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A curriculum design for emergent English language learners in middle school science

Allison Simpson
Otterbein University, asimpson1814@gmail.com

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Otterbein University

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Dr. Paul Wendel	______________________________	_______________
Advisor	Signature	Date
Dr. Sue Constable	______________________________	_______________
Second Reader	Signature	Date
Dr. Daniel Cho	______________________________	_______________
Third Reader	Signature	Date

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VITA

Teaching Experience

2014-Present	6th Grade Science Teacher Walnut Springs Middle School Westerville, Ohio
2010-2013	Middle School Science Teacher St. John's Lutheran School Marysville, Ohio

Education

2019	Master in Education of Arts Reading Otterbein University Westerville, Ohio
2008	Bachelors of Science in Education Middle School Math and Science Bowling Green State University Bowling Green, Ohio

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ABSTRACT

The purpose of this Capstone project is to design a curriculum for emergent English Language Learners (ELLs). This subgroup of students typically comes from a different educational background and speaks a different native language than native English-speaking students. This presents a challenge for educators to include modifications to their current curriculum. While most curricula include modifications for educators to use, they are usually not at the level Emergent ELLs need to be successful in the classroom. This curriculum focuses on emergent level students in the middle school science classroom. The research question is *How do we meet emergent ELL students at their level in the middle school science classroom?* Through my research I found in the literature review the most effective frameworks Sheltered Instruction Observation Protocol (SIOP), 5E Model, and includes the Inquiry-Based Learning approach. Five specific needs featured within this curriculum include prior knowledge, frontloading information, vocabulary, higher-level comprehension, and connecting language and content standards. These frameworks provided the structure of the lessons and the five specific needs were addressed in each lesson, creating an effective, research-based, emergent-level middle school science curriculum.

SECTION ONE

This curriculum design project was created for emergent English Language Learners (ELLs) who have come into a middle school science classroom from a different educational background than the native English-speaking student. This is a subgroup of students who are new to the country, knowing little or no English, and have a variety of educational backgrounds.

They bring cultural differences to the classroom that challenge successful learning in grade-level content.

An emergent ELL is defined as a student who receives direct, daily services or is monitored as needing services based on their achievement on academic assessments (Garcia, Kleifgen, Falchi 2008). Emergent ELLs have educational needs that require direct instruction of language-based lessons, activities, and leveled texts to support their success. Such students may have gaps in their learning due to either interrupted education or being taught different standards at different levels, in addition to a language barrier, so they tend to struggle more than the average middle school student to keep up with the pace in a classroom where lessons are taught in English.

As a middle school science teacher, I have seen my students struggle with science concepts because of the language barrier. Some know the concepts and some do not, but they struggle in explaining what they know in English. I used a district-given curriculum for emergent ELLs but I saw that their needs were not being met and grade-level science content standards that were being taught did not go in depth enough. The curriculum did not provide strategies for me, the educator, to help close these gaps or enough support to reach the depth of the science concepts. Through my personal trial and error and with the research from this project, I have discovered what would help make ELLs the most successful in the classroom. Since the curricula that was provided to me were not meeting the needs of my students I wanted to create my own curriculum, to provide support for both the educator and learners.

Our district also has a grade-level curriculum which might be attainable to the typical middle school students; however the curriculum is inaccessible and overwhelming for newcomers and emergent English Learners. The problem is that most middle school science curricula assume native English fluency and background knowledge and lack the materials to support a regular classroom teacher to modify materials to provide appropriate interventions. There is a great need to provide non-native English speaking students with a curriculum that is within their ability to understand while being taught in the English language. There is also lack of student support materials and connections to the science and language standards. Students need to have the ability to become successful, independent, and confident in every classroom and this curriculum will be designed to do just that. Since having to teach a co-taught emergent level ELL class in the past five years I have created and searched for the perfect curriculum, activities and assessments but have had to change it every year. I noticed that each year not only are the student dynamics different, but the amount of background knowledge was different and reading and writing skills were different.

As any educator knows, each year brings a new group of students with different abilities that require modifications or adaptations to our lessons and assessments to new students. The changes that I make every year are a re-creation of a curriculum to help provide background, add grade-level content that students need to know, and find the best ways to present information and assess what they know. I not only modify the grade-level content but also include the most critical information, inferred by the elementary standards, to build their background knowledge. It was challenging to choose the most critical information to build on so that the students were successful when we moved into the sixth grade science content.

The present curriculum will be connected to the grade-level academic science vocabulary and language standards. This curriculum design project will explore, with literature review, the ways emergent ELLs can be successful in a science class. It will also help the educator understand the sequence to teach the standards, including background knowledge needed to support learners, the scope used to see the overall goals, and modifications that can be made in each lesson to support this specific population of learners. This curriculum will be based on the newest Ohio Science Standards (2018), research-supported teaching strategies, and teaching experience.

