Model Course Mapping Resource

A Resource Developed by the Michigan NGSS Internal Review Team

To Provide a Michigan Context to NGSS Appendix K

(Original Draft based on January 2013 DRAFT NGSS, Appendix J (4-10-13)

Revised to reflect May 2013 NGSS, Appendix K (5-23-13)

Considerations for Transitioning to NGSS

- The NGSS present a new vision for science education, one that aims to develop student proficiency in doing science.
- While it is important to think about goals for eventual course offerings, it is critical that we
  - focus first on getting to know the NGSS and the NRC Framework
  - embrace the integration of the three dimensions, and
  - view our current practice through the lens of the standards.
- Teachers are encouraged to get to know the NGSS and the Framework well enough to analyze current practice in light of the NGSS.
- First and second year goals should focus on implementing the NGSS practices and cross cutting concepts.
- Teachers are encouraged to take advantage of professional development that will support careful transition planning.
- Key message: We will have time to work on course redesign, development of curricular plans and common local assessments, when more is known about how large-scale assessment will be adjusted to reflect the new standards. This work should take place after teachers know the standards, how well their current plans align with the standards, have a better understanding of the impact of the NGSS on instruction, and know more about plans and supports for NGSS assessment.

Getting to Know the NGSS

- Download the Topic Arrangement of the NGSS, read the introductory material and supporting appendices.
- Review the matrices that provide an overview of the practices, disciplinary core ideas, and crosscutting concepts.
- Review the K-12 topic progressions, and grade band standards/performance expectations (PEs).
- Consider recommended/provided model course descriptions (included in Appendix K and in the resources that follow here).
- Identify current course offerings, map NGSS to current structure.
- Consider topics and PEs already being addressed in current courses/curricula, using planning tools provided.
- Identify areas/units that align, select topics or clusters of PEs to use in planning ways to better address the associated practices and crosscutting concepts.
- Consider implications for adjusting instruction to reflect the NGSS.
- Begin to plan for a workable transition to NGSS, including plans for rearranging course offerings, and building coherent K—12 plan for meeting the NGSS.

MS and HS Course Models

Numerous 6-12 course models are described below as a resource for transition planning for future course offerings and hiring decisions.
The model courses are listed in three groups, Adapted NGSS Models (Adaptations of Models listed in NGSS Appendix K), Innovative Ideas for Consideration, Models that Reflect Current Practice in Michigan.

- These models assume that meeting ALL NGSS equates with meeting the MMC requirements. For high school, the NGSS provide expectations for Physics, Chemistry, Biology, and Earth and Space Science. They define career and college readiness in science.
- All recommended models should allow for meeting ALL HS NGSS in three years of HS coursework (9-11 to be nearly completed by Spring Grade 11 State Assessment). Any models that indicate a four-year plan, should also indicate options of integrating necessary topics before state assessment in Grade 11.

Tools for Planning

- Course Models
- Strengths and Challenges for each model
- Tool for mapping NGSS topics to current practices (course offerings, units of instruction), identifying gaps, planning for filling gaps, planning for the future

Sample NGSS Model Course Pathway Options (developed by Michigan NGSS Internal Review Committee)

