Engineering is Elementary®
Just Passing Through: Designing Model Membranes

Repurposed for Mandarin immersion by the Minnesota Mandarin Immersion Collaborative (MMIC)
MMIC Engineering is Elementary® "Model Membrane" Unit

Immersion Unit Plan

Introduction

The MMIC Engineering is Elementary® "Model Membrane" curriculum stems from the Boston Museum of Science Engineering is Elementary® curricular program (Museum of Science, 2008). It integrates engineering topics with science, social and cultural studies, and Chinese language arts. Purchase and use of Boston Museum of Science Engineering is Elementary® teacher guide and curricular materials are required. This unit serves as an introduction to the field of bioengineering culminating "in an engineering design challenge in which students 'Create,' test, and 'Improve' a model membrane for an imaginary frog" (Museum of Science, 2008, p. 7).

CONTEXT

Program Particulars

Program model (one-way/two-way; total/partial, etc.): Early, total, one-way world language immersion
Immersion language(s): Mandarin Chinese
Grade level: Third grade

Student Characteristics

Ethnolinguistic background: All native speakers of English; 3% African American, 65-67% Anglo American, 25-30% Asian American (many adoptees from China).
Estimated proficiency levels:
L1: Native-like speaking and listening; reading and writing unknown
L2: Junior intermediate low speaking, junior intermediate mid listening (Center for Applied Linguistics (CAL) CAL Oral Proficiency Exam/Student Oral Proficiency Assessment (COPE/SOPA) Rating Scale, 2010); novice high-intermediate low reading and writing (National Council of State Supervisors for Foreign Languages (NCSSFL) LinguaFolio® Self Assessment Grid, 2009)

Listening	Jr. Intermediate mid	I can understand the main idea and many details on familiar topics in a series of connected sentences, conversations, presentations, and messages (Linguafolio®, 2009). Understands sentence level speech in new contexts at a normal rate of speech although slow-downs may be necessary for unfamiliar topics. Carries out commands without prompting (CAL, 2010).

Speaking	Jr. Intermediate low	I can provide information on familiar topics using a series of sentences with some details (Linguafolio®, 2009). Goes beyond memorized expressions to maintain simple conversations at the sentence level by creating with the language, although in a restrictive and reactive manner. Handles a limited number of everyday social and academic interactions (CAL, 2010).
Reading	Jr. Novice high	I can understand some ideas in simple texts that contain familiar vocabulary (Linguafolio®, 2009).
Writing	Jr. Intermediate low	I can write on familiar topics and experiences using a series of sentences with some details (Linguafolio®, 2009).

Unit Timing

This interdisciplinary immersion unit is designed to be taught intensively for multiple periods during the day. Approximate time of instruction/activities equals 52 hours. If taught for three hours/day, the unit may be completed in four weeks.

Prior Knowledge and Skills

Knowledge/Understandings **Students will already know/understand…**	**Essential Skills** **Students will already be able to…**
Chinese Language Arts	
• Language has rules • Elements of a narrative (characters, setting, major events, problem, resolution) • WH-question summary (who, when, where, what, why and how) • Orthographic and morphological components of characters (e.g., semantic radicals, appropriate placement of specific character components, etc.) • Basic stroke order and character formation	• Use metalinguistic skills to access meaning with oral and written text • Use story elements to retell a story • Describe how characters in a story respond to major events and challenges • Ask and answer WH questions to demonstrate understanding of key information in a text • Infer meaning when given key words and other context clues • Report on observations and experiences in writing
Science and Engineering	
• Living vs. non-living things • Properties of different materials	• Describe and classify living things by characteristics, behaviors and basic needs • Observe and describe materials by their properties, e.g., color, size, texture, etc.
Math	
• Measurement of volume • Fractions and decimals	• Use number sense, fractions and decimals to measure and report volume
Social Studies and Culture	
• Geographic place within the world • Four directions (NEWS) • Cultural practices, products, perspectives • Family relationships and family life	• Locate city/state/country/continent on a map and use • Recognize that communities include people who have diverse ethnic origins, customs and traditions • Record observation and reflection by writing in a science journal

DESIRED RESULTS

Big idea: Bioengineers use knowledge of nature and biology to design technologies that solve real-world problems.