Having a curriculum that is more refined for ELLs would help make accommodations easier to build up to more challenging concepts and vocabulary. The modified curriculum for ELLs that I intend to create could be modified, or expanded on, depending on the students that year. I am incorporating lessons that have instructional frameworks such as the 5E model, the SIOP model, and inquiry-based learning. The 5E model and inquiry-based learning approach have aspects of engaging students to understand scientific concepts through discovery learning. The SIOP model is structured to help guide the educator in providing the needed language support for students. These specific models have been chosen because they are supported by studies that show significant growth for learners.

In this curriculum I will provide a variety of support materials such as leveled texts, differentiated activities, making explicit cross-curriculum connections, and alternative assessments. For example, reading informational text independently, doing collaborative work with classmates, and using projects and objectives to make stronger cross-curriculum connections will give students the ability to show mastery of grade-level standards. Furthermore, encouraging students to use their native languages can lead to higher levels of comprehension. The purpose of having these things within the curriculum is to give the educators a starting place that is appropriate for emergent ELLs. The research question that guides this capstone project is how do we meet emergent ELL students at their level in the middle school science class?

SECTION TWO

Literature Review

Understanding the Population of Emergent Learners

In our ever-changing world and students within our classrooms one thing is sure, school districts in the United States have a growing population of diverse English Language Learners (ELLs). Lara-Alecio, Irby, Tong, Guerrero, Koch, and Sutton-Jones (2018) identify ELLs as students who are learning the English language within the school setting but speaking a native language, other than English, at home. This population of students come to the U.S. speak a language other than English, and are learning the English language in school, at the grade-level age in which they enter the system. They face the challenge of learning a content subject, such as science, while developing their English language and literacy skills (Song, Higgins, & Harding-DeKam, 2014). Seeing a classroom full of students with a variety of languages being spoken and students can embrace cultural and linguistic diversity. With this change, we see the need to have a curriculum to best meet the needs of this diverse population.

The data confirms that the nonnative English-speaking population is rapidly growing in the United States (NCES, 2018). From the fall of 2000 to the fall of 2015, there was an increase from 3.8 million ELL students, or 8.1 percent, to 4.8 million ELL students, or 9.1 percent

(NCES, 2018). Overall, the trend we see in the population of ELLs is that there's a definite steady increase and is growing at a faster rate (increasing 84% from 1992 to 2003; Echevarria, Short, & Powers, 2006) than the English-speaking student population in our schools (Garcia, Kleifgen, & Falchi, 2008). This becomes a challenge in a diverse classroom of what to teach and how to teach.

The No Child Left Behind Act[1] (NCLB) refers to limited English proficient students (LEPs), identified as students who are unable to perform proficiently on State assessments (Garcia et al., 2008). Educators are in the middle of high-demand test scores and are challenged to truly understanding how to develop a teacher-student relationship with cultural sensitivity and to use best teaching practices to reach students (Echevarria, Short & Powers, 2006). The NCLB act of 2001 also provides federal dollars to states, which dispersed to the local school systems, to the largest increase ever for Title I and Title III funds (Echevarria et al., 2006). The Title III funds are specifically for English Language Learners (Echevarria et al., 2006). This funding acknowledges the demand of improved education for this specific population.

The academic achievement of ELLs significantly behind that of their English-speaking peers (Echevarria et al., 2006). NAEP data shows that the percentage of 8th grade ELLs who are proficient in reading is at 4% and proficient in math is at 6% (Garcia et al., 2008). The data shows the gaps between native and non-native English speaking students, which can lead to lower graduation rates, higher dropout rates, and frequently placement in lower ability groups (Echevarria et al., 2006). It is crucial that the education being provided for ELLs includes most

[1] NCLB act has been updated to Every Student Succeeds Act (ESSA) by the U.S. Department of Education (2019).

effective teaching strategies and best practices for subject areas because we need to be educating these students in a different way.

Students in this population are inconsistently reported in state data. The NCLB requires each state to report the number of students who are identified as ELLs and requires students who receive direct daily services to be included in that number (Garcia et al. 2008). However, each state determines the definition used when describing their population of ELLs. This can lead to inconsistencies when comparing data from state to state, or even districts within the same state, partly because the reports made by the state do not include the mechanisms used to come up with their identifications. The U.S. Department of Education should help guide the states and districts in providing consistent and accurate testing for identifying these students and alleviate any confusion between states and districts.

