Lexington Public Schools
146 Maple Street ❖ Lexington, Massachusetts 02420

To: Dr. Paul Ash
Members of the Lexington School Committee

From: Fran Ludwig, Chairperson
K-12 Science and Technology/Engineering Curriculum Review Committee

Re: Update on Year Three of the Science and Technology/Engineering Curriculum Review

Date: June 8, 2010

A Statement of Purpose: Science and Technology/Engineering in the Lexington Public Schools

In the 21st century, educated citizens must have a comprehensive knowledge of science and its applications. Our students will be called upon in the future to make informed decisions that will have wide ranging effects on society and our planet.

In order to provide high quality science education in the Lexington Public Schools, the curriculum must meet the highest national standards in core scientific concepts in all disciplines: biology, chemistry, physics, earth and space science, and technology/engineering. Lexington students will be taught to apply methods that scientists use to investigate the natural world and that engineers use to create technologies to meet the needs of society. As their skills are developed and their knowledge base is expanded, students will demonstrate the scientific habits of mind: curiosity, open mindedness balanced with skepticism, respect for evidence, persistence, and a sense of environmental stewardship. They will gain both an understanding of science and the ability to apply scientific knowledge as a human enterprise.

"The National Science Education Standards (NSES) identify three goals of science education for all students:

- to learn important principles and concepts of science ("learn science")
- to develop the procedural skills and critical reasoning skills needed to carry out a scientific investigation ("learn to do science")
- to understand the nature of science as a human activity and a way of constructing knowledge ("learn about science")

These goals emphasize the scientific process for building new knowledge as much as the existing facts and concepts of scientific knowledge. The term "inquiry" refers to this scientific process, in particular as it applies to education, where inquiry is both a strategy for "learning science" and a subject of study itself, in "learning to do" and "learning about" science." **From web site of:** Cooperative Institute for Research in Environmental Science

"Scientific inquiry reflects how scientists come to understand the natural world, and it is at the heart of how students learn. From a very early age, children interact with their

environment, ask questions, and seek ways to answer those questions. Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences.

Scientific inquiry is a powerful way of understanding science content. It implies that students are in control of an important part of their own learning. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions." From NSTA web site: http://www.nsta.org/about/positions/inquiry.aspx

I. Introduction

We are pleased to present a summary of the findings and accomplishments from Year Three of the Science and Technology/Engineering Curriculum Review of the Lexington Public Schools. Over the three year period of the review process, we have sought to find ways in which we can enhance the scientific and technical literacy of our students. The revised K-12 Lexington Learning Standards in Science and Technology/Engineering, and new initiatives developed to support these standards represent the outcome of the efforts of our committee.

The Science and Technology/Engineering Curriculum Review Committee, with 28 members, consists of representative teachers from each grade level and science discipline, special education teachers, and community members, including scientists, engineers, science educators, and parents. Workshops were held in summer 2009, and subgroups met during the 2009-2010 school year to further the work of the committee in developing curriculum documents, revising curriculum, and implementing other Year 2 recommendations. The K-12 Review Committee met for full-day sessions on October 7, 2009, January 13, 2010, and May 5, 2010 (See committee membership list and agendas in Appendix A).

II. Science and Technology/Engineering Curriculum Review Year 3

The science curriculum review process has been a successful endeavor with products and processes in place that will impact the program in future years. The science and engineering concepts and skills identified in the Lexington document are aligned with the Massachusetts Science and Technology/Engineering Framework at all grade levels. In several areas, Lexington standards have been developed that are more rigorous than state standards.

Year 3 Goals:

Elementary

a. Complete curriculum document (materials alignment, vocabulary, common assessments).
b. Revise science section of K-5 report cards, to follow a standards-based reporting format.
c. Fully implement new units in grade 3, Water Cycle in Massachusetts, grade 4, Sun, Moon and Stars, and grade 5 Weather and Climate. Provide professional development, as necessary.
d. Offer Science Notebooks workshops for all K-5 classroom teachers and literacy specialists.

e. Provide a selection of technology/engineering design challenges for each grade level K-5, including "Engineering is Elementary" units (at least 1 per year required). Include lessons on the application of technologies such as recycling and energy conservation.