Unit Theme: Organisms, basic needs, and bioengineering

Key Content Concepts:
Basic needs of organisms, the Scientific Method, rain forest ecology, membranes, the Engineering Design Process, technology, bioengineering, engineer, scientist, elements of narrative, the writing process, mapping, cultural practices in El Salvador, China and the US.

Targeted National and State Standards

American Council on the Teaching of Foreign Languages (ACTFL) National Standards for Chinese Language Learning (2006)

COMMUNICATION
Communicate in Chinese
Standard 1.1: Students engage in conversations, provide and obtain information, express feelings and emotions, and exchange opinions in Chinese.
Standard 1.2: Students understand and interpret written and spoken language on a variety of topics in Chinese.
Standard 1.3: Students present information, concepts, and ideas to an audience of listeners or readers on a variety of topics.

CULTURES
Gain Knowledge and Understanding of the Cultures of the Chinese-Speaking World
Standard 2.1: Students demonstrate an understanding of the relationship between the practices and perspectives of the cultures of the Chinese-speaking world.
Standard 2.2: Students demonstrate an understanding of the relationship between the products and perspectives of the cultures of the Chinese-speaking world.

CONNECTIONS
Connect with Other Disciplines and Acquire Information
Standard 3.1: Students reinforce and further their knowledge of other disciplines through the study of Chinese.
Standard 3.2: Students acquire information and recognize the distinctive viewpoints that are only available through the Chinese language and culture.

COMPARISONS
Develop Insight into the Nature of Language and Culture
Standard 4.1: Students demonstrate understanding of the nature of language through comparisons of the Chinese language with their own.

Standard 4.2: Students demonstrate understanding of the concept of culture through comparisons of Chinese culture with their own.

COMMUNITIES

Participate in Multilingual Communities at Home & Around the World

Standard 5.1: Students use the Chinese language both within and beyond the school setting.
Standard 5.2: Students show evidence of becoming life-long learners by using Chinese for personal enjoyment and enrichment.

State Content Standards (Minnesota)

Science (MDE, 2009)

Strand 1: Nature of Science and Engineering	Substrand: *The Practice of Science*
3.1.1.1 Understand that scientists work as individuals and in groups, emphasizing evidence, open communication and skepticism. • Benchmark 3.1.1.1.1: Provide evidence to support claims other than saying "Everyone knows that," or "I just know," and question such reasons when given by others.	
3.1.1.2 Scientific inquiry is a set of interrelated processes incorporating multiple approaches that are used to pose questions about the natural world and investigate phenomena. • Benchmark 3.1.1.2.1: Generate questions that can be answered when scientific knowledge is combined with knowledge gained from one's own observations or investigations. • Benchmark 3.1.1.2.3: Students will maintain a record of observations, procedures and explanations, being careful to distinguish between actual observations and ideas about what was observed. • Benchmark 3.1.1.2.4: Students will construct reasonable explanations based on evidence collected from observations or experiments.	
	Substrand: *Interactions among Science, Technology, Engineering, Mathematics, and Society*
3.1.3.2 Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry. • Benchmark 3.1.3.2.1: Students will understand that everybody can use evidence to learn about the natural world, identify patterns in nature, and develop tools.	
3.1.3.4 Tools and mathematics help scientists and engineers see more, measure more accurately, and do things that they could not otherwise accomplish. • Benchmark 3.1.3.4.1: Students will use tools, including rulers, thermometers, magnifiers and simple balances, to improve observations and keep a record of the observations made.	
Strand 4: Life Science	Substrand: *Structure and function in living systems*
3.4.1.1 Living things are diverse with many different characteristics that enable them to grow, reproduce and survive. • Benchmark 3.4.1.1.1: Students will compare how the different structures of plants and animals serve various functions of growth, survival and reproduction.	