6th Grade	7th Grade	8th Grade	Model	9th Grade	10th Grade	11th Grade	12th Grade	Comments*
Adapted NGSS Models – Adaptations of Models Described in NGSS								* See more thorough discussion of strengths and challenges of these models in subsequent pages.
Physical Science (+)	Life Science (+)	Earth Systems Science (+)	Conceptual Progression (Appendix K)	Physical Science (+)	Biology (+)	Earth Systems Science (+)	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	By title the high school courses appear to be a standard science domain model, but careful mapping of learning progression has topics placed in each course as they support learning in the subsequent courses.
Physical Science	Life Science	Earth Systems Science - Since HS ESS after MME, add some HS ESS to 8th	Physics First Conceptual Model Expanded to 4 Years HS Science	Physics	Chemistry	Biology	Earth and Space Science	While Earth and Space Science comes after that spring of eleventh grade, we can't know if this is problematic until the nature of that assessment is determined.
Physical Science OR Integrated Science	Life Science OR Integrated Science	Earth Systems Science OR Integrated Science	Integrated ESS	Physics (Astronomy)	Chemistry Earth Systems (Geology, Weather and Climate)	Biology Earth Systems (Environmental, History of Earth)	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	It may be that many schools are enticed by this model because it offers a low duty change effort. Our goals won't be well served by an appetite for the easy.
Physical Science Life Science Earth/Space	Physical Science Life Science Earth/Space	Physical science Life science Earth/space	Multi-Topic Science Similar to MS GLCE and as in other countries	Physics (Astronomy) Geology (Macro)	Chemistry and Biology (Biochemistry)	Environmental Biology Earth Systems Science (Evolution, climate change, human impact) [:omit Plate tectonics]	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	The clusters presented here are mere examples of the concepts. Many reasonable groupings could be construed.
Innovative Ideas for Consideration – (With 6-8 following either organization above)								* See more thorough discussion of strengths and challenges of these models in subsequent pages.
			STEM Centric Application drives science; real-world issues	Material Science	Bioengineering	Natural Resources and Energy Use	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	The STEM areas presented here are mere examples of the concepts. Many reasonable groupings could be construed.
			Career Clusters Engineering Cluster Medical Sequence Energy Sequence Biosciences Seq.	Physical Science	Earth Systems BioGeoScience	- Medical Program - Energy and Innovations Program - Engineering and Technical Program	- Medical Program - Energy and Innovations Program - Engineering and Technical Program	The programs presented here are mere examples of the concepts. Many reasonable groupings could be construed.
			Socially Relevant Science (Ontario emphasis model)	Nanotechnology Energy and Resource Needs	Global Climate Water Crisis Bioethics	Environmental Chemistry Food Chemistry	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	The topics presented here are mere examples of the concepts. Many reasonable groupings could be construed.

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6th Grade	7th Grade	8th Grade	Model	9th Grade	10th Grade	11th Grade	12th Grade	Comments
Models That Reflect Current Practice in Michigan								* See more thorough discussion of strengths and challenges of these models in subsequent pages.
Integrated Science P, L, ESS (MS)	Integrated Science P, L, ESS (MS)	Physical Science (HS)	**B, C, ESS**	Biology	Chemistry	Earth Science / Environmental Science	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	This model lacks the high school physics that undergirds the other three disciplines. Earth and space science is well served by the preceding chemistry course, but biology is not. Middle school physics will not suffice for high school because it is less sophisticated.
Integrated Science P, L, ESS (MS)	Integrated Science P, L, ESS (MS)	Earth and Space Science (HS)	**B, C, P**	Biology	Chemistry	Physics	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	This model lacks high school Earth science and does not benefit from the learning progressions in the NGSS that build on a foundation of high school physics and chemistry. Middle school Earth and space science will not suffice for high school because it is less sophisticated.
Life and Physical	Life and Physical	Earth Space Science (MS, HS)	**B, C, P,**	Biology	Chemistry	Physics	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	This model has the same issues as the one above but images that there is time in middle school for high school Earth space and science content in Grade 8. That is not the case.
Integrated	Integrated	Physical Science Emphasis (HS)	**ESS, B, C**	Earth and Space Science	Biology	Chemistry	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	Like the top model, this one lacks the high school physics that undergirds the other three disciplines. With Earth and space science preceding chemistry course along with biology, the opportunity to provide a deeper treatment of these disciplines and review chemistry in context is lost. Middle school physics will not suffice for high school because it is less sophisticated.
Integrated	Integrated	Earth and Space Science (MS, HS)	**PS, B, C**	Physical Science	Biology	Chemistry	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	This model lacks high school Earth science. Middle school Earth and space science will not suffice for high school because it is less sophisticated.
Physical	Life	Earth and Space Science (MS, HS)	**PS, ESS, B**	Physical Science	Earth Science	Biology	Optional Advanced Science Courses (AP, IB, H, Dual Enrollment)	

Proposed Trimester HS Model

		8th Grade	ERPS Proposed	Over 6+ trimesters in 9th, 10th (and part of 11th) Grades (Some students will complete by end of 10th)				
		Basics for HS PEs ESS, B, PS	Two trimesters each of B, C, P and one trimester ESS Offer Regular and Advanced B, C, P	Biology - 1 Ecosystems and Cells Chemistry -1 Properties and Bonding	Physics - 1 Waves Biology -2 Biochemistry ESS	Physics – 2 Forces Chemistry – 2 Equilibrium and Heat		
								Add other trimester models

Transitioning to NGSS

A school may be compelled to transition to one of the NGSS adapted or Application Centric Models from one that is more commonly enacted. Depending on local factors (teacher endorsements, special interests, local assets) this change effort may be more or less difficult. Transitioning to an intermediate sequence may be necessary to give time for new courses to be designed or resourced.