Since criteria by state and sometimes by district vary, the assessments that are used are to provide tangible data to identify students are inconsistent. Current assessments used for identifying ELLs are the Language Assessment Scales (LAS), the IDEA Language Proficiency Tests (IPT), and the Woodcock-Munoz Language Survey (Woodcock-Munoz) (Kindler, 2002). The assessment system that is used in Ohio is the Ohio Language Proficiency Assessment, or the English Language Proficiency Assessment for the 21st Century, ELPA21. Ohio is one of seven states that use this system to determine and measure ELL abilities as well as inform evaluation practices of this subgroup (English Language Proficiency Assessment for the 21st century, 2017). Other pieces of information are also included such as a home language survey, where families are asked about their spoken language at home, whether they are proficient in English themselves, school achievement of their child, and informal & formal teacher assessments

(Garcia et. al., 2008). When students are reclassified, or reevaluated, more data is collected by the teachers and their judgements of the abilities of students are also included to help future evaluators understand each student's unique ability.

NCLB Title III requires school districts and teachers to come up with achievement objectives and to provide a language instruction curriculum that is research-based (Flynn & Hill, 2005). In the process of educators identifying the best objectives and instructional curriculum many of the initial ideas have changed. Educators previously believed that students needed to master the English language before entering a content specific classroom but the students were then only having basic English skills and no content-specific language background (Nargund-Joshi & Bautista, 2016). With this challenge, we see teachers who have not been trained or have had experience with this population. These teachers require additional skills, including the curriculum, lesson planning, and knowing their students' backgrounds. Lack of preparation for teachers working with this population can lead to educators feeling inadequate in their abilities to reach the needs of ELL students (Flynn & Hill, 2005).

Providing Sheltered Instruction for English Learners

When English Language Learners (ELLs) are tested in Ohio, using the OELPA, it includes four domains to determine their overall performance level as Proficient, Progressing, or Emerging (ODE, 2017). This assessment is taken each year until the student is exited by reaching Proficient in each of the four domains (ODE, 2017).

Students identified at the emergent level are provided sheltered instruction (where students have small class sizes that are focused on certain reading or language targets) until they can enter the regular education classroom. Immigrant students come from a wide range of educational backgrounds, from strong academics to very limited formal schooling (Echevarria, Short & Powers 2006). Student achievement on mandatory high-stake testing, taken in English, shows a significant achievement gap from their native English-speaking peers (Short, Fidelman, & Louguit, 2012). This gap shows the need for accommodations, such as sheltered instruction, to address these needs (Short et al., 2012). Sheltered instruction provides educators with various instructional strategies for teachers to implement within their content (Verma et. al., 2008) to support learners in speaking and understanding the English language fluently within a classroom (Verma, Martin-Hasen, & Pepper, 2008). The typical sheltered instruction classroom can look different depending on the district needs, enrollment, and teacher education and preparation. Sheltered instruction generally refers to a core subject that is taught in English using grade-level content incorporating specialized strategies (Echevarria, et al., 2006) since there are mostly English Language Learners in the class (Short, Echevarria, & Richards-Tutor, 2011). I will be presenting two types of models used in classrooms that are specifically designed for ELLs.

Sheltered Instruction MALP (Mutually Adaptive Learning Paradigm)

One type of sheltered instruction is the Mutually Adaptive Learning Paradigm (MALP) for teaching ELLs or students with limited English proficiency and formal education (DeCapua and Marshall, 2011). MALP is commonly used to help catch up ELLs to their native English speaking peers in subject areas while developing academic language proficiency and literacy skills (2011). This instruction helps to facilitate the transition for this population from their country to the U.S. schools, which helps guide the educator in providing lessons within the three specific areas.

The first area of instruction is immediate relevance, emphasizing the importance of education to the student and their native culture (DeCapua & Marshall, 2010). MALP proponents explain that creating a sense of understanding and learning from one another enables interconnectedness to the other students and teachers in the class. Educators know that connecting curriculum to real-life situations help learners have the sense of meaning of what they are learning.

The second area is identified as the oral and written modes of learning, with shared and individual accountability (DeCapua & Marshall, 2010). This strategy of presenting information in the classroom is where they combine the students' learning paradigms with the U.S. learning paradigm (DeCapua & Marshall, 2010). The U.S. educational system focuses on individual accountability, whereas some ELL cultures focus on collaboration and helping each other learn (DeCapua & Marshall, 2010). Mixing these approaches helps guide students to prepare for the U.S. educational system.

The third area focuses on academic tasks, which promotes the building of their critical thinking skills (DeCapua & Marshall, 2010). The educator needs to provide scaffolded lessons to incorporate the academic tasks and to help provide needed support for ELLs. The support provided would include familiar language and content with scaffolded alternatives (DeCapua & Marshall, 2010). This is the combination of their prior ways of thinking and forming their own new academic ways of thinking (DeCapua & Marshall, 2010). Each of these three parts, which are immediate relevance, oral and written modes of learning, and the academic tasks, have a critical role in this model.

