plan, science &

recruiting these students and would review our admissions requirements for these populations.

7. This is a difficult question to answer without knowing what the rigorous courses would include regarding content and technical application. The minimum "science" admission standards would need to be clearly defined for programs of study at the college. The new high school courses would need to relate to the prerequisites for college coursework at the state colleges as well as at the community colleges for transfer programs and courses. Student advisement as well as the selection of high school science courses will be somewhat critical for students. Chosen courses may not be acceptable for admission to specific programs of study or they may not provide sufficient background for students to begin specific programs. Engineering uses the application of scientific principles to solve problems. If students do not gain a solid science foundation (in the natural and physical sciences) in high school, their progress at the college may be hindered, depending on the program of study they choose to pursue.
8. I think this will ensure that the students will be better prepared to succeed in majors that require courses in science based content. I have no idea how this will impact the college overall. I think the current minimum standards are too low.
9. I think it would help us. Currently, we have so many students who get into college not knowing the basics. The state wants us to get them out in 4 years, but when they come in behind and have to take remedial courses for NO credit to get "caught up" to where they should be, it puts them behind a year at least! I think that the students should take more science courses and math courses as this is the changing world. Look at Japan and China, they are leaders in technology due to their challenging math and science courses. We need to challenge our students, not drop down and just say okay, pass them along. It hurts them in college.
10. Students would be better prepared to carry out experiments in both engineering and electronic courses. In addition, the rigor would hopefully improve students' real world application of math.
11. We would be thrilled. We have a growing science/math program, and we are committed to producing graduates who can not only go on to graduate school, but who can also jump into a technically-oriented job upon graduation.
12. I don't know the requirements at UMass Amherst or the UMass system in general. However, in order to increase the number of students in STEM and particularly, minority students and female students, then admission

technology/engineering curriculum framework and Massachusetts effort to build a STEM workforce in the 21st century. It is a change that is overdue and needs to be rectified.

- 16. Financial, staffing, and facility issues would ensue.*
- 17. With the two part phase in, this could be accomplished with little impact. Assuming the economic climate takes an upward turn, and professional development would be available, it is feasible.*
- 18. The new amendment would bring a whole new dynamic with an eye towards promotion of our own present Technology/Engineering (T/E) course offerings and may also focus attention towards creating a true STEM course as an elective in our Technology/Engineering department. Many opportunities would be created for our Somerset and Berkley students and at the very least the we would see a higher enrollment in our Technology and Engineering courses. T/E is lab based...but more specifically our Project Based Learning(PBL) approach to curriculum and instruction fosters our students 21st century skills of critical thinking, problem solving and lifelong learners.*
- 19. The biggest problem would be finding qualified personnel to teach the subjects. People who have this type of talent are making more money in other areas. Second, school districts have gone away from lab based classes due to budget restrictions. Finally, school districts have spent the last 10 years slowly eliminating these types of courses by not taking them seriously. The concentration has been on the core at the expense of the real world practical classes.*
- 20. Minimal (impact) as long as technology/engineering courses are optional and not required for graduation. Problem with the then science-technology-engineering courses the certifications to teach courses in this "department" would include Biology, Chemistry, Physics, and now technology and engineering. We need to simplify the science teacher certification not make it more complex. In History, there is not a special certification for US history, World History, European History, but in science we require separate certifications for each discipline and the addition of engineering/technology would further complicate certification. If you go forward with the inclusion of technology/engineering in the science department, suggest you simplify the Chem-Bio-Phy-Earth science certification to simply be a science certification and keep the engineering and technology certification separate. Any teacher who majored in a science in college should be able to teach any science on the high school level.*
- 21. We have offered a course in engineering in the past, taught by the physics*

requirements in these fields should be more flexible, thus allowing a variety of courses eligible for admission. However, there needs to be good and meaningful measures for quality of these courses.

- 13. If the Board were to amend its minimum science admission standards in science, technology, or engineering, it would have a long-term positive impact on course curriculum in the Industrial Technology department at Fitchburg State University. Students that are not exposed to Technology / Engineering learning standards at the K-12 level are at a major disadvantage to students that have studied these concepts. Many of the careers that students begin after graduation in Massachusetts are in Technology or Engineering fields.*
- 14. My institution would have a wider pool to draw students and better prepared ones as well.*
- 15. I think that the inclusion of rigorous courses in science, technology and engineering will have a positive impact in retention of students in college. It will prepare them to handle college level science courses.*
- 16. I believe that this amendment to minimum science admissions standards would be highly beneficial to Framingham State University. Currently, it is my understanding that we require students to have passed only 2 high school laboratory science courses at a minimum. As a chemistry faculty member whose primary teaching responsibility lies within the freshman science major's chemistry sequence, I find that many students are woefully underprepared for college science. In some cases this seems to stem from the fact that as high school students, they simply did not realize the importance of science to many career paths - leading them to only fulfill the minimum science requirements for entrance to a college or university. Unfortunately, as they select a career path of interest, they often find that college science classes are a significant portion of their major or graduate program requirements. Any student who plans to pursue college level chemistry, physics, or biology courses with any measure of success must certainly have an appropriate foundation provided by high school laboratory science courses - and this high school experience should certainly include (in my opinion) 4 years of a laboratory science. In conclusion, I believe that the Commonwealth of Massachusetts is serving its young people, (and Universities) well with the proposed amendment to the minimum science admissions standards. It helps to send a much clearer message regarding the importance and relevance of science and technology to their lives, careers, and the economy of the State of Massachusetts.*
- 17. Students would be better prepared and better informed about particular*

teacher, and may do so again in the future. This change would strongly encourage us to do so.