Accomplishments:

Elementary

1. **Curriculum documents:** Curriculum documents have been completed for K-5 (see Appendix B for sample document). For each grade, these documents include information on: Massachusetts Science and Technology/Engineering Standards, Lexington Learning Standards, Materials Alignment, and Assessment. Essential vocabulary is included in an appendix of the curriculum documents. These curriculum documents reflect the work of the K-5 Science and Technology/Engineering Curriculum Review Subgroup as well as input from all 128 K-5 elementary teachers. The documents assume the following time allotments for science instruction: K-2, 1 1/2 hours per week, grades 3-5, 2 hours per week.

2. **Report Cards:** The K-5 Science Curriculum Coordinator and representative teachers from each grade level have met over the past year to revise the elementary report card in all curriculum areas, including science and engineering. We have evaluated existing Lexington report cards and have looked at report cards from other communities. We have also identified the broad areas for assessment on our revised report cards: Inquiry and Engineering Skills, and Content Understandings. Further meetings scheduled this summer and during the next academic year will help us to hone in on the most important science concepts to be assessed for each unit.

5. **Revisions of Curriculum Units:** Progress was slow in producing new, revised teacher guides for selected units in grades 3-5. The time consuming process of testing new lessons, researching the best materials available, and formatting and editing the final product competed for time with other initiatives and everyday duties. However, given that commercial teacher guides presently cost up to $200 each, developing in-house guides that address our unique curriculum needs offer an economical option. Unit revision work will continue over the summer (see Appendix E).

   - The Grade 3 Water Cycle teacher guide, developed by the K-5 Science Coordinator, in consultation with several grade 3 teachers, was distributed for implementation in March. Material in this guide represents collaboration between LPS staff, the town Conservation Office, town Water and Sewer Department, and the MWRA. Principles of water conservation were also included. Grade 3 teachers gave this revised unit a good rating in a survey administered to all K-5 teachers in May (Appendix C).

   - Grade 4 teachers received Part A of their Sun, Moon, and Planets revised teacher guide. Part B is in process and will be completed in June.

- Grade 5 Weather and Climate mini-unit is still in the trial phase. Materials are assembled, but a number of lessons still need to be revised. This revision will take place during a workshop in June (See Appendix E).

4. **Scientist's Notebook Workshops:** Motivated by limited time in the school day and the learning benefits of integrated literacy and science instruction, a team of teacher/facilitators and the K-5 Science Coordinator designed a series of workshops on the use of the Scientist's Notebook strategy. Students use their Scientist's Notebook during investigations to record and reflect on observations, to make scientific drawings, to collect and analyze data, and to record conclusions from their data. Following group discussions on science investigations, they are challenged to make claims supported by evidence documented in their notebook.

   - In October 2009, all K-5 classroom teachers and a number of literacy specialists attended a 2 ½ hour introductory workshop on using Scientist's Notebooks. A carefully coordinated schedule allowed one sub to be used to release 2 teachers from their classroom duties in order to attend the workshop session. Using Science Notebooks in the Elementary Classroom, a book by Michael Klentschy was distributed to all teachers, as well as an extensive resource binder. Klentschy, a former superintendent from a California district where 50% of the students were designated as needing ELL services, has documented substantial gains in both understanding of science content AND literacy skills with the use of specific notebook strategies. (See Appendix C for details on the Scientist's Notebook workshop.)

   - At several follow up sessions, teachers looked at student Scientist's Notebook work in grade level groups. The teacher/facilitators and their colleagues shared successful techniques and writing prompts specific to their own science units. We believe that the introduction of the Scientist's Notebook initiative benefited the science program and helped to integrate science and literacy instruction.

   - Based on a May 2010 survey (see Appendix C), when asked about the Scientist's Notebook initiative, a large majority of K-5 teachers agreed that:

     - All K-5 teachers should know the basics of using Scientist's Notebooks.
     - They are using Scientist's Notebooks more skillfully as a result of the workshops. (65%) (note: some teachers were already skillful in the use of notebooks, and are not included in this group)
     - The use of Scientist's Notebooks improved students' science skills. (73%), science content learning. (67%), and literacy skills. (59%) (as reported by teachers)
     - Literacy block is sometimes used for science writing. (78%)

5. **Engineering:** A template was developed for engineering design challenges using the steps in the design process outlined by the Museum of Science's "Engineering is Elementary" program (Ask, Imagine, Create and Test, Improve). A team of teachers and the Science Coordinator developed several engineering design challenges for each grade level with criteria and constraints for each. See Appendix C for examples. As suggested by teachers, these challenges are integrated into existing science units, and in some cases, social studies, literacy and math lessons. Each teacher is required to include at least one of these engineering design challenges in their lessons each year. We will provide a section of the new report card to evaluate student achievement in this area.