Another general aspect of this teaching strategy identifies the norms within the U.S. schooling system, called the Western-style model of education that the typical U.S. student has learned while going through schooling. The western-style model is a certain way schools function, from the time frames students are expected to be there, how and where to write their class notes, and when they can collaborate with classmates. This model designates when students are in school, how long each class should be, and when their lunch will be during the day. During class time students are expected to ask to leave the classroom to use the restroom, and not just to leave. Students are expected to bring supplies to class, such as a folder, paper, notebook and pencil, or to ask for supplies when needed. During class time there are appropriate times to work with a partner and other times, like during assessments, that students are expected to work independently. There are some regularly used graphic organizers that students are expected to understand what they represent and how they're used such as Venn diagrams, T-charts, and other graphics to provide a main idea with supporting details.

The MALP model combines best practices for this population which helps promote a positive climate and instructional effectiveness within the classroom (DeCapua & Marshall, 2011). This model also supports the two main types of cultures that ELLs grew up knowing, individualistic or collectivistic culture (DeCapua & Marshall, 2011). Using this model gives the teachers some background understanding on how to support their diverse learners and to view learning as a condition, process, and within activities.

There was a study conducted in a suburban high school outside of New York City, where about 90% of students are minority and 75% receive free or reduced-price lunches (DeCapua and Marshall, 2010). In this period of five months, the teacher included an intervention guided by the MALP method. The results showed an increased ability to understand print and use graphic organizers on their own to identify important facts within a text. They were also able to independently respond to guided questions, developed academic thinking, and were able to navigate through internet-based print (DeCapua and Marshall, 2010).

This model focuses the learner on new concepts and academic tasks that they are learning for the first time (DeCapua and Marshall, 2011). This is a powerful reminder that when teachers do something in our classroom for non-native English speaking students, it’s important to provide activities that create a sense of interconnectedness with known information before diving into our curriculum. Educators need to use what our ELLs bring with them to guide their lessons in teaching them new information.

Sheltered Instruction Implementing the SIOP Model

The second type of sheltered instruction is the Sheltered Instruction Observation and Protocol (SIOP) model. This method is a cyclical process that allows researchers and project teachers to design, use, analyze, and then redesign features to support best practices (Echevarria, Short & Powers, 2006). This model was originally made as a research observation instrument (Echevarria et al., 2006), which then evolved into lesson plan guidelines, fostering a meaningful change within practices, delivery, and techniques (Short et al., 2012).

The SIOP Model includes strategies that integrate language with content knowledge and the scaffolding of instruction to provide needed support for learners (Echevarria et al., 2006). This method helps teachers that are in mainstream classrooms to guide their instruction, specifically for ELLs (Nargund-Joshi & Bautista, 2016). It also provides a systematic way of examining features of instruction that will help support ELLs. Some of these features include the pace at which the information is being presented, the vocabulary being used in the presentation of new information, clear images and texts that are not cluttered, and other pieces that provide literacy instruction in content areas (Echevarria et al., 2006).

The Echevarria, Vogt and Short (2008) SIOP model explains the different components and their connecting features. Each feature is outlined in Table 1 which explains how each of those features should look in a lesson and classroom. Teachers prepared and trained in using the SIOP method look at these components to provide structured instruction when implementing this method.

Using this framework provides educators with strategies and techniques to deliver high quality instruction and makes the information accessible for all ELLs (Short et al., 2011). Many studies have been done, with over 10 years of revisions and improvements, indicating a positive effect for ELLs (Short et al., 2011). The ideal curriculum would combine best teaching strategies for both language and science, but this curricular step has not yet been taken.

Table 1. Components and features within the SIOP method (Echevarria, Vogt and Short, 2008)