Mathematics (MDE, 2007)

Strand 1: Numbers and Operations	
3.1.2: Add and subtract multi-digit whole numbers; represent multiplication and division in various ways; solve real world and mathematical problems using arithmetic.	

• Benchmark 3.1.2.2: Use addition and subtraction to solve real-world and mathematical problems involving whole numbers. Use various strategies, including the relationship between addition and subtraction, the use of technology, and the context of the problem to assess the reasonableness of the results.
3.1.3: Understand meanings and uses of fractions in real-world and mathematical situations. • Benchmark 3.1.3.1 Read and write fractions with words and symbols.
Strand: Measurement
3.3.2: Understand perimeter as a measurable attribute of real-world and mathematical objects. Use various tools to measure distances. • Benchmark 3.3.2.3: Measure distances around objects.

Social Studies (MDE, 2011)

Strand: Economics	Substrand: *Fundamental Concepts*
3.2.3.5 Individuals, businesses and governments interact and exchange goods, services and resources in different ways and for different reasons; interactions between buyers and sellers in a market determines the price and quantity exchanged of a good, service or resource. • Benchmark 3.2.3.5.1: Explain that producing any good or service requires resources; describe the resources needed to produce a specific good or service; explain why it is not possible to produce an unlimited amount of a good or service.	
Strand: Geography	Substrand: *Geospatial Skills*
3.3.1.1 People use geographic representations and geospatial technologies to acquire, process and report information within a spatial context. • Benchmark 3.3.1.1.1: Use maps and concepts of location (relative location words and cardinal and intermediate directions) to describe places in one's community, the state of Minnesota, the United States or the world. • Benchmark 3.3.1.1.2: Create and interpret simple maps of places around the world, local to global; incorporate the "TODALS" map basics, as well as points, lines and colored areas to display spatial information	
	Substrand: *Human Systems*
3.3.3.6 Geographic factors influence the distribution, functions, growth and patterns of cities and human settlements. • Benchmark 3.3.3.6.1: Identify landforms and patterns in population; explain why human populations are unevenly distributed around the world.	
Strand: History	Substrand: *Historical Thinking Skills*
3.4.1.2 Historical inquiry is a process in which multiple sources and different kinds of historical evidence are analyzed to draw conclusions about how and why things happened in the past. • Benchmark 3.4.1.2.3: Compare and contrast various ways that different cultures have expressed concepts of time and space.	

3.4.1.3 Historical events have multiple causes and can lead to varied and unintended outcomes. Benchmark: • Benchmark 3.4.1.3.1: Explain how an invention of the past changed life at that time, including positive, negative and unintended outcomes.

Hopkins School District Standards

Hopkins Public Schools Grade 3 Chinese Language Arts (2011)

Reading

Reading Skills	
• Use knowledge of radicals and the form and structure of characters to decode the form and meaning of unfamiliar characters • Use context clues to determine the meaning of unfamiliar characters • Understand Chinese character relationships: synonyms, antonyms, homonyms • Read aloud grade-level texts fluently and with appropriate intonation, expression and pacing	
Reading Comprehension	
• Recall and use prior learning and previews text using title, headings and illustrations to prepare for reading • Generate and answer literal, inferential, interpretive and evaluative questions to demonstrate understanding about what is read • Retell, restate or summarize information orally, in writing, and through graphic organizers • Infer and identify main idea and relevant details in texts • Monitor comprehension and use strategies to self-correct when needed • Follow three-step written directions	
Active Engagement in the Reading Process	
• Identify literary elements of characterization, plot, setting and theme	

Writing

Writing Skills	

• Mechanics/sentence structure/grammar
  • Punctuate correctly using periods, question marks, exclamation marks
  • Recognize a complete sentence in written and oral expression, states a complete thought, expands and joins sentences
  • Recognize parts of speech: nouns, pronouns, verbs, adjectives
• Paragraph format
  • Begin to write a multiple paragraph essay using a structured model and teacher guidance	