Recommendations:

- **Adequate science time:** The K-5 Review Committee strongly suggests an exploration of strategies for finding adequate time for Lexington teachers to meet national, state, and local standards in science and technology/engineering. These standards include expectations not only for science and engineering content understanding, but for the development of the skills needed to DO science: observing, designing an investigation, collecting and analyzing data, arriving at conclusions and communicating them to others. The heart of these disciplines is hands-on, minds-on investigation, and this takes time.

  - Lexington Learning Standards for the elementary science and technology/engineering curriculum are based on a schedule that allows for 1 ½ hours per week for science instruction in K-2, and 2 hours per week for Grades 3-5. . (Note: New state standards are currently being developed for Science and Technology/Engineering. These will be based on the following assumption for science instruction: K-2, 2 hours per week, Grades 3-5, 3 hours per week.)

  - In a recent survey, however, 58% of K-5 teachers reported a schedule that allows 2 hours a week or less that is split between science AND social studies. An average of 41% of K-5 teachers do NOT believe that they have sufficient time to teach the required science units and address all the major concepts and skills identified in the new Lexington Curriculum documents. Some thirty minute science blocks were reported by 40% of K-5 teachers. Thirty minute time blocks do not allow for an in depth hands-on activity (with associated set up and clean up). Transition time from and to other activities can further reduce the usability of a 30 minute block. Most science lessons are designed for a 45-60 minute period.

  - We strongly recommend collaboration between curriculum leaders and principals in the next few months as these building leaders plan schedules for next year. It is only through such collaboration that the minimum recommended quality time for science and engineering learning can be provided equitably across the school system (Minimum recommendation: K-2, 1 ½ hours per week and Grades 3-5, 2 hours per week).

- **Collaboration between Science, SPED and ELL**: Strong efforts should be made by the Elementary Science Coordinator and SPED and ELL leadership to provide science content and skill building for SPED and ELL students. For some SPED and ELL students, the hands-on nature of science and engineering activities may be a key to their progress in the area of literacy, especially if they are kinesthetic learners or have a special interest in science or engineering.

    - 48% of K-5 teachers report that students often leave science class for SPED or ELL services. Teachers try to help these students acquire science knowledge at other times, but often the students complain that they miss science experiments (see teacher comments in Appendix C). This is a serious concern, as a consistent 20% or so of Grade 5 students do not score in the "proficient" or "advanced" categories in MCAS Science and Technology/Engineering test.

- **Professional Development Offerings for K-5 Teachers:** Professional development offerings for classroom teachers should be provided in: Engineering Design, Science Assessment, Inquiry Science, Science Content for Curriculum Units, and Teaching Tips for Unit Lessons (See survey in Appendix C). In addition, new teachers should attend a workshop on using Scientist's Notebooks. (EDCO will offer an after school Scientist's Notebook workshop in the fall and we recommend that funding be provided for all new teachers to attend.) Based on research on adult learning, these workshops should take place in sessions of at least 2 hours in length with some shorter follow up sessions.

    - The district is currently reviewing all professional development needs, particularly at the K-5 level, where classroom teachers are required to be current in all subject areas. Of special concern is the time required for Professional Development in order to implement curriculum review recommendations beyond year 3 when the review process continues or is initiated in other curriculum areas.

- **Consultation and Model Lessons:** Consultation and model lessons with the K-5 Science Coordinator are essential, particularly for new teachers. This should continue to be a focus for the K-5 Science Coordinator.

- **Continued Revision of Units:** Curriculum units with mixed reviews on the teacher survey (Appendix C) should be examined and teacher suggestions solicited. Plans should be made for revision.

- **Continued Non-Fiction Integration:** Continued integration of non-fiction reading in the sciences should be supported, with the purchase of books by the K-5 Science Coordinator. These titles should be chosen in conjunction with the reading department with input from grade level teachers. However, caution should be used to assure that scientific inquiry should still be the focus of the science program, with reading as a supplemental resource.

- **Evaluation and Improvement in Big Backyard Training:** The Big Backyard outdoor education program is a valuable asset that supports the curriculum (survey, Appendix C). The parent training program should be evaluated and improved to maintain the program's effectiveness.