Components	**Features**	**Description(s)**
Lesson Preparation	Content Objectives, Language Objectives, Appropriate Content Concepts, Supplementary Materials, Adaptation of Content, and Meaningful Activities	These features provide insight for which goals are appropriate for their age and educational background.
Building Background	Concepts Linked to Students' Background, Links between Past Learning and New Learning, Developing Key Vocabulary: Academic Language	The features here help the educator make connections to prior knowledge and emphasize key vocabulary for specific lessons.
Comprehensible Input	Appropriate Speech, Clear Explanation of Academic Tasks, A Variety of Techniques Used	Using different levels of English proficiency to explain step-by-step instructions.
Strategies	Learning Strategies, Scaffolding Techniques, Higher-Order Questioning	Providing many techniques, learning opportunities, and different leveled questions or tasks for students to master a concept.
Interaction	Frequent Opportunities for Interaction, Grouping Configurations, Sufficient Wait Time, and Clarifying Concepts in L1	Providing students time to practice elaborating their responses and varying group configurations allows students the opportunity to discuss and process the information. Having concepts explained in their first language (L1) supports the understanding of key concepts that otherwise are taught in English.
Practice & Application	Hands-On Practice with New Knowledge, Application of Content and Language Knowledge in New Ways, Integration of All Language Skills	Manipulatives and activities provide ways for students to apply new language skills and content knowledge.
Lesson Delivery	Content and Language Support During Lessons, Promote Student Engagement, Pace Lesson Appropriately	Communicating clear learning objectives for both the content and language development, keeps the goals clear throughout the lessons and finding a pace which keeps the interest of students.
Review & Assessment	Key Vocabulary, Key Content Concepts, Regular Feedback on Student Output, Assess Student Comprehension of Objectives	Using a variety of techniques to support the review of key vocabulary and content concepts. Educators can provide clarification to students' output of their understanding which is an ongoing process.

Many studies have been done using this method, which has helped it become more successful and has shown significant differences in student achievements (Echevarria et al., 2006; Short et al., 2011; Short et al., 2012). One study was conducted over a two year time frame in New Jersey, where two districts were chosen, one as the treatment and one as the comparison district (Short, Echevarria, & Richards-Tutor, 2011). The teachers in the treatment district had professional development in SIOP and incorporated that framework, while the comparison district teachers did not have the SIOP professional development (Short et al., 2011). The academic literacy data collected in this study was from the IDEA Language Proficiency Tests (IPT), which is a state standardized assessment (Short et al., 2011). After two years, the treatment group's mean score for oral proficiency was significantly higher than the comparison (4.00 vs. 3.66; $p = 0.004$, $d = 0.29$; Short et al., 2011). Similarly, the treatment group's mean score for writing proficiency was significantly higher than the comparison (4.32 vs. 4.02; $p = 0.002$, $d = 0.31$; Short et al., 2011). As for the reading proficiency scores, statistical significance was not reached (Short et al., 2011). These results show that SIOP-trained teachers have a more positive impact on English language proficiency within the ELL content classes in all subject areas (Short et al., 2011).

The SIOP method is a framework for ELLs to focus on the language aspect of a lesson, and to support this focus in the content areas. For the purposes of this project, it is necessary to look at the best framework for teaching science. When we look at individual classrooms across the disciplines, each classroom will look different in many ways. In a science classroom, we might see students experiencing hands-on learning, which lends itself to a framework for science that is inquiry-based.

Teaching With Inquiry-based Science Instruction

Inquiry-based learning (IBL) is a process where students are engaged in investigating and using higher-level thinking to make meaning of concepts being learned, specifically in the science classroom (Gomez-Zwiep, Straits, & Topps, 2015). This form of introducing new concepts promotes the creation of background knowledge, experience, and allows for students to use the process of argumentation and collaborative inquiry through inquiry-based lessons. This instruction is a scaffolded sequence of tasks that are student-centered and is a type of instruction that is continuously evolving for students' needs and interests (Ernst, Hodge, & Yoshinobu, 2017). Engaging students and their curiosity is key to learning, and yet, when we use grade-level textbooks there is a high vocabulary demand which can lead to a loss of interest (Groves, 2016). Using IBL will promote engagement and the use of academic language in students' explanations of what they are experiencing.

Another way educators can use IBL is by relating language to sensory motor activities and physical context, which provides other ways of communicating a concept that is being taught. With this way of teaching we are engaging students to explore scientific concepts that are linked to hands-on activities with naturally occurring events in the environment, so this is less dependent on mastery of the English language (Lee, Maerten-Riviera, Penfield, LeRoy, Secada, 2008). Students benefit in many ways from this approach, where they can connect inquiry science to their formal development of the English language.

Inquiry-based learning (IBL) in the science classroom is well supported by research as an effective way to engage and educate learners (Song, Higgins, and Harding-DeKam, 2014).

Sixty-one studies were included in a meta-analysis of research on the best teaching practices and the effects on student achievement in science (Schroeder, Scott, Tolson, Huang, & Lee 2007). This meta-analysis included eight categories that the 61 students were divided and effect sizes were included to see the significance (Schroeder, et al., 2007). This analysis provided evidence to support the most effective teaching strategy for science, which was Enhanced Context Strategies with an effect size of 1.48 that related topics to experiences to engage students (Schroeder, et al., 2007). This teaching strategy included real-world examples through technology and field experiences. The next effective as Collaborative Learning Strategies, with 0.96 effective size, relating to group inquiry projects (Schroeder, et al., 2007).