Writing Composition Strategies	
• Develop the traits of writing: ideas, organization, sentence fluency, word choice • Apply the writing process: pre-writes, drafts, revises, proofreads and publishes • Write in three or more of the following modes: personal narrative, instructions, fictional story, research report, description • Write to learn: including journal writing, reader response, interdisciplinary writing (writing in all core content areas in the third grade curriculum), student-selected topics and prompt writing	

Listening and Speaking

Listening Skills	
• Understand classroom instructions in Chinese • Understand Chinese vocabulary related to the third grade curriculum • Understand stories in Chinese with some contextual support • Understand content area concepts in math, science, engineering and social studies in Chinese with contextual support • Develop and apply speaking skills • Read texts aloud fluently that are related to the third grade curriculum in both Chinese characters and pinyin • Use Chinese to ask and answer questions on familiar topics related to the third grade curriculum • Use Chinese in social conversations with classmates and teachers communicates needs, personal experiences, opinions, and ideas in classroom discussions in all core content areas (Chinese language arts, math, science, engineering and social studies) • Present oral reports • Retell stories	
Speaking Composition Strategies	
• Apply sound-symbol correspondence to correctly pronounce words in pinyin • Read texts aloud fluently that are related to the third grade curriculum in both • Chinese characters and pinyin • Use Chinese to ask and answer questions on familiar topics related to the third grade curriculum • Use Chinese in social conversations with classmates and teachers • Communicate needs, personal experiences, opinions, and ideas in classroom discussions • Present oral reports • Retell stories	

Unit-Level Goals:

Potential Enduring Understandings and Essential Questions:

Enduring Understandings: Students will understand that…

1. We can observe and learn from nature to help us solve problems.
2. Failure is the mother of success. 失败乃成功之母。
3. Each organism has its own way to fulfill basic needs.
4. Engineers and scientists use specific methods to solve problems and to learn about the world.
5. Everything that we create to solve problems is "technology." (Museum of Science, 2008, p.36)
6. People transfer and apply knowledge from one context to another. 学以致用。
7. Bioengineers use what they know about biology to solve problems that living things might have.
8. Cultural practices, products and perspectives vary from country to country.
9. There is power in teamwork. 团结就是力量。
10. A membrane is a thin protective layer that lets some things through and blocks others.
11. Humans impact the environment, sometimes positively and sometimes negatively.

Essential Questions: Students will ask…

1. How can observing nature help us solve problems?
2. How can we learn from our mistakes?
3. How do living organisms meet their basic needs?
4. What methods do engineers and scientists use to learn solve problems and learn about the world?
5. What is technology?
6. How can what we learn in one situation help us in another?
7. What is a bioengineer?
8. How and why are countries the same or different?
9. How is teamwork valuable?
10. What is a membrane—what are its characteristics/properties?
11. How do humans impact the environment?

Knowledge and Skills:

Chinese Language Arts

Knowledge/Understandings	Essential Skills
• Language has rules • Key phrases for addressing a letter to an adult (e.g., greeting, suitable use of pronouns, closing) • Sentence patterns for describing, making comparisons, giving suggestions/commands, predicting • Cause-effect connectors (e.g., because of-therefore/so vs. state reasons-tell conclusion) • Classifier-noun alignment • Question formation • Vocabulary related to basic needs, animal body parts and functions of these parts, object/tool and their functions, professions and their duties, the sport of soccer, map concepts, steps in the EDP and Scientific Method, etc. • Sentence stems related to the functions of predicting, analyzing relationships between ideas and concepts, identifying similarities and differences, evaluating results, expressing agreement, disagreement, negotiating consensus, stating and supporting opinions and ideas, etc. • Formation of similes • Character formation for vocabulary in use • Comparative and superlative adjective formation • Adverbs of degree, quantity, location, etc.	• Make use of metalinguistic skills • Comprehend and retell the "Juan Daniel's Fútbol Frog " story • Express opinions about the characters and plot of the story • Write a register-appropriate letter that describes and explains their model membrane design process and the effects of any improvements/changes • Predict meaning of unfamiliar characters with help of semantic radicals and context clues • Maintain written reflections and records in their science journals • Present, discuss, and report on their experiences using with designing a model membrane using correct measure words with appropriate nouns • Compare/contrast the first model membrane design with "improved" design • Use sequencing words to retell events in various chapters of the Juan Daniel story and to sequence the steps in the EDP and the Scientific Method • Make predictions about story events, results of raisin experiment and the relative efficacy of testing materials • Explain what worked and what did not work in their model membrane design and why they think this happened • Use correct word order to describe basic needs of different animals (placement of time/place phrases, modifying phrases, etc.) • Use listening comprehension skills and context clues to comprehend meaning of story read alouds • Use social interpersonal language for negotiating tasks and carrying out assigned group roles