Year 3 Goals:

Middle School

a. Complete curriculum documents: Include activities associated with standards, develop common assessments, develop climate change strand, and develop activities for using the Vernier Probeware System.
b. Evaluate and choose textbooks and student reference materials
c. Collaborate with Review Team members to develop Technology/Engineering program. This involves identifying student objectives that will enable the achievement of state standards in technology/engineering. In addition activities and materials need to be chosen and the sequence of offerings planned and piloted.
d. Continue to look at common vocabulary to coordinate with common assessments using the Classroom Performance System (personal response "clickers").
e. Workshops offered to ensure all teachers are trained to use new equipment.

Accomplishments:

Middle School

Both middle schools have collaborated to develop a uniform curriculum document to guide science instruction in the Lexington Public Schools. Additional local science standards have been added to provide a higher science literacy expectation for students in Lexington's Middle Schools. The following items are areas of accomplishment achieved by the middle school Science and Technology/Engineering Curriculum Review committee:

1. **Curriculum Documents:**
   - This year the middle school science curriculum documents for grades 6-8 have been completed. The documents at each grade level contain: unit of study, Lexington Learning Standards (learning objectives and outcomes), the Massachusetts State Standards, along with vocabulary for each unit, and some examples of instructional activities to support these standards and common assessments. See a sample of the middle school curriculum document in Appendix B. Included in the document are standards, activities and vocabulary related to the topic of climate change, where appropriate at each grade level.

   - A draft curriculum document has been developed for middle school Technology, Engineering & Design instruction. This program will be piloted and will evolve as the course and curriculum are implemented. Potential activities at grade six and grade eight have been decided upon for 2010. Planning time and collaboration between both schools is necessary to develop consistent curriculum outcomes.

     - A technology/engineering teacher was hired. The Engineering Design course was piloted successfully for Grades 6 and 8 in spring 2010. This provided an opportunity to identify necessary materials, space and activities. This course is still in the development phase and curriculum

needs will be determined as the course takes shape. Collaboration between Clarke and Diamond will continue during a summer workshop where activities and materials for the Engineering Design courses will be determined by the technology/engineering teachers and a science department head (see Appendix E).

- Included as an appendix in the curriculum document are two suggested templates to promote science literacy. These templates assist with reading and writing in science. They can be found in Appendix D in this report. The writing template suggests a way to use the scientific method when writing laboratory reports. Other rubrics have been developed to guide students when writing open response questions in science on the Science, Technology & Engineering MCAS test. The reading template provides suggestions and a methodology to improve student comprehension and understanding when reading science information.

2. **Textbooks**

   The committee met jointly and at grade levels to assess several available options for appropriate textbooks and written materials. A text at each grade level was selected to meet the teaching learning objectives outlined in the curriculum document. The proposal has provided options for printed text and/or on-line access for students. This proposal has been submitted and approval is pending.

3. **Science and Technology Materials and Equipment**

   - During the year attention was given to upgrading the Vernier Probeware currently used at both schools. Additional probes, Go-Links, and upgraded Vernier software were purchased. Probes are used to collect data for temperature, pH, motion and sound. Lessons from the Vernier printed materials were integrated along with teacher-developed lessons in the laboratory.

   - Materials and supplies for the initial start up of the Engineering Design course were purchased. Consumable items and items to fabricate and test prototypes resulting from the design process were purchased.

   - Climate Change Backpacks with materials and curriculum arrived and are now being piloted within several of the life science classrooms.

4. **Professional Development**

   Representatives from the review committee from both schools attended several workshops and conferences. Conferences included: the National Science Teachers Convention, Massachusetts Association of Science Teachers Conference, the state sponsored STEM (Science, Technology, Engineering and Mathematics) Summit, the American Association for the Advancement in Science (AAAS) conference: Using the Atlas of Science Literacy Workshop.

   In addition to the conferences several members within both science departments took advantage of Lexington's Professional Development courses such as Using Vernier Probes in Science. Workshops or in-service programs were also held for the CPS personal response systems and ELMO projectors.

Recommendations:

The following items are recommendations for the middle school science program. The foundations for the science curriculum document have been established. The review committee felt that additional time in the following areas could enhance the middle school science program.

- **Time for Middle School Articulation:** Schedule time within the school year for the continued articulation of curriculum between Clarke and Diamond at each grade level. Monday department meetings can be used for this purpose, but they need to be designated as system-wide middle school meetings, not building meetings. Currently only one system wide meeting is on the calendar, (designated #3 on calendar) and that is for grades 6-12.

- **Continued Development of Assessments:** Further development of common and summative assessments should continue during department meetings and PLC meetings. These would be used by both middle schools. Additional assessments and common activities can be attached to each grade level curriculum document as they are developed.