Descriptions of Each Model Course Pathway (listed above)

Key: P – Physics, C – Chemistry, B – Biology, ESS – Earth Systems Science, PS – Physical Science
ENV – Environmental Science, G – Geology, CCC -- Crosscutting Concepts, PD – Professional Development

Conceptual Progressions Model		
This model spirals through science topics from sixth to eighth and again from ninth through eleventh grades. Both sixth and ninth are organized around topics in physical science, including astronomy. Seventh and tenth grades are centered on life science topics. Eighth and eleventh grades address Earth and space science while reinforcing biological evolution, since coevolution in the biosphere and other Earth systems is an important big idea. The sequence is designed to build conceptual understanding over time using well-mapped learning progressions. Deep treatment of the life and Earth sciences depends on a foundation in physics, chemistry and mathematics. The foundational concepts around energy and matter are reinforced in the life and Earth sciences.		
	Strengths	**Challenges**
Overall	The progression is a strength; it provides opportunities for applying P and C in B and ESS. This model will be supported by NGSS lead state initiatives.	Staffing -- new ESS and potential HQ issues for PS
Progressions	• P and C concepts are reinforced in Life and ESS. • Life and earth are richer/deeper because of PS base.	• It may be difficult to thoroughly address all P and C PEs in one year. (Physics First Model (below) extends this model to 4 years of HS science.)
HQ	• Biology teachers are in place.	• Those with P or C endorsements only cannot teach this as described. • Lack of HQ ESS teachers • The temptation to split PS into a semester of P and C would undermine the progression when some teachers offered C before P. • Depth of content knowledge in both P and C necessary for PS.
Transitions	• Physical science is not an uncommon HS course; schools that currently have PS in place will have fewer adjustments to move to this model.	• For schools w/o current PS, this could be problematic because of HQ law. • Would require more equipment for use by all 9th graders. • Will need intensive PD for teachers in Earth Systems Science.

Physics First Model (Conceptual Progressions Expanded to 4 Years of HS Science)		
This high school model is a typical physics first design, which views physics as the foundation of all other disciplines of science, therefore it is placed in the 9th grade. Because chemistry is the foundation of modern biology and critical to deeply understanding Earth and space science, it is placed next in the sequence. Also, modern biology is currently one of the most dynamic areas of science, with extensive career opportunities and relevance to societal concerns. Placing it in 11th grade allows for a treatment that does justice to its importance. Earth science, a set of disciplines of especially high societal relevance, applies physics, chemistry and biology to questions related to our critical challenges regarding food, water, energy, risks to natural disasters and societal sustainability itself. This model allows for a strong, high level Earth science capstone course in 12th grade. To the degree that the high school targets specific earth science content, there will need to be the means to expose students to the core concepts. This could include adding some high school topic placement in eighth grade, or use of online or application oriented projects in the other courses.		
	Strengths	**Challenges**
Overall	The progression is a strength; it provides opportunities for applying P and C in B and ESS.	Staffing -- new ESS, may need more P and/or C teachers.
Progressions	• P and C will be thoroughly addressed (full year of each). • P and C concepts are reinforced in Life and ESS • Life and ESS are richer/deeper because of PS base	• Will want to address some HS ESS PEs in 8th Grade, since HS ESS is taught after the 11th Grade assessment.
HQ	Biology, Chemistry, and Physics teachers in place. (PS not a problem)	• Lack of HQ ESS teachers; may need additional teachers for C and P • Even though taught in courses focusing on P, then C, still need to build integration and application across physical science concepts.
Transitions	• Schools that have PS in place will not have difficulty with transition to this model, but the expansion to two courses needs to be carefully planned for application throughout.	• Would require more P and C equipment for use by all 9th and 10th graders. • Will need intensive PD for ESS teachers to be well-versed in Earth Systems Science. • Will need careful planning for ESS preparation in 8th Grade.

Integrated (Parsed) Earth Systems Science Model

This model assigns Earth and Space topics to physics, chemistry, and biology as they connect to those subjects. It assumes planned integration of ESS.

