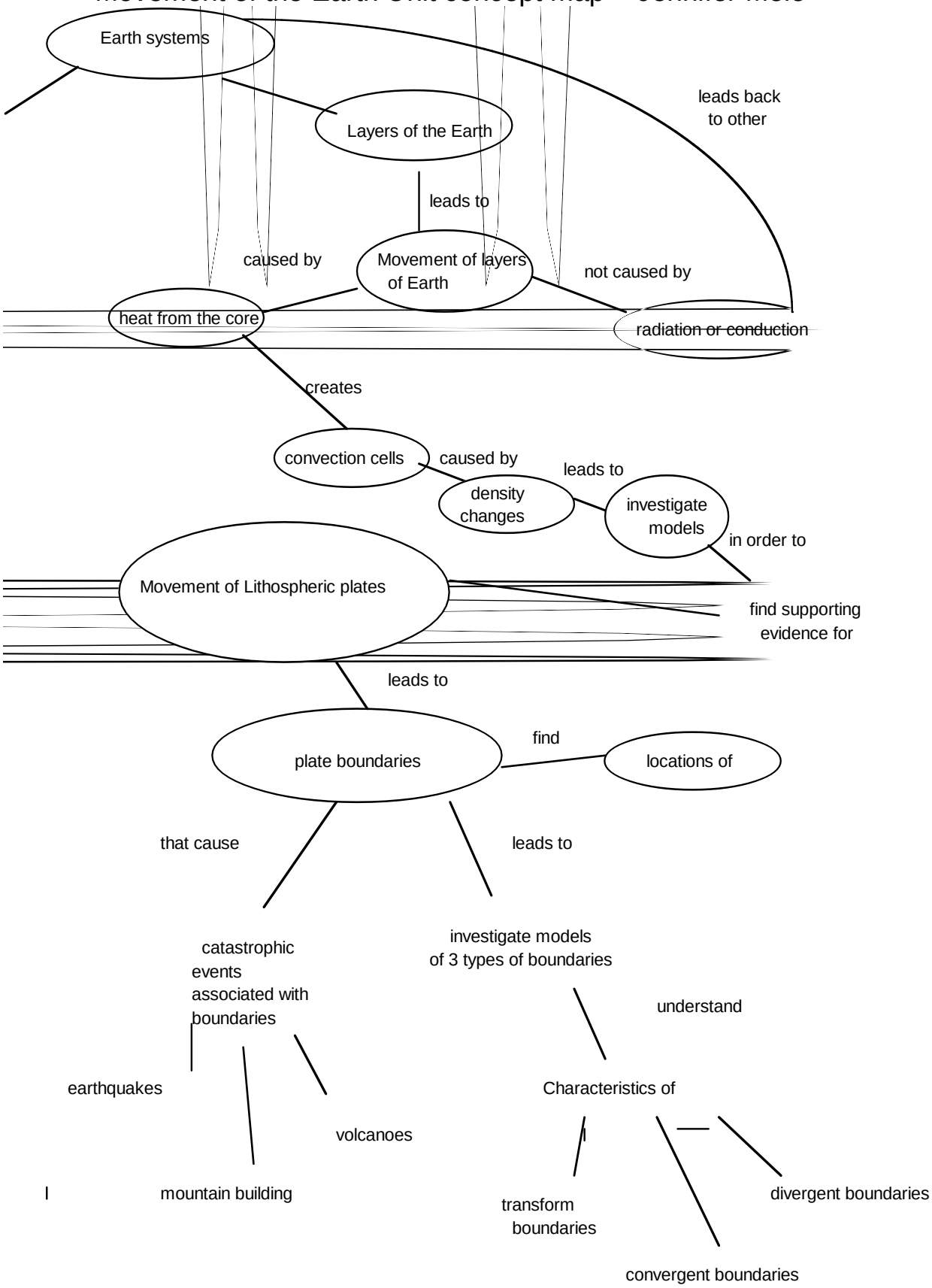
Movement of the Earth Unit concept map - Jennifer Mele



Movement of the Earth Unit

1 - Name of nationally-validated, Standards-based, STS-based curriculum

Investigating Earth Systems: Our Dynamic Planet

This book starts with students learning how scientists use models to investigate and test theories about the Earth systems. Students investigate characteristics of the Earth's interior by modeling how earthquake waves travel through different materials. Students then look at how seismological wave interpretations tell us about characteristics of the Earths interior material. The Movement of the Earth Two week unit plan specifically covers:

Investigation 3 - Forces that Cause Earth Movements.
(Heat transfer – Convection cells) Pages in student text: pp.22-29
Pages in teacher's guide: pp.118-144 and Black line Masters pp. 323-326

Investigation 4 – The movement of the Earth's Lithospheric Plates. Pages in student text: pp.30-40
Pages in teacher's guide: pp.145-181 and Black line Masters pp. 327-331

The book concludes with investigations of characteristics of earthquakes, volcanoes and mountains (Natural disasters).