- **Ensure Replacement of Textbooks:** The proposal for textbooks has been submitted. If the proposal is not funded, then the need for written support materials will need to be revisited. Currently our textbooks are ten or more years old. The rapid change of scientific information necessitates that written materials in our discipline stay current.

- **Fund Engineering Design Course:** With the addition of a new Engineering Design course there is a need for increased funds. This course will ultimately service two-thirds of the population in each building, each year. Funding for initial capital outlay, tools and consumable items are needed to support engineering skills and design projects. It needs to be understood that in order to appropriately teach the course using the engineering design process, the course must be experiential and hands-on, thus making the course materials intensive. Funding for materials must be considered each year. It is recommended that either there be an increase in the science budget with a line item specifically for the Engineering Design course, or that the course have its own budget and be managed by the engineering design instructors.

Year 3 Goals:

High School

a. Reformat curriculum documents using NEASC work as a base, include vocabulary.
b. Implement new curriculum/labs using the Vernier Probeware System and collect data (student assessments) to compare student achievement before and after implementation.
c. Collect and review data about the impact of the new ecology unit in the Earth Science course.
d. Offer professional development workshops for teachers to address ways to help

and encourage struggling and underperforming students. Design and implement workshops to bring teachers of Level 2 classes together to discuss best practices.

e. Review MA Technology/Engineering standards and identify the essential standards. Examine current LHS science courses for areas where these essential technology/engineering standards can be integrated into the current curriculum. (Rationale: There are five sets of science/engineering standards for high school. It is not feasible to teach full-year courses for all five. By adding some technology/engineering standards to the four comprehensive courses, Earth Science, Biology, Chemistry and Physics, all students will be exposed to the essential technology /engineering standards.)
f. Identify opportunities for students to learn additional technology/engineering skills through after-school programs, electives and courses taught in other departments.

Accomplishments:

1. Curriculum Documents: The curriculum documents for all science courses have been rewritten/reformatted from the original NEASC documents. Finishing touches are being added to reflect the inclusion of engineering and technology standards.

2. Vernier Probeware System: The Vernier probeware has become an integral part of many of the science courses. Based on the successes of the pilot program, additional equipment has been purchased and will be used in 2010-2011. The following provides a summary of the use of the probe ware during 2009-2010. Many of these experiments would not be possible without real-time reporting of data. Teachers noted that students seemed to grasp concepts better as a result of the use of these electronic probes, and the time required to collect data for these labs has been significantly reduced.

Earth Science

- Intensive inquiry-oriented labs: Questions included: Why is the equator warmer than the poles? Why does the interior of the continents have more extreme temperatures than the coastal areas?
- Engineering Design Unit: Probes enabled students to collect data in order to demonstrate performance and improvements in their design. The probeware greatly facilitated this project because many of the student devices were "proof of concept" and their performance was marginal. The probeware allowed students greater precision than is possible with alcohol thermometers.
- Additional activities for selected classes: Eutrophication lab, field studies of pond water, sun angle and solar insolation, and labs showing the advection of heat during convection.

Biology

- Dissolved oxygen: Probes were used to complete one of the required AP lab investigations. The use of this equipment significantly shortened the amount of time required to collect data as well as increasing the accuracy of the data.

- Temperature and pH probes: These probes are used in a variety of classes to monitor and collect data.

Chemistry

- Freezing/melting point of ice: Temperature probes led to more students getting better data to document the temperature change during a phase change.

- Evaporation and intermolecular forces: Temperature probes and Go Links were used in a new lab activity. Probes allowed the measurement of simultaneous temperature changes for the evaporation of two different liquids. Students had a better understanding of how intermolecular forces affect the properties of a substance as a result.

Physics

- Newton's Laws and the Conservation of Momentum: Use of Vernier wireless probeware in Integrated Lecture Demonstrations of these principles allowed students to move their respective carts and view the forces as compared to each other. As a result, students have been better able to conceptualize Newton's Third law where forces are equal and opposite no matter the circumstances. Students experienced a big "Aha" moment with the visual and physical representations of the concept.

- Acceleration in an Elevator: The physics team also replaced calculator-based elevator lab/demo with LabQuest measurement of normal force and calculation of acceleration in an elevator. This probeware provided students with real-time graphs of force vs. time for instant feedback with an increased number of data points. The conceptual and qualitative comparisons afforded by this probeware compares favorably to data obtained by earlier methods. Now the students can directly measure and calculate the acceleration, filling a traditional gap in student understanding of straight line acceleration and Newton's First and Second Laws.