	Strengths	Challenges
Overall	Good conceptual flow if school occurred over 12 months.	Staffing – expertise, necessary PD, possible certification issues. Physics, chemistry and biology courses too easily fill an academic year, and finding time to adequately treat Earth science is unlikely.
Progressions	• Great progression and conceptual flow (P, C, B) • Still address highest level of environmental biology in 3rd year	• Need careful planning; will require a conscious effort to do justice to Earth Systems Science • Biology is already crowded; difficult to find time for ESS/ENV
HQ	• Physics, Chemistry, Biology teachers could teach the three courses in this model. • An Earth and Space teacher could rotate through courses across the grade band.	• Need strong ESS background so can teach P in the context of ESS, and can teach Biology in the context of ENV. • Need best practices workshop to do justice to ESS integration.
Transitions	• This model allows teachers who currently teach P, C, and B to continue to teach these courses, but with adaptations to address progression (P, C, B) and to integrate ESS • Allows for rearrangement of topics within courses (and for some will not require moving content to new grade levels)	• Need careful planning for transitions, since all of ESS is taught within the context of P, C, B. • Need strong ESS background so can teach P in the context of ESS, and can teach Biology in the context of ENV.

Multi-Topic Model

This model distributes topics from physical science, life science, earth science and engineering in each middle school and high school grade. Because there are four disciplinary core ideas in the NGSS each would be placed in 3 of 12 quarterly slots. Topics can be strategically grouped to leverage logical progressions at each grade level.

	Strengths	Challenges
Overall	This model is employed in some other very successful countries and regions. This model allows for logical progressions within a grade.	Staffing – expertise, necessary PD, possible certification issues. Other countries who use this model have other aspects their system that connect to and support this design (teacher preparation, resource use).
Progressions	• Biology taught more in context than in other models • Sets conceptual foundation; good conceptual flow	• Shallow in P and C
HQ	• Biology and Chemistry teachers can teach Biochemistry (may need additional PD) • Teachers HQ in Environmental Science can teach Biochemistry (may need additional PD)	• Need careful planning for concept building (practices and CCC) • Need to design to cover HQ issues w/o splitting content into two discipline-specific semesters; need strength of integration.
Transitions	• This model is an extension of the current plan many schools use for MS (5-7 or 6-8).	• Limited support materials for this option; practices are at the heart of this change. • Other countries who use this educate pre-service teachers to teach such course explicitly using the very resources available to the classroom. This is not our current system.

Sample NGSS Model Course Pathway Options (developed by Michigan NGSS Internal Review Committee)

STEM – Centric Model

This sequence provides examples for emphasizing the application of NGSS topics in currently exciting and highly relevant fields. By engaging the NGSS through application, the practices are especially well treated and the content (DCI and Crosscutting Concepts) is strongly connected to the real world scientific fields as well as personal learning experiences. Students gain experience conducting investigations and solving problems in these fields. These courses can develop a robust conceptual understanding of science content while making prominent its relevance to society and career opportunities. Material science could be an excellent avenue to apply physical science, bioengineering or genetics could provide the same for the life sciences, and natural resources and energy use could focus investigations and problem solving in the Earth science.

	Strengths	Challenges
Overall	The STEM model promotes application of science knowledge and practice.	Care must be taken to assign topics to courses in a way that aligns with the intended STEM focus, while allowing for all NGSS to be addressed.
Progressions	• The progression can be carefully planned to reflect application of the topics included in the conceptual progression model.	• Will want to plan for more integration since some of the topics will not relate directly to planned STEM units.
HQ	• Similar courses may already be taught in CTE programs.	• HQ issues – may require team teaching of science HQ teachers with CTE teachers.
Transitions	• Schools with special staff or community expertise/ experience could leverage such resources in course design and student learning opportunities.	• Teachers will need to develop deeper understanding of the applications and field of whatever STEM emphasis is determined.

Career Clusters Model

This high school sequence organizes important selected topics of physical science, biology and earth science into ninth and tenth grade in order to allow student to pursue career focused education. Programs in eleventh and twelfth grade include content and practices of the NGSS connected to the STEM fields of the programs. Conventional high schools could develop career academies in STEM fields such as engineering, medical, information technology or innovations related to energy. Career technical centers could accommodate students in a similar manner.