2 - What are the state CONCEPT standards addressed by this unit?
Massachusetts Science and Technology/Engineering Curriculum Frameworks:

Strand 1: Earth and Space Science Topic: Earth's structure

Standard 2: Describe the layers of the solid earth, including the lithosphere, the hot convecting mantle, and the dense metallic core.

Strand 1: Earth and Space Science Topic: Earth's History

Standard 5: Describe how the movement of the earth's crustal plates cause both slow changes in the earth's surface (e.g., formation of mountains and ocean basins) and rapid ones (e.g., volcanic eruptions and earth quakes)

Strand 3: Physical Sciences Topic: Heat Energy

Standard 14: Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system.

Standard 16: Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium.

3- What are the PROCESS SKILLS that you will focus on in this unit?

Predicting	Modeling	Observing
Interpreting data	Communicating	Experimenting

4 - List each student activity, describe it briefly, and list the number of 45 minute periods needed to complete it. (This includes processing the ideas).

A. Student Activity: Corn syrup/ cardboard Convection cell

Description: Students predict what will happen to (2) touching pieces of cardboard floating in corn syrup when heated from below by a candle.

# of periods: 2 (1 for introduction and 1 to perform activity & to process and communicate)

B. Student Activity: Teacher demonstration Comparison convection cell

Description: Students will predict what will happen when oatmeal, food coloring and sawdust are placed in water and heated. They will compare and contrast the way the materials behave. Students should see oatmeal and food coloring convecting and the floating sawdust being pushed to the sides of the container. The material in the lab models the core, mantle and lithosphere of the Earth.

# of periods: 1(1 to perform activity & process and communicate)

C. Student Activity: Modeling Plate Convergence

Description: Group discussion to predict what happens when plates move toward each other. After answering some questions about this phenomenon, students create a model of this using cardboard and shaving cream. A piece of thin cardboard is put down on table. Two pieces of corrugated cardboard are placed on top with space in the middle. A thin layer of foaming shaving cream is put in the middle. Students slowly move the two pieces of

corrugated cardboard together and stop to record observations at various points.

# of periods: 2 (1to make predictions and perform activity & 1 to process and communicate)

D. Student Activity: Modeling Plate Boundaries

Description: Students choose a type of plate boundary (convergent, divergent, and transformation) they will model. They write their investigation in the form of a question then make predictions about what will happen. They have to design a model for one of the boundaries, make a list of materials needed and explain why they used the materials. Finally, they need to demonstrate their model .

# of periods: 4 (1 to design activity & 2 to build model, 1 to process and communicate)

5 – What is the STS context for the unit?

This unit crosses over Earth Sciences (Earth in Space and Catastrophic Events) and Physical Science (Properties of matter).

How can you make this more personalize to adolescents?

Honestly, I have no idea. I would have to ask my students to help me with this one.

6- What publicly presented project will students produce?

In Activities A-C students are required to complete lab recording sheets and journal entries. In Activity D students design a model then demonstrate to the class.

7 – What are the materials needed for this unit?

Candles
books of matches
empty metal containers (clean tuna cans)
pieces of laminated cardboard 1x1 cm
bricks
corn syrup
clear heat proof (1L) beaker

hot plate
oatmeal
food coloring

scissors
thick corrugated cardboard
thin card board
duct tape
foaming shaving cream
metric rulers
safety goggles

sawdust
other materials to be selected by students

Shared between classes per group of four **# of groups – 5:**

Candles
books of matches
10 bricks
5 empty metal containers (clean tuna cans)
25 safety goggles

scissors
metric rulers
foaming shaving cream

Consumables for classes per group of four **# of groups – 5:**

Candles
Books of matches
empty metal containers (clean tuna cans)
pieces of laminated cardboard 1x1 cm
Bottle of corn syrup
Container of oatmeal
sawdust

thick corrugated cardboard
thin cardboard
duct tape
foaming shaving cream

8 - Week One (3-5 days of student focused activities)

Activity	Introduction to unit (Investigation 3) by posing key question and group discussion	Activity A Corn syrup/ cardboard Convection cell activity	Group presentation of conclusions of lab results Activity B teacher demonstration of convection cell comparison	Group discussion of Observations and conclusions	Activity C Modeling plate convergence Discussion of Key questions and group discussions
At home assignment	Individual KWL chart with questions related to key question	Write up lab observations and link to discussion on day 1	Reading pp.25-28 in student text and questions 1-5 on p. 29 in student text	Questions 9-10 on p. 29 in student text	Review the model procedure under Design Investigations #2 & # 3 a. & b on pp.31-32 in text book. Record your predictions and side view drawings in your journal.