3. **Ecology:** This is the third year that Ecology has been included in the Environmental Earth Science course. Biology teachers report that this has allowed them to significantly reduce the amount of time spent on Ecology (30%-50% reduction). Since Ecology is a major topic on the Biology MCAS, coverage of this topic is crucial. By adding it to the ninth grade curriculum and then reviewing the material in the 10th grade, students are very well prepared for this portion of the MCAS.

4. **Addressing Needs of Underperforming Students:** Although our original intent of bringing teachers of struggling students together to share ideas and strategies in a workshop format did not come to pass, this was a frequent topic in some of our Science PLC groups. The current Science Study Skills class is being retooled to focus primarily on 9th grade and Earth Science. In addition, there will be 16-18 blocks of Science Intervention available each week. The Science Intervention blocks will be covered by Biology, Chemistry, and Physics teachers. This will occur with no increase of FTEs as these teachers have two available blocks in their schedule (due

to fact that AP classes meet 6 blocks per week so AP teachers only teach 18 blocks).

5. **Engineering Integration:** Each discipline reviewed the Massachusetts Engineering and Technology Standards for current and anticipated integration into the existing course work. A detailed table in Appendix E describes the ongoing process of exploring ways to incorporate some of the Engineering and Technology Standards into the core Curricula.

    - Some sample items:
      MA Technology/Engineering Standard: Identify steps in the Engineering Design Process;
      LPS Curriculum Connections:
      Earth Science: Renewable energy project
      Biology: Design a Seed for Maximum Dispersal
      Chemistry: Design a Calorimeter to be used with the Food Calorie Lab
      Physics: Use the Engineering Design Process to solve a problem

Recommendations

- **Six blocks per week of science instruction:** Restore curriculum to previous levels by providing funding to offer six blocks per week of all core sciences. If a phased in approach is necessary, the Level 2 ("Conceptual Courses") should be given top priority.

    - In 2006, a failed override necessitated the reduction of Level 1 and 2 science classes from six blocks per week to five blocks per week. This resulted in a revision of earlier content. This particularly affected hands-on and inquiry activities, including laboratory experiments. Although teachers have adjusted and continue to cover the required content, students do not receive the additional rich and extensive experience that historically has been the hallmark of the Lexington High School Science Program. For example, our coverage of biotechnology has been cut by about 80%. This is unfortunate, given that biotechnology is one of the fastest growing fields/job market in the state and it is an area that the students love!! In addition Optics was dropped from the physics course in order to address engineering standards.

- **Technology Hardware and Training:** Continue to improve/increase both technology hardware and training.
  For example, complete the installation of mounted LCD projectors with audio and video connections. As more and more technology becomes available teachers need training to make sure they are making maximum use of the new equipment.

- **Science Intervention Program:** Provide opportunities for teachers to continue to explore ways to work with struggling students to improve their attendance, engagement, and performance. The new Science Intervention Program should be monitored to determine its effectiveness and modified as needed.

Year 3 Goal:

K-12

Schedule time on the district calendar to meet with elementary, middle, and high school coordinators to articulate the K-12 science program.

Update:

Limited time was available in 2009-2010 for conversations about articulation due to scheduling constraints. Currently there are no scheduled Monday K-12 "department" meetings on the calendar.

Recommendations K-12:

- **Schedule time for articulation:** The schedule for Monday department meetings should include time for vertical articulation/alignment K-12. Topics for common discussion include: Measurement, energy, climate, astronomy, geology, and engineering.

  This should also include time for middle school science teachers to communicate the topics that are being taught in grades 6-8 to elementary and high school teachers to insure vertical articulation. An outline/summary of topics for the middle grades should be developed. The outline would inform high school teachers of the concepts and vocabulary that were uniformly covered during the middle grades. A district wide 6-12 science meeting early in the year would be helpful for this articulation.

- **Reconvene K-12 Committee when new State Science and Technology/Engineering Standards are issued:** It is recommended that the K-12 committee reconvene when the new Massachusetts Science, and Technology/Engineering standards are published in 2011 or 2012. As our discipline is dynamic and changing, curriculum and instruction must evolve concurrently. When the state implements the changes in the science framework, we need to examine the documents to insure that the Lexington Standards are in line with the Massachusetts State Standards.