	Strengths	Challenges
Overall	Many students would be better served if our educational system more explicitly provided promising career education programs, rather than the current over emphasis on academic goals. High quality models and resources exist.	While high quality resources and models exist in high schools and career-technical centers, they are currently under-utilized. Schools might place more students in these courses if they had evidence that the courses address all mathematics and science standards as assessed.
Progressions	• A physics first sequence can be applied across two years, and career clusters continue to apply science practices and conceptual understanding	• 9-10 progression will need to be carefully planned to address any NGSS that are not addressed in specific Career Program. • Health program may be able to address some Chemistry and Biology NGSS in 11 and 12, so will need to address all other NGSS in 9 and 10.
HQ	• Similar courses may already be taught in CTE program.	• HQ issues – may require team teaching of science HQ teachers with CTE teachers.
Transitions	• Schools that have access to existing career and technical programs and facilities can leverage these resources.	• Would require coordination with local resources such as work place settings for internships and career-technical centers for special expertise.

Socially-Relevant Science Model		
This sequence is organized around socially or economically relevant topics. It puts what's interesting and important in the forefront of curriculum. By engaging the NGSS through important questions, issues and cutting edge science, the practices would be especially well treated and the content (DCI and Crosscutting Concepts) would be strongly connected to real world issues and opportunities. These types of courses can develop more a robust conceptual understanding of science content while making prominent its relevance to society. Courses built around topics such as nanotechnology, energy and resources needs, global climate change, the global water crisis, environmental or food chemistry are examples of compelling and critical issues.		
	Strengths	**Challenges**
Overall	No student could be confused by the notion that science does not connect with their life and society as a whole. Having the relevance prominent in an engaging curriculum will inspire more students to pursue scientific fields. Citizens will hold science in the regard it deserves when faced with the challenges of our time.	Curriculum will require prompts, routines and support for issue based curriculum.
Progressions	• Issues can be selected and organized in a way consistent with the conceptual understanding/progression model.	• A sequence built around issues could present concepts in orders not as optimal as other more ideal learning progressions.
HQ	• Issue-based course titles alleviate the hurdles presented by highly qualified law. The central discipline of an issue could guide teacher assignment. For example nanotechnology would be best taught by a physical science teacher	• Many issues are multidisciplinary at least in part, putting some teacher out of area.
Transitions	• More resources are now available from major publishers for issues based science courses.	• New equipment and resources would be needed in order to engage students in new issues based projects. • Will need intensive PD for ESS teachers to be well-versed in Earth Systems related issues. • The most important issues tend to change over time requiring continuing monitoring and repurposing of courses.

Sample NGSS Model Course Pathway Options (developed by Michigan NGSS Internal Review Committee)

Describe your district's current focus for each grade/course.
Identify NGSS topics currently addressed in each (content with or without practice)
List NGSS topics to be assigned to courses.
See MS and HS NGSS Topics List (below)
See also Topic Alignment document (compares NGSS with MI GLCE/HSCE)

6th Grade	7th Grade	8th Grade	Model	9th Grade	10th Grade	11th Grade	12th Grade
			Focus				
			Topics				

Working DRAFT document

Sample NGSS Model Course Pathway Options (developed by Michigan NGSS Internal Review Committee)

NGSS MS and HS Topics (Copied from Topic Alignment document)

Life Science / Biology	Earth Systems Science	Physics and Chemistry
HS.SF Structure and Function **HS.IVT** Inheritance and Variation of Traits **HS.MEOE** Matter and Energy in Organisms and Ecosystems **HS.IRE** Interdependent Relationships in Ecosystems **HS.NSE** Natural Selection and Evolution	**HS.SS** Space Systems **HS.HE** History of Earth **HS.ES** Earth's Systems **HS.WC** Weather and Climate **HS.HI** Human Sustainability	Chemistry **HS.SPM** Structure and Properties of Matter **HS.CR** Chemical Reactions Physics **HS.FI** Forces and Interactions **HS.E**N Energy **HS.WER** Waves and Electromagnetic
MS.SFIP Structure, Function, and Information Processing **MS.GDRO** Growth, Development, and Reproduction of Organisms **MS.MEOE** Matter and Energy in Organisms and Ecosystems **MS.IRE** Interdependent Relationships in Ecosystems **MS.NSA** Natural Selection and Adaptations	**MS.SS** Space Systems **MS.HE** The History of Earth **MS.ES** Earth's Systems **MS.WC** Weather and Climate **MS.HI** Human Impacts	**MS.SPM** Structure and Properties of Matter **MS.CR** Chemical Reactions **MS.FM** Forces and Interactions **MS.EN** Energy **MS.WER** Waves and Electromagnetic Radiation