Concept	Fluids can move when heated.		Movement of Earth's mantle is due to convection cells	How convection cells operate in Earth and how it affects landforms	Pre-assessment tool to find out prior knowledge of plate boundaries and characteristics
Process Skill	Prediction/ formulating hypotheses	observation	Interpret data	communication	communication
Transition to understanding	Allow students to come up with their own questions to investigate about this.		Allow students to perform this lab instead of teacher demonstration	Density is an important factor in plastic behavior in solids, density labs like our density jigsaw activity in class might need to be inserted here.	

Week Two (3-5 days of student focused activities)

Activity	Activity C Modeling plate convergence	Activity C group discussion of questions about model Activity D Students begin working on their models	Activity D Clinical interviews while students work on models	Activity D Clinical interviews while students work on models	Activity D Students demonstrate or explain their models
At home assignment	Outline plan design with a list of possible materials needed	Work on models and journal entry on progress	Work on models and journal entry on progress	Work on models and journal entry on progress	Critiques of presentations and journal entry on what you learned from this modeling process
Concept	There are 3 types of plate boundaries: and characteristics depend on Lithospheric plate composition	Divergent boundaries are due to convection currents and associated with volcanic activity and earthquakes (rift zones)	There are 2 types of Convergent boundaries. Subduction occurs and is due to density differences in materials. Usually associated with mountain building , volcanoes and earthquakes	Transform boundaries occur with 2 plates sliding passed each other. Transform faults and earthquakes occur but not volcanic activity.	Characteristics and locations of 3 types of plate boundaries.
Process Skill	observation	Interpret data	modeling	modeling	communication
Transition to understanding		This activity seems to be more inquiry based than the others. I would leave it as is and not open it any more.			

9 – What are the big ideas in each of the activities?

A. Student activity : Corn syrup/ cardboard Convection cell
Big Idea: systems, conservation of mass and energy.

B. Student activity : Teacher demonstration of Comparison convection cell
Big Idea: systems, conservation of mass and energy.

C. Student activity : part A Modeling plate convergence
Big Idea: orogeny and balancing forces.

D. Student activity : part B Modeling plate boundaries
Big Idea: orogeny and balancing forces

10 – Is there some outdoor fieldwork possible?

Not for this unit

Is there a fieldtrip connected to this material?

Not for this unit

11 – What concepts need to be known from previous units for students to tackle these activities successfully?

Density, concept of systems, heat transfer: radiation and conduction

12 – Which activities need to be "opened up" and made more inquiry?

The intro to Activity A should allow room for students to come up with some of their own questions to investigate.

Activity B should be performed by the students, not seen as a teacher demonstration.

Activity C is a benchmark investigation to allow students to design their own models in Activity D.

13 – Which state standard (related to this topic) are not addressed in the unit as it is now written?

After reviewing the frameworks, I believe the unit adequately addresses the standards related to this topic.

Activity plan 1

Brief Description of Group to be taught: An 8th grade Science class of 25 students. There are 8 students on IEPS.

Relationship of this Lesson to the unit: This lesson ties together investigations of how fluids can flow when heated to how the mantle flows due to convection currents from heat generated in the core. This investigation focuses on what happens at divergent plate boundaries & volcanism. This will lead into another activity of inquiry about how the earth's dynamic properties are affected by these forces.

Massachusetts Frameworks Strand and Learning Standard:

Strand 1: Earth and Space Science Topic: Earth's structure

Standard 2: Describe the layers of the solid earth, including the lithosphere, the hot convecting mantle, and the dense metallic core.

Strand 3: Physical Sciences Topic: Heat Energy

Standard 14: Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system.

Standard 16: Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium.

Concepts:

- Heat transfer via convection cell.
- Convection cells in the earth's mantle
- Density

Processes:

- Prediction / formulating hypotheses
- Observation

Science Habit of Mind:

- Be curious. Be careful and accurate in observations.
- Offer reasons for findings and consider reasons suggested by others.

Other Subject Area Objectives:

Art – Visual Arts: 3.1 Create 2D artwork from direct observation by drawing diagrams of teacher demonstration and student labs.

Session Length: three 45 minute class periods

Materials needed:

Per group of 4 for Student Lab investigation 1

- candles
- Matches
- Small empty metal containers
- Two pieces of thin cardboard, 1 cm square
- small bricks
- Corn syrup or maple syrup
- Safety goggles

Teacher demonstration

hot plate
Matches
1 clear heat proof beaker
1 cup of oatmeal
Food coloring
sawdust

Activity 1 Part I & II student investigation:
Key Question: Does the rock of the Earth's mantle move?

Relation of this Lesson to the unit: Student investigation shows how convection cells operate related to the earth system.