Conclusions:

While significant progress has been made with the production of a K-12 science and technology/engineering curriculum document for Lexington, and the inclusion of engineering activities in the curriculum at all grade levels, teachers continue to be challenged by the need for more quality time for science and engineering instruction. Professional development offerings at all levels are essential to the continued implementation of the program. In addition, attention still needs to be given to finding ways to assist students who are not proficient in science. As we move beyond Year 3 of the science and engineering curriculum review, we will continue to find ways to improve the program.

Lexington Public Schools
Science and Technology/Engineering
K-12

Year Three Curriculum Review

June 8, 2010

Goals of Science Education

- To learn science
- To learn to do science
- To learn about science

Scientific inquiry reflects how scientists come to understand the natural world, and it is at the heart of how students learn. Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences. National Science Teachers Association.

Year 3: Elementary

Goals/Accomplishments

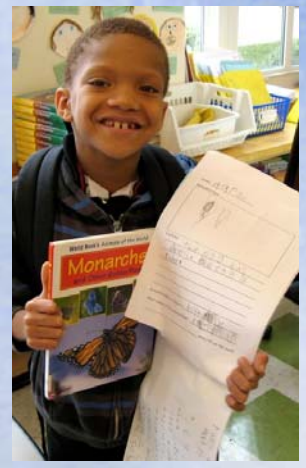
- Complete curriculum documents
  - ✓K-5 curriculum documents completed, including MA standards, Lexington Learning Standards, Materials Alignment/Activities, Assessments, and Essential Vocabulary

- Revise science section of the K-5 report card
  - ✓Report card committee met over the past year. Areas for Assessment: Inquiry and Engineering Skills, and Content Understandings

- Implement new units in Grade 3, 4 and 5
  - ✓Grade 3 Water Cycle unit completed, Grade 4 Sun, Moon, and Planets, and Grade 5 Weather to be completed in June.

Year 3: Elementary

Goals/Accomplishments



- Offer Scientist's Notebook workshops for all K-5 teachers
  - ✓All K-5 teachers and several literacy specialists attended a 2 1/2 hour workshop on implementing Scientist's Notebooks plus follow up sessions.

    A majority of K-5 teachers agree:
    - •All K-5 teachers should know the basics of Scientist's Notebooks
    - •They are now using Scientist's Notebooks more skillfully
    - •Students skills in science AND literacy improved

- Provide technology/engineering design challenges for each grade level.
  - ✓A template was developed: Ask, Imagine, Create and Test, Improve. Engineering design challenges were created for each grade.

Year 3: Elementary
Recommendations

- Provide adequate time for science and engineering.
  - Δ Curriculum based on 1 1/2 hours per week, K-2 and 2 hours per week, Grades 3-5. Curriculum leaders and principals should consult on ways to make this happen consistently.

    41% K-5 teachers reported that they do NOT believe that they have sufficient time to teacher to address all the concept and skills in the new curriculum documents.

    Inquiry science takes time.

- Science content and skill building needed for ELL and SPED students.
  - Δ K-5 Science Coordinator should work with ELL and SPED leadership .

    48% of teachers report that students often leave science class for SPED or ELL services.

Year 3 Elementary
Recommendations

- Professional Development offerings in science and engineering should be provided for classroom teachers.
  - Δ These should include Engineering Design, Science Assessment, Inquiry Science, Science Content for Curriculum Units. New teachers should attend a workshop on Scientist's Notebook.
  - Δ Difficulty in scheduling workshops given curriculum demands on K-5 teachers and competing curriculum reviews should be addressed.
- Continue to integrate non-fiction reading with science units
  - Δ K-5 Science Coordinator and Reading Specialists should make joint selections of supporting science books.
- Continue consultation and model lessons with the K-5 Science Coordinator.
- Evaluate parent training program for the Big Backyard program.

Year 3: Middle School

Goals/Accomplishments

- Complete curriculum documents for Grades 6-8 Science
  - ✓Documents completed for each grade. Include: unit of study, learning objectives and outcomes, MA standards, instructional activities, assessments, and vocabulary.
  - ✓Templates to promote reading and writing in science included in the document
  - ✓Climate change backbacks support this strand in the curriculum.

- Evaluate and choose textbooks and student reference materials.
  - ✓Textbooks chosen for each grade level. Options for printed and on-line access provided.

Year 3: Middle School

Goals/Achievements

• Collaborate with the Review Team members to develop a Technology/Engineering Program.

✓Drafted a curriculum document for Technology, Engineering and Design.