Another study focused on the first year of a 5-year professional development intervention looking at science achievement of ELLs within urban elementary schools (Lee, et al., 2008). Pretests and posttests were given to all students in the treatment group to show their gains in science from the beginning to the end of the year (Lee, et al., 2008). The results showed a statistically significant increase in the treatment group, where the effect size for all of the students was 1.7 and for ESOL students in level 1 to 4 had an effect size of 1.4, when looking at the science test scores (Lee, et al., 2008). This supports the idea that IBL is highly effective with ELLs and is a type of instruction that should be implemented in the science classrooms.

Most ELLs are typically relegated to remedial instructional programs, where they are not exposed to grade-level academic content language, which results in them falling significantly behind their native English-speaking peers. Using inquiry-based science (categorized by student observations, experiments, and hands-on activities; Stoddart, Pinal, Latzke, & Canaday, 2002) is a powerful way to promote an authentic use of academic language. Providing authentic context to use scientific vocabulary is crucial for ELLs and is a more realistic way to study science, rather than memorized facts (Groves, 2016).

Inquiry-based science can be a powerful instructional context in which students learn academic content and language development for ELLs. This provides an authentic context for using academic science language and promotes students' literacy skills (Lara-Alecio et al., 2018). They need to provide predictions, hypotheses, explanations, and reflect on their understanding within these activities mentioned above. Educators will see their student's language skills grow when we provide opportunities to comprehend content and express their understanding of the material (Nargund-Joshi and Bautista, 2016).

Although IBL is an effective way to teach students new concepts in science, there are challenges in this teaching approach with students who are not familiar with the English language (DeCapua & Marshall, 2011). Educators may assume students are familiar with the U.S. educational expectations without support. It can be a struggle when you start teaching a lesson and only a couple of students know what you're referring to, such as talking about a common place, like the grocery store, or popular candy, like skittles. These may not be common for our ELLs and as educators we try to anticipate what our students know coming into the classroom. The ELLs in our classrooms typically do not have an understanding of common English terms to understand what we are saying.

Teachers need to be aware of when to support students in their learning and teach explicitly certain parts within lessons and activities where needed (Fradd & Lee, 1999). This support can be explaining the common candy being used in an experiment or explaining a concept in 6th grade that is usually covered in a 3rd grade classroom. A typical native English-speaking classroom would need less guidance and background knowledge support which would lead into the IBL framework or a self-guided, investigative learning process. While teachers provide needed support, they should promote inquiry learning with a sense of discovery in science, where there are clear learning outcomes, for an effective approach (Bergman, 2013). The goal when using the IBL approach is for the teacher to become more of a facilitator in the learning process. They should provide only the necessary background knowledge, like prior key concepts and vocabulary to be used as the building blocks to support ELL investigative learning (Fradd & Lee, 1999). Allowing ELLs to explore science vocabulary and concepts will help them become more motivated and to refine their language skills which is the key goal that supports this framework.

Integration of Language and Inquiry into the Emergent Science Classroom

Students, both native English-speaking students and ELLs, who make cross-content connections will have a stronger understanding of the concepts being presented when there is an integration of multiple content areas. This process is identified as interdisciplinary instruction (Stoddart et al., 2002), where educators can have a thematic unit where multiple subjects can play a role in the educational process for all learners. Another way to describe this is the big ideas in science where the focus is around real-life issues that are intriguing, and allow students to connect the science content and processes within science with other areas of their learning (Lara-Alecio et al., 2018). This concept of a big idea is that students are given an idea that branches into different areas of science (Lara-Alecio et al., 2018). ELLs need to have grade level content in their subject areas, and we should see this as an opportunity to provide support in learning the English language while they are learning the subject material.

Providing a science-language integration allows a deeper understanding of both the science content and the academic English language, where the language and content objectives are used to support one another (Bergman, 2013). Students in their science class can explain their experience within a lab, activity, or other physical context. IBL is one way to provide this integration, where the effective participation within IBL promotes language proficiency, literacy, and learning in general (Fradd & Lee, 1999). Integration can be perceived in a variety of ways in the eyes of educators. A model that science educators try to follow is the 5E Model.