TIME	PROCEDURE	CONCEPT
Day 1 (5 min) (10 min) (30 min)	**Part 1 Introduction**: 1. Point out the need for trust and a community of learners in a classroom. 2. Pose question "Does the rock of the Earth's Mantle Move? 3. Hand out pages 1-3 of lab recording packet and have students individually answer the question: Is it possible for this solid rock to move? Why/why not? What evidence do they have for their answers? 4. Have a group discussion where everyone shares predictions in order to come to a group prediction consensus. Post answers on the board or chart paper. 5. **Summary and Wrap up:** Tell students we will be conducting a lab investigation to explore this phenomenon.	Prediction of forces that cause earth movement Look for evidence for answers not just yes or no answers. Misconception: solid rock doesn't flow
Day 2 (10 min)	**Part 2 Set-up**: 1. Divide participants in groups of four. 1. Post and explain group roles: **Getter** – person who gets materials needed for the group and who asks questions of the teacher after activity has begun. **Starter** – person has to be really clear on parts of the task so as to keep the group on task. **Recorder** – person responsible for assuring that each team member is recording all data, ideas, conclusions, and questions of the team **Reporter/Observer** – person who orally communicates the team results for the whole class. Also the person who takes quick notes on how the group worked together for the activity. 2. Explain procedure for conducting the lab. Review lab safety procedures: when working with flames use safety goggles, tie back long hair, roll up sleeves, how to light a match and put it out safely.	See if fluid can flow if heated. Focus on students' predictions (or formulating hypotheses)

(30 min)	3. Have students collect and assemble materials to conduct investigation. **Part 2 Hands on Activity:** Have students record their predictions prior to starting. After groups have finished recording, they can light candles. As corn syrup heats up, have the students record observations and interpretations on recording sheet. Have students draw movement of cardboard with solid arrows and movement of corn syrup with dashed arrows. 1. As students are conducting experiment, circulate around the room checking that students are following proper safety procedures and asking the following questions. 2. Ask students: What reason did you have for your prediction? This answer will vary depending on what they predicted. Novice will say because they just thought so. Competent will expand on this by saying they thought solid rock can't flow. Expert will say their prediction was based on _____ reason. 3. Continue circulating around the room and ask: "What are you seeing? Or "Are you seeing what you thought you'd see? What do you think is happening? These questions should motivate students to think about what they are seeing with their predictions.	
(5 min)	**Summary and Wrap up:** Five minutes prior to end of class remind students to wrap up investigations and clean up work stations. Students blow out candles & clean up spilled corn syrup. Don't let them touch cans because they are very hot. Tell students to keep their handouts to use with the homework and that we will be discussing what we saw in the next class. Homework: Review lab recording sheet and make sure to write up observations and complete diagrams.	

Formative assessment rubric for Part I & II to be used with checklists:

	Method	**1. Novice**	**2. Competent**	**3. Expert**
Process Skill: Prediction	Circulating around the room and later reviewing prediction sheets	Will make a prediction but won't be able to give reason for prediction (I think the cardboard will move. Or I think the oatmeal, food coloring and sawdust will move around.)	Will make a prediction and will give a reason for it. (I think the cardboard will move because the bubbles rising will push the cardboard, oatmeal, food coloring, and saw dust around.)	Will make a prediction, give a reason and link it to some previously knowledge or experience. (I think … because… and it reminds me of when…….)
Habit of Mind: Be curious. Be careful and accurate in observations	Circulating around the room and later reviewing prediction sheets	Writes down incomplete predictions, does not draw accurate pictures or record what is happening in the models.	Writes down predictions with reasons prior to experiments, draws accurate pictures of what is happening in the experiments, records what is happening in models.	Writes down predictions with reasons and linking prior to experiments, draws accurate labeled pictures of what is happening in the experiments and writes down step by step what is happening in the models.
Science Concept: Heat transfer via convection cell	Circulating around the room and later reviewing prediction sheets	Does not notice the complete cycle of upward movement, lateral movement and a downward movement of the syrup/water.	Notices the syrup/water has an upward movement, lateral movement and a downward movement.	Not only notices the pathway of the syrup/water but makes the connection that this is a convection cell.

Activity 1 Part III Teacher demonstration & group conclusions
Does the rock of the Earth's mantle move?

Relation of this Lesson to the unit: This is the syntheses of investigations showing how convection cells operate related to the earth system to move the earth's mantle.