✓Technology/engineering teacher hired and materials purchased.

✓Engineering Design course piloted successfully for Grades 6 and 8, spring 2010.

✓Collaboration between Clarke and Diamond continues in a summer workshop. Activities and materials will be evaluated

✓Vernier Probeware upgraded and additional probes purchased (used to measure temperature, pH, motion and sound).

Year 3: Middle School

Goals/Achievements

- Offer workshops to ensure that all teachers are trained in the use of Vernier probeware

✓Lexington PD course Using Vernier Probes in Science was offered and a number of teachers attended.

✓Additional workshops: Classroom Performance System (clickers), ELMO projectors.

✓Teachers also attended NSTA National Conference, MAST, STEM, and the AAAS Conference: Using the Atlas of Science Literacy.

Year 3: Middle School

Recommendations

- Provide time for Middle School Articulation:
  - ∆ Schedule time for Clarke and Diamond teachers to continue the articulation of the curriculum.
- Continue Development of Assessments:
  - ∆ Develop common summative assessments during department and PLC meetings. Include these in curriculum document.
- Ensure Replacement of Textbooks.

Year 3: Middle School

Recommendations

- Fund New Engineering Design Courses:
  - New courses service 2/3 of middle school students.
  - Need funding for capital outlay, tools and consumable items for engineering projects.
  - Funding for materials needed each year.

Year 3: High School

Goals/Accomplishments

- Complete curriculum documents
  - ✓Curriculum documents for all science courses based on original NEASC documents.
  - ✓Include engineering and technology standards.

- Implement new curriculum/labs using Vernier Probeware System.
  - ✓Probeware:
    - Allows new labs not possible without real-time data reporting.
    - Improves student grasp of concepts.
    - Reduces time required to collect data.

  - ✓ Earth Science: Intensive inquiry-oriented labs, Engineering Design Unit
  - ✓ Biology: Dissolved oxygen, Temperature and pH
  - ✓ Chemistry: Freezing/melting point of ice, evaporation and intermolecular forces.
  - ✓ Physics: Newton's Laws and Conservation of Momentum, acceleration in an elevator.

Year 3: High School

Goals/Accomplishments

- Collect and review data about the impact of ecology unit in Earth Science course:
  - ✓Ecology now included in 9th Grade Earth Science.
  - ✓Allows 10th grade biology teachers to reduce time spent on Ecology (30-50%)
  - ✓Helps students to be prepared for MCAS in grade 10.

- Address needs of underperforming students:
  - ✓Science Study Skills class being retooled for 9th grade Earth Science.
  - ✓16-18 blocks of Science Intervention per week, covered by Biology, Chemistry, and Physics teachers with no increase of FTEs.

Year 3: High School

Goals/Accomplishments

- Identify essential Technology/Engineering standards; find integration opportunities in 9-12 science curriculum.
  - ✓Sample: MA Standard-- Identify steps in the Engineering Design Process.
  - ✓LPS Curriculum Connections:
    - •Earth Science: Renewable energy project
    - •Biology: Design a seed for maximum dispersal
    - •Chemistry: Design a calorimeter to be used with food calorie lab
    - •Physics: Choose a problem to solved with the Engineering Design Process.

- Address needs of underperforming students:
  - ✓Science Study Skills class being retooled for 9th grade Earth Science.
  - ✓16-18 blocks of Science Intervention per week, covered by Biology, Chemistry, and Physics teachers with no increase of FTEs.

Year 3: High School

Recommendations

- Restore six blocks per week of science instruction:

  ∆ Failed override reduced Level 1 and 2 classes from 6 blocks per week to 5 blocks per week, resulting in reduction of depth of content and ability to do inquiry activities, I.e. biotechnology labs

  ∆ Some curriculum topics dropped in order to address engineering standards, I.e. optics dropped from physics to do engineering project.

- Continue to improve/increase both technology hardware and training:

  ∆ Complete installation of mounted LCD projectors with audio and video connections.

Year 3: High School

Recommendations

- Monitor Science Intervention Program to determine effectiveness:

Year 3: K-12

Recommendations

- Schedule time for articulation:

  ∆ Provide time for middle school teachers to communicate topics taught both to high school and elementary colleagues.

  ∆ Schedule professional development time for curriculum mapping of key concepts in such areas as energy, climate, astronomy geology, and engineering.

- Reconvene the K-12 Science and Technology/Engineering Curriculum Committee when new state standards are issued in 2011 or 2012.

QUESTIONS?