22. *I would welcome a requirement from college boards that all students require high school education in: Earth Science, Biology, Chemistry, Physics and Engineering/Technology. I see many students completing a high school degree taking advanced AP classes at the expense of the breadth that all future scientists, engineers, and citizens should have in the 21st century. About 1/3 of my 8th graders are slated to skip Earth Science during high school so they can take an AP class in Bio, Chem, or Physics, which are all second year courses. Only a fraction will be able to take the Engineering Classes available to them. At the middle school level, we are supporting these changes by making students are exposed to all of these areas in grades K-8.*
23. *Need to hire and train educators to work with student with learning disabilities or ELL students. If not the rate of drop outs or failing the grade will increase, due to not be observant of this particular population's needs. The curriculum must be revised in order to meet these rigorous courses.*
24. *We have already planned ahead so tech engineering courses will be available to our next year 9th grade incoming class. A review of the science courses next year has an opening for a Principles of Technology as an elective course for our upperclassmen.*
25. *It would be a positive effect, I believe. The rigorous standard needs to be well-laid out for guidance when assigning students to these classes. Pre-requisites are needed.*
26. *Since we have a well established vocational-technical department within the high school, the transition would probably include the option for students to fulfill the requirements by taking these courses as well relieving some of the burden of curriculum re-design and re-tooling from the science and math departments.*
27. *This would directly affect me. I believe that I, to the best of my ability, do teach a science course that is rigorous--regarding skill and content. Although microscope skills, editing videos for content, or effectively utilizing the software and probes to conduct experiments IS NOT currently in the frameworks, I do believe it is a necessary skill for college. I do, however, have problems with instituting technology use at home. I use the school website, and give homework (almost on a daily basis) that requires computer and internet access--I experience a significant amount of "push-back" from parents and students. In order for something of this magnitude to occur, our classrooms (and students) would have to be equipped with the*

majors with additional coursework and lab time when they enter college. As a retired HS Technology/Engineering teacher the implications for the K-12 districts include: adding or revamping traditional Technology Education Labs (this does not need to be all that expensive) and some professional development for the teachers involved. Many traditional Tech Ed teachers would need to re-orient their practice to include more math and science. Most science and math teachers would need to learn how to incorporate design and the more hands-on aspects of Technology/Engineering if they were to slide to that content area. Districts might also struggle with lab time if they were already at capacity but with declining enrollment that may not be as much of an issue. I do believe that in many districts students are already taking 3 lab science classes. In practice this might not have all that much effect in much of the state.

appropriate technology to allow us to do this.

- 28. The primary impact would be more laboratory time for students. This would necessarily affect the choices students would have to make in their high school career. However, this is a doable change, given the structure of the school day now. It would be an incentive to look at alternative scheduling of the school day.*
- 29. The eighth grade middle school teachers already teach many of the technology / engineering standards in conjunction with the science standards. I think that the toughest part is that many students that learn the technical piece go to the Regional Technology School in Taunton so not much is offered in the High School. I think that many of the high school science teachers would embrace these standards.*
- 30. We teach Science, Technology and Engineering basics to all of our students in Vocational Education. We already have high standards for our students, but I feel typical academic schools could prosper by immersing their students in Science and new Technologies to promote the higher level thinking we expect and demand from our students. It works for us, it should work for them.*

Appendix B: Survey Questions

1. Potential Change in Science Admissions Requirements

Please answer to what extent you agree with the following statement: Better alignment between college admissions requirements and the state's K-12 recommended college preparatory course of study (MassCore) will send clearer signals to students about the courses they need in high school to get ready for college.

[Choices: Strongly agree, Agree, Neither agree nor disagree, Disagree, Strongly disagree]

2. Science, Technology and Engineering Coursework

Since the time of the design of the classic model high school curriculum in the 18th century, there has been a convergence of science and technology/engineering that is reflected in the state's science standards. The Department of Elementary and Secondary Education (ESE) has an approved technology/engineering specialization for educator licensure. The Massachusetts Curriculum Framework counts technology/engineering courses that are awarded science credit as part of the science framework and increasingly high schools are offering technology/engineering courses through the science department. Further, there is an end-of-course high school Technology/Engineering MCAS test that is offered along with Biology, Introductory Physics, and Chemistry.

Science and technology/engineering courses that have been designated as a science course (taken for science credit) by the high school should be acceptable under higher education's science admissions standard.

[Choices: Strongly agree, Agree, Neither agree nor disagree, Disagree, Strongly disagree]

3. Course Quality

I support including rigorous technology/engineering courses in the admissions science requirement at this time. Subsequent to this change, I support the convening of a P-12/higher education working group to consider criteria for rigorous science and technology/engineering courses (including criteria for what constitutes a lab-based course) and over time build a repository of exemplar courses. This should include a review of any next generation P-12 science standards and their implications for teaching, learning and assessment. I believe that this approach will provide quality assurance to future students, schools and admissions officers.

[Choices: Strongly agree, Agree, Neither agree nor disagree, Disagree, Strongly disagree; space for narrative comment also provided.]

4. Narrative: Impact of Science Admissions Policy Change

Board of Higher Education admissions standards for public higher education provide minimum parameters for admissions requirements. Institutions set requirements for admission to their campus, which may be higher than the Board's minimum standards.

Similarly, School Districts set requirements for graduation from their high schools.

What would be the impact on your institution if the Board were to amend its minimum science admissions standards to include rigorous courses in science, technology, or engineering?

[Space for narrative response provided.]

Appendix C

College Participation Advisory Group Members and Participants

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Dorothy Presser, President, Massachusetts Association of School Committees and Chair, Lynnfield School Committee

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