TIME	PROCEDURE	CONCEPT
Day 3 (10 min)	**Part 3 Introduction**: 1. Review lab investigation procedure. Hold a group discussion about observations recorded in lab investigations.	Focus on students' observations How well did they record what they observed? Did drawings accurately record what they observed?
(10 min) (10 min)	**Part 3**: **Introduction**: Explain procedure: Teacher will heat beaker of water over hotplate. As water heats up, a cup of oatmeal will be added, have students observe and record what happens. Then a drop of food coloring will be added to water/oatmeal mix and they will observe and record findings. Finally sawdust will be added to beaker. **Set-up**: Have students individually come up with predictions and reasons of teacher demonstration. **Hands on activity:** Have students record observations and a series of drawings of teacher's demonstration of procedure above. Have students get into groups and answer questions 6 & 7 on p.24 in student text. Question 6: Evidence of models and mantle. a. Core = candle b. Mantle = corn syrup and oatmeal c. Lithospheric plates = cardboard and sawdust Question 7: compare models with diagram: a. Heat source = interior core of earth b. ^ movement mantle = heated water/syrup c. horizontal movement mantle = water/syrup d. separation cardboard = plates in mid ocean ridges e. horizontal movement lithosphere = cardboard/sawdust	Focus on students' observations How well did they record what they observed? Did drawings accurately record what they observed?
(15 min)	**Summary and Wrap up**: See if students can come up with a consensus as to what their predictions and observations.	

	Homework: read pp. 25-28 and answer questions1-5 on p 29.	
Day 4 (5 min)	**Introduction:** 1. Explain that now we will bring it all together. **Hands on activity:** 1. Have students get into groups to answer the questions 6-8 on p. 29	Focus on students' observations leading to syntheses of science information
(20 min)	Allow 20 minutes for groups to discuss the answers. Circulate around the room to view group discussions and their recording sheets.	
(15 min)	**Summary and Wrap up**: Each Group reports their conclusions to the class. Each group answer will be recorded on the board. See if students can come up with a consensus as the answers to the questions. Have students answer questions 9-10 have for homework.	

Formative assessment rubric for Part III to be used with checklist:

	Method	**Novice**	**Competent**	**Expert**
Process Skill : Observation	Circulate around the room to view recording sheets and then collect recording sheets to review.	Does not draw pictures or they are inaccurate. Doesn't record observations or records observations inaccurately.	Draws accurate pictures of what is happening in the experiments, Records most parts of observations / what is happening in models	Draws accurate labeled pictures of what is happening in the experiments. Writes down step by step what is happening in the models accurately and in detail.
Habit of Mind: Offer reasons for findings and consider reasons	Group reports their observations and conclusions to the class.	Minimal contribution of reasons to group findings or is unable to consider	Contributes reasons to the group findings. Is open minded enough to consider suggestions of	Contributes reasons to the group findings. Is open minded enough to consider

suggested by others		reasons suggested by others.	others.	suggestions of others and tries to link personal opinions to others opinions.
Science Concept: Convection cells in the earth's mantle.	Answers to questions 6-9 on p. 29 in text.	Can distinguish heat transfer in a convection cell, but doesn't make the connection that it is the change in density that drives a convection cell	Understand it is the expansion of liquids due to heating that decreases density to allow material to flow up. When it is cooled at the surface the density decreases and the fluid sinks again.	Not only understands that the change in density due to heat drives a convection cell, but also can connect other examples of where convection cells occur.

Activity plan 2

Brief Description of Group to be taught: An 8th grade Science class of 25 students. There are 8 students on IEPS.

Relationship of this Lesson to the unit: This section focuses on the nature of plate tectonics. They will understand the interaction of Lithospheric plates by using and designing models to explain what happens at the three types of plate boundaries.

Massachusetts Frameworks Strand and Learning Standard:
Strand 1: Earth and Space Science Topic: Earth's structure

Standard 2: Describe the layers of the solid earth, including the lithosphere, the hot convecting mantle, and the dense metallic core.

Strand 1: Earth and Space Science Topic Earth's History

Standard 5: Describe how the movement of the earth's crustal plates cause both slow changes in the earth's surface (e.g., formation of mountains and ocean basins) and rapid ones (e.g., volcanic eruptions and earthquakes).

Concepts:
- The lithosphere is not just one continuous piece, but is instead large and small sections that move relative to one another.
- The Earth's crust is not uniform. There is thicker, less dense continental crust and thinner, more dense oceanic crust.
- There are 3 kinds of plate boundaries: Convergent (moving together), divergent(moving apart), and transform(sliding past).
- Each type of plate boundary has its own set of characteristics and catastrophic events associated with it.

Processes:
- Communicating
- Interpreting data
- Experimenting
- Modeling

Science Habit of Mind:

- Seek better reasons for believing something than “Everybody knows that…” or “I just know” and discount such reasons when given by others.
- Be aware that there may be more than one good way to interpret a given set of findings.
- Buttress their statements with facts found in books, articles, databases, and identify the sources used and expect other to do the same

Other Subject Area Objectives:

- Strand 4: Technology/Engineering standards.

Standard 1: Materials, Tools, and Machines. Broad concept: Appropriate materials, tools, and machines enable us to solve problems, invent, and construct.

Skill 1.1 Given a design task, identify appropriate materials(e.g. wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g. weight, strength , hardness, flexibility)

Standard 2: Engineering Design. Broad concept: Engineering design is an iterative process involving modeling and optimizing for developing technological solutions to problems within given constrains.