Science and Engineering

Knowledge/Understandings	Essential Skills
• Basic needs of all animals and human beings include food, water, shelter and air • Animals and plants have different body parts or structures that serve particular functions, such as locomotion, navigation, feeding, drinking and protection, etc. • Animals have to live in a suitable environment • Frogs get the majority of their water by absorbing it through their skins • Frog skin is called a membrane and frogs use their membranes for water absorption and protection • The characteristics and properties of a membrane and a model • An engineer uses his/her knowledge of science, math, and creativity to design new objects or develop new processes to solve problems (Museum of Science, 2008, p.36). • Scarcity affects human resource management • The Engineering Design Process includes the following five steps: Ask, Imagine, Plan, Create and Improve • The Scientific Method includes the following five steps: Ask questions, make hypothesis, test hypothesis, analyze results and report conclusion/new finding • Everything that is created by people to solve everyday problems is "technology"	• Describe and classify living things by characteristics, behaviors and basic needs • Observe and describe materials by their properties, e.g., color, size, texture, etc. • Construct definitions of membrane and model using the Frayer concept model • Carry out the five steps of the Engineering Design Process (EDP) with model membranes • Carry out the steps of Scientific Method with the raisin experiment • Collaborate with others to design the model membrane • Interpret data and set up hypotheses for factors of membranes • Define and distinguish between engineers, scientists, and technology

Math

Knowledge/Understandings	Essential Skills
• Fractions, decimals, units of measurement, space (area), size (population)	• Estimate size/ relative area • Use tools to measure units of liquid volume

Social Studies and Culture

Knowledge/Understandings	Essential Skills
• The relationship between practices/products and perspectives in Chinese-speaking world and other cultures • Geographic representations and mapping, regional variety and climate differences • Community relationships and professions • Scarcity and resource conservation • Culturally-appropriate writing	• Compare and contrast cultural practices/ products/perspectives and geographical locations among El Salvador, the US and China • Use and interpret maps and concepts of location (cardinal rose, latitude and longitude, equator, etc.) to describe places in the world • Distinguish the geographic and climatic differences between "rain forest" and "a hot, dry place" and give the reasons why certain kinds of animals, plants and insects live in these areas • Distinguish between the roles and responsibilities of various story characters and professional community members, e.g., an engineer, a bioengineer, a scientist, a restaurant owner, and a team captain • Explain the importance of water conservation in El Salvador • Distinguish between formal and informal email writing styles in Chinese

EVIDENCE OF LEARNING

Unit Level (Summative):

Integrated Performance Assessment (IPA)

The comprehensive Integrated Performance Assessment (IPA) is designed to provide students an opportunity to demonstrate interdisciplinary content and language understandings and skills. A series of interrelated language-dependent tasks will elicit knowledge gained during this unit in the disciplines of science and engineering, social studies/culture, math, and Chinese language arts. The tasks will also invite reflection and critical thinking about the Juan Daniel narrative, the Salvadoran/Chinese/US cultures and student experiences with the model membrane design process.

Lesson and Unit Level (Formative):

Lesson handouts and worksheets
Graphic organizers
Science/ Engineering journal entries
Working groups' model membrane designs
Observed student-student and student-teacher interaction
Reflection on group work

Professional Curriculum Development References and Resources

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