This specific model includes the five Es which are: Engage, Explore, Explain, Elaborate, and Evaluate, which promotes a literacy-infused science curriculum (Lara-Alecio, et al., 2018). Within these five distinct steps teachers can modify their lessons to blend science inquiry-based investigating with formal English language development strategies (Gomez-Zwiep, Straits & Topps, 2015). The lessons are created in a sequence of concepts relating to science, language functions, and vocabulary, to provide learners with a way to develop language skills in a meaningful and useful way (Gomez-Zwiep et al., 2015). Teachers can also think of ways to include differentiating assessments where they are embedded throughout the 5E lessons, or where they can include written and oral forms of assessments. The idea is to have the assessments be less language dependent, such as drawing, completing graphic organizers, and manipulating materials to show mastery of the concepts (Gomez-Zwiep et al., 2015). This 5E framework provides ideas to modify science lessons and assessments to help overcome the language barrier that ELLs face in the U.S. schools.

Specifically Designed Science Curriculum for ELLs

To drive student success we need the curriculum to be relevant and build on students' prior knowledge. Including real-world and interesting concepts in science helps motivate and intrigue students to learn and use science terminology (Lee, et. al., 2008; Stoddart, et. al., 2002). This approach is essential for effective instruction, and it needs to include high-quality materials that meet current science standards. Modifications can be made to current curricula being used in schools, but working with Emergent, level 1, students these modified curricula are typically still too challenging. The typical modifications do not allow for building of the amount of prior background knowledge, alternative non-language based assessments, or language-based lessons that are needed for students to be successful (Gomez-Zwiep et al., 2015). The combination of the frameworks from the IBL and 5E model with the SIOP framework can support ELLs' language growth in the science classroom (Nargund-Joshi & Bautista, 2016). These are critical pieces and frameworks in a curriculum that will support the educator in helping all students, especially the ELLs, become successful in the science classroom.

Part of a student's ability to be successful in the classroom is the ability to do well on assessments. Thinking of assessments for science as an isolated fact-based set of questions does not represent the complexity of real-world science (Lara-Alecio, et al. 2018). We should not be teaching memorization and rote acquisition of vocabulary, since we want students to have a better understanding of science (Lara-Alecio, et al. 2018). We should allow students time in class to explore, investigate, and rebuild their understanding of science concepts (Nargund-Joshi & Bautista, 2016). Our assessments should reflect students' ability to connect their learning from the inquiry-based lessons and assess students the way the information was presented to them (Lara-Alecio, et al. 2018).

An example of implementing an inquiry-based science lesson uses M&M. While M&Ms are a common candy for native U.S. students, newcomers may be encountering them for the first time (Song, Higgins, & Harding-DeKam, 2014). Song et. al. recommend a series of lessons based on this candy. To prepare ELLs, these lessons begin with a trade book that talks about candy, then allows the teacher to provide more detailed information about the candy (Song et al., 2014). This example shows the background knowledge being provided for ELLs that wouldn't typically be provided for the native U.S. student. The teachers can use this experience to relate to the science vocabulary in an authentic way. Providing this experience helps ELLs prepare for new knowledge or to expand on what they already know.

ELLs come from diverse languages and cultures which are different from the typical U.S. student, which leads to the need of a curriculum that supports closing this gap. The curriculum is a guide in knowing what students should know, and where we need to lead them to be prepared for the years after. Curricula are built with the assumption that students are coming in prepared with prior knowledge to learn the new grade-level content and how the educational, or western-styled system works. ELLs will have different approaches to learning science, where the native English-speaking students traditionally relies on cultural examples and artifacts which may be unfamiliar to ELLs.

Knowing this, we need to build teaching norms into the curriculum where educators can support students in how to learn in the U.S.. We need to construct new knowledge to bring together students' lives, the science discipline, and the science classroom. This can be done by creating a science classroom where we explain how we see what collaborative work looks like, sounds like, and how this is related to what scientists do (Fradd & Lee, 1999; Lee, 2003). "For students who are not from the culture of power, teachers need to provide explicit instruction about that culture's rules and norms for classroom behavior." (Lee, 2005, p. 503). We need to approach this with instruction on both academic norms and academic content to gain the required knowledge that their peers have had in and out of school.

Native English-speaking students, who have grown up in the western-style educational system, are able to be given strategies and can work with less guidance on completing tasks. ELLs need more guidance and prior knowledge of how things work within a classroom. A sample strategy such as using children's books can help engage and spark a child's interest (Song et al., 2014). Using a strategy such as a read aloud supports comprehension, or interactive group work, to help build comprehension (Song et al., 2014). Specifically chosen texts that may reference popular culture stories can support language and literacy instruction for ELLs (Ciechanowski, 2009). Popular cultural references are ones that student may or may not be familiar with, so teachers need to know what additional support will be needed in that lesson. Language structures and thought processes can be analyzed to understand the scientific language and writing within the story (Ciechanowski, 2009).