Skill 2.1: Identify and explain the steps of the engineering design process, i.e. identify the need or problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s) and redesign.

Skill 2.3 Describe and explain the purpose of a given prototype.

Skill 2.4 Identify appropriate materials, tools, and machines needed to construct a prototype of a given engineering design.

Session Length: six 45 minute sessions

Materials needed: (Per group of 4)

Part I: Modeling plate convergence

- Scissors
- Thick corrugated cardboard
- Thin cardboard (like a cereal box)
- Duct tape

- Foaming shaving cream
- Metric ruler

Part II: Modeling plate boundaries:
Materials to be selected by teacher and students

Activity Plan 2 Part 1 student investigation: Key Question: What happens where Lithospheric plates meet?

Relation of this Lesson to the unit: This investigation focuses on what happens at convergent boundaries and the results depend on the composition of the plates.
Continental plate + Continental plate convergence = mountain building, earthquakes & volcanism.
Ocean plate + continental plate = Subduction due to density of plates and results are volcanism & earthquakes.
Transform boundaries = faults & earthquakes (no volcanism)

TIME	PROCEDURE	CONCEPT
Day 5 (10 min)	**Introduction:** Have students individually record in their journals answers to the following questions. Key question: What happens where Lithospheric plates meet? Sub-questions: • What do you think happens when plates move toward each other? • What do you think happens when plates move away from each other? • What do you think happens when plates slide past one another?	Pre-assessment tool to find out prior knowledge Misconceptions: Volcanoes & earthquakes don't always occur together
(10 min)	**Hands on Activity:** Hold a group discussion of answers to above questions to give all students an opportunity to share their ideas. Record ideas on class chart.	communication
(20 min)	**Hands on Activity:** Have students assemble in groups to discuss and record in their journals answers to the following questions. Using what you know about mountains, volcanoes & earthquakes, work together to answer: • How do mountains form there? • Might volcanoes develop where plates meet, and if so, Why? • Could there be earthquakes where plates collide & why?	Pre-assessment tool to find out prior knowledge

(5 Min)	**Summary & Wrap Up:** Review the purpose of the model and link to class discussions. Homework: Review the model procedure under Design Investigations #2 & # 3 a. & b on pp.31-32 in text book. Record your predictions and side view drawings in your journal.	
Day 6 (5 min)	**Introduction:** Summarize ideas generated from last class. Tell students that they are going to explore what might happen when 2 plates collide by using a model.	
(5 min)	**Activity Part I Set Up**: The teacher's guide recommends precutting the cardboard to the dimensions before class to save time. Prior to investigating model: • students get into groups • get materials • create data table • record observations	
(30 min)	**Hands on Activity:** Have students perform investigation using model described below. • Have students lay out precut cardboard like in picture in book with thin cardboard underneath and thick cardboard overlapping on either side, leaving a gap in the center. • Apply a thin layer of shaving cream on thin cardboard (in gap) • Have students push the (2) pieces of corrugated cardboard together slowly, 2.5 cm at a time. • At each 2.5 cm distance have students record shape, height, and width of shaving cream in their data table. •	Interpreting data
(5 min)	**Summary & Wrap Up:** Homework: Write up lab report detailing model results and compare with predictions.	

Formative assessment rubric for Part I to be used with checklist:

	Method	Novice	Competent	Expert
Process Skill : Communication	Group discussion on predictions about what happens at the 3 types of plate boundaries	Will not generate ideas or will not cite evidence or reasons for their ideas	Even if the ideas generated are speculation, student cites evidence or reasons for their idea. "I think … because it seems like… in our investigation."	Will not only generate ideas and evidence supporting reasons but will provide specific examples as to the occurrence. This is like … in investigation… and if you look on the map it is an example of what happens ….. here.
Habit of Mind: Seek better reasons for believing something than "Everybody knows that…" or "I just know" and discount such reasons when given by others.	Record responses in group discussion answering the Key Question for this section.	Will state "Everybody knows that…" or "I just know" for a reason or will not ask for justification or reasons.	Will offer reasons for ideas and will not accept "Everybody knows that…" or "I just know" answers from other students by asking for justification or stating that is not a scientific explanation.	Will offer reasons for ideas and will not accept "Everybody knows that…" or "I just know" answers from other students by asking for justification or stating that is not a scientific explanation.
Science Concept: The model to be investigated is a convergent plate boundary.	Journal entries of predictions and results of what happened in model	Won't be able to link model to what happens at a convergent plate boundary	Will be able to link results of model to a convergent plate boundary	Will be able to link results of model to a convergent plate boundary and describe where it may occur globally

Activity Plan 2 Part II Modeling Plate Boundaries:

Relation of this Lesson to the unit: Student design models to explain what happens at plate boundaries.

TIME	PROCEDURE	CONCEPT
Day 7 (20 min)	**Introduction:** Hold a group discussion of model results and answers to question 6 parts a-d on pp.32-33 in text to give all students an opportunity to share their ideas. Record ideas on class chart to the global locations of the 3 types of plate boundaries. Also, generate a whole class theory about effects at transform plate boundaries such as earthquake generation but not volcanic activity, Subduction boundaries of oceanic (more dense) and continental (less dense) plates, and convergent boundaries of different types of plates.	By looking at relative motions of major Lithospheric plates students should see patterns of effects at different types of plate boundaries (earthquakes, mountain building & volcanoes)
(20 min)	**Hands on Activity:** Have students read the Digging Deeper section pp.35-39 in text. Students then choose one type of plate boundary to model. Have students get into groups of no more than (4) according to wanting to model same type of plate boundaries. Have students come up with a question that will be answered in the model. (ie. Do mountains form at transform plate boundaries?) Have students make predictions about what will happen at their chosen plate boundary to answer their question.	
(5 min)	**Summary & Wrap up:** Homework: Groups create materials list for model and an outline of steps to set up and run model. Materials need to be simple enough and inexpensive enough to build. Consider safety factors in material selection (do not use materials that will shatter or will need excessive force to work) Provide reasons why specific materials are selected. How do materials selected model the properties and behaviors of your selected plate boundary?	Assesses science concepts: characteristics and locations of 3 types of plate boundaries

Day 8-9 (40 min)	**Introduction:** Students get into groups to work on designing models. Teacher circulates around the room to answer questions related to designs and helps students get materials to build models. Provide computer access for groups who want to additional research about plate boundaries. The Investigating Earth Systems web site www.agiweb.org/ies/ provides links to web sites that will help students supplement their findings and model building.	Focus on Modeling
Day 8-9 (5 min)	**Summary & Wrap up:** Students clean up work stations. Homework: continue to work on models and journal entries related to the process of model design & building. (What is working & What needs to be changed to make model work).	
Day 10	**Introduction:** Announce Student presentations their models. **Hands on Activities:** As Groups present models, other students take notes on procedure and findings of each group model. **Summary & Wrap up:** Homework: Take journal entries starting from Day 1 of Key Question: What happens where Lithospheric plates meet to present and create an outline for a paper detailing the investigations and how they are supported by information learned during this section. Complete journals on model progress and critiques of each group's model. Critique includes how feasible and easy would it be for others to reproduce the model and results, were the materials used a realistic representation of the processes that occur in the boundary modeled, and how does the model tie in with unit material.	

Formative assessment rubric for Part II:

	Method	Novice	Competent	Expert
Process Skill : Modeling	Demonstration of model of a specific plate boundary	Does not use materials that model the behavior of earth materials in the chosen plate boundary.	Uses appropriate material to model behaviors of earth materials in the chosen plate boundary.	Uses appropriate materials to model properties of earth materials in chosen plate boundaries and produce expected behaviors predicted
Habit of Mind: Buttress their statements with facts found in books, articles, databases, and identify the sources used and expect other to do the same.	Presentation of models	In presentation of models and procedures, statements are not backed by facts found in books, articles, databases, and identify the sources used and does not expect other to do the same.	In presentation of models and procedures, statements are backed by facts found in books, articles, databases, and identify the sources used and expect other to do the same. Will ask for sources if not present.	In presentation of models and procedures, statements of conclusions are backed by facts found in books, articles, databases, and identify the sources used and expect other to do the same. Will ask for sources if not present.
Science Concept: Characteristics and locations of 3 types of plate boundaries.	Presentation of models and by report paper generated from journal entries in this investigation	Will correctly identify only some of the characteristics and locations of the 3 types of plate boundaries	Will correctly identify most of the characteristics and locations of the 3 types of plate boundaries	Will correctly identify all of the characteristics and locations of the 3 types of plate boundaries

Personal Reflection:

During the planning stage of the lab with the 8th grade science teacher, it was concluded that modifications to the lab in *Investigating Earth Systems: Our Dynamic Planet* needed to be made due to the needs of the students. The procedure of the lab and the teacher demonstration were reversed and performed in the same 45 minute period. Most of the processing and discussion was conducted the next day.

What worked well:

Opening up the teacher demonstration to hands on activity was the right approach to this task. Even though the lab didn't work right, allowing the kids to mess around with it was a valuable experience. Although the lab didn't work as planned, it did lead to a very dynamic and rich discussion on what could we have done to improve the outcome of the experiment. Each group was able to come up with different changes to the procedure. They also had a great discussion about independent vs. dependant variables in designing an experiment. We also discussed the trials and errors scientists in the real world encounter. This was not my initial goal, but, an important discussion to have.

Using the techniques from chapter 7 in our text *Teaching Science in Elementary and Middle School Classrooms* p.281 table 7.6, I was very conscious of monitoring my responses. I stated that these were some very interesting hypotheses and that we would perform a lab that would investigate this further. At times I resisted the urge to respond in the Teacher Centered mode and focused more on responding to the Student Centered method.

I also implemented the wait time before calling on students. I was able to get input and answers from a larger variety of students than if I had just called on the first or second person.

What I learned:

What really stood out was that it takes a lot more time than planned to have students come up with predictions and think about answers to questions. The directions stated have a brief discussion. When the students were asked the question "Does the rock of the Earth's mantle move?" most of the students simply answered Yes or No even when instructed to come up with reasons to justify their answer. As I went around the room, I noticed that I had to ask students to explain why they said yes or no. I had to really draw out reasons for their predictions and I didn't expect to have to work that hard at that task. I

was expecting to see most of the students in the competent range of predictions, but most of the students were still in the novice range(20 out of 25 students).

As we learned in class, I had misconceptions in mind before the class, but I found that while thinking about misconceptions, some students have misconceptions that I didn't think about. It is best to have misconceptions in mind but to remember you will never be able to think of them all.

I got a few interesting ones that I didn't think about*.

The class came up with:

*Yes – it (the mantle) breaks apart from the heat underneath (from the core)

*Yes – the pressure from the top (lithosphere) causes the crust and mantle to crack.

When it cracks lava might come up.

Yes – the mantle gets thinner that's why it moves {this couldn't be elaborated on by the students}

What would I have changed?

Using the overhead projection camera detracted from viewing the experiment fully because the bubbles and the corn syrup convecting weren't very visible. I understand why *Investigating Earth Systems: Our Dynamic Planet,* suggests having the students perform this lab. There are two ways the cardboard can behave due to heating. A richer discussion of observations and conclusions could have occurred if different groups had observed these different behaviors. Also, the ambient temperature in the class caused the cardboard to spread apart prior to the candle being lit, so part of the answer was "given away" before the demonstration.

It took a lot longer to set up and instruct the convection cell lab. Modifications to the proportions of materials also needed to be made due to the beakers on hand. Because the proportions weren't quite right, the experiment really didn't adequately show convection currents. (Both labs worked perfect in my kitchen, prior to the class) More students (14 of 20) were able to get to the competent range of predictions for the experiment after seeing the demonstration.

The beginning of the group discussion activity started out with reviewing observations. Each group reported their observations. Two groups saw a little more convection than the other three groups. All the students had recorded observations, but again, as I circulated around and scanned recordings 18 of the 25 were still at the novice stage of observations.

The discussion activity also didn't go quite as planned for a few reasons. The students weren't really used to discussion groups. They had also just moved into a new lab group configuration they had a hard time working together. Even when I thought I was clear about how they should collaborate, they all started to work at answering the questions individually, with no real sharing of ideas. As I circulated around the room many of the students wanted to tell me the answers. I had to constantly redirect all the groups to discuss the ideas with each other.

Because the students couldn't see the materials convecting, it made it hard for some students to conceptualize the process. As I circulated to each group, I had to keep asking them to think about the heat source and where the heat was going. I also had to keep alluding to density changes. All groups were finally able to report conclusions and we did finally manage as a class to come up with important aspects of convection cells.

I also noticed that I became so engaged with the students' answers that I forgot to write their predictions on the board. In my future classes, I would like to designate a "recorder" for class charts.

Despite the activities not going as I planned, I would use these two activities again. I would have the students perform both labs but not on the same day. I would have them perform the corn syrup lab as it is written, but I would have them design the Teacher demonstration to see what types of materials would simulate convection in the mantle. I would also build in more time for group discussions and presentations. I can see the importance of starting collaborative learning at the beginning of the year in order for students to feel comfortable sharing ideas.

If I had more time I would:
I would like to insert the Hot & Cold experiment described on the PASCO site using temperature probes to discover and evaluate convection currents in water tanks. This experiment could be inserted anywhere in Investigation 3 to reinforce the concept of convection currents.

The PASCO site also has an interactive ocean floor mapping program that would really enhance the divergent plate boundaries section. They would be able to see where mid oceanic ridges form and what they look like.

The PASCO site had a link to the GIS system. The GIS has a program that looks at global earthquake epicenters over time to discover

patterns. This would be nice to insert in Part II of Investigation 4. I think it would help the students predict where plate boundaries occur and to understand the relationship between plate boundaries and earthquake generation.

I found a great simulation project on http://www.k12science.org called Musical Plates. It is an interactive web site for students. They collect real time earthquake data, chart results, and post conclusions on the site. There is great student and teacher support sections for using this program. It would be an effective engaging activity for the students since they spend a small amount of time each day collecting data before putting it together. The students could continue to collect data while they worked on the Dynamic Planet Investigations. It would enhance the level of understanding for the students as well as provide another related artifact for this unit.