Other strategies and tools can be used to help ELLs make connections within the science classroom, with both language and science concepts. Some of these strategies and tools include the use of graphic organizers and sentence frames giving students a starting place to understand new knowledge (Song et al., 2014). Having students use real-life objects and physical movement supports the opportunity to discover new vocabulary, specifically using new science vocabulary (Song et al., 2014). Students can use a science notebook to record their experiences and data during a lab, and can be introduced to physical pieces of materials being used for an investigation (Song et al., 2014). These suggestions are tools to support all learners in the science classroom as they investigate new science concepts.

When we look at both inquiry-based science instruction and the components of sheltered instruction, we can see that using these approaches together has promising benefits for ELLs. The curriculum that integrates Ohio ELP standards and the Ohio Science Standards (2018) has been done on a class-by-class basis, where each teacher is designing their own curriculum for this population. Teachers of ELLs have typically needed to recreate their curriculum because of the changing needs of their classes. The present curriculum addresses this problem by incorporating ideas to support this population and will specifically support emergent-leveled students. This curriculum will incorporate the two frameworks with both standards that will be a base for teachers to then make modifications when needed. It will be a curriculum where science provides the real-world content and purpose to use and strengthen language and literacy skills.

SECTION THREE

Curriculum Design Focus

When we look at curricula that are created for grade-level students, typical ELL modifications do not address some critical pieces to support ELLs in the science classroom. ELLs are faced with many challenges when they enter the U.S. school system. Some of the most critical needs categories are connecting to their prior knowledge, higher-level comprehension, frontloading information, vocabulary of grade-level content, and connecting science content to English language standards. Since ELLs are learning the English language, educators need to be aware that, in most cases, cognitive abilities are much higher than their level of English reading. ELLs have the potential to fall even further behind if we do not support their learning of both content and language skills (Stoddart, Pinal, Latzke, & Canaday, 2002). We want all of our students to be successful in the classroom and this curriculum is to help educators reach ELLs to support them in the appropriate ways to be successful.

Critical Needs Categories

Prior Knowledge

Providing background knowledge is crucial for ELLs of all educational levels to have this information to build on experiences (Bergman, 2013). Supporting students to receive new information can start with a class discussion on a general topic, where the teacher can step in and provide additional prior knowledge if needed. The teacher can help make the connection from the learner’s background to the concepts (Nargund-Joshi & Bautista, 2016). Then, giving students an opportunity to have an experience, such as a lab, can create an experience to make a strong connection to the topic being taught. When science lessons include prior knowledge or what students are familiar with, this can help promote a safe environment and increase motivation (Song, Higgins, Harding-DeKam, 2014).

Higher-level Comprehension

ELLs are learning both English and science content in the classroom. The educator needs to make sure there is no language barrier to understanding science concepts. Using diagrams, tables, and data that are not heavily language-based, will lead students to have higher-level thinking about those science concepts (Gomez-Zwiep, Straits, & Topps, 2015). Graphic organizers such as a Venn diagram are a great tool to visualize their understanding (Song, Higgins, & Harding-DeKam, 2014). Interpreting these different diagrams, tables, and data can support their understanding of the concepts being taught.

The expectation is that ELLs will be learning science content and develop their English language comprehension, which must be planned by the teacher to teach both simultaneously (Bergman, 2013). When focusing on higher-level comprehension educators should allow ELLs to communicate with peers of the same native language to support that higher levels of thinking. Teachers can plan to group students based on their native language to support the communication between peers about the content being learned. Having students make connections between new science vocabulary and concepts by using the activities to explain what they learned can help bridge that gap of explaining what they learned in English. Including hands-on activities and projects that will be formatted to help students' create curiosity and be challenged in their own thinking. Students should then be assessed in a similar way to explain their understanding based on how they learned the concepts.

Frontloading Information

Prior knowledge is when the educator strategically asks questions that help students to start thinking about what they already know about a certain topic. Frontloading refers to introducing concepts and vocabulary to prepare students for this new information. This approach connects to prior knowledge to the new concepts and vocabulary, where the educator can identify what the students have been exposed to before the current lesson. Since ELLs come to the classroom with different educational backgrounds, educators need to include extra support for frontloading information.

Structured lessons, where teachers are explicitly teaching the new vocabulary or concepts, are an important support for students. Providing information in this way, frontloading, will help guide ELLs through their learning experiences. Students will use activities help support their connections between past and present concepts and to organize their thinking when obtaining new information (Bybee, 2014). This support to make connections and see how things work together is a goal for educators. Students can make these connections through the use of an experience which can be a lab, group project with some research, or conducting an investigation using research.

Grade-level Vocabulary

Including grade-level vocabulary helps students recognize these terms in and out of the classroom, expanding their English vocabulary. Providing authentic context to use scientific vocabulary is crucial for ELLs and is a more realistic way to study science, rather than memorizing definitions (Groves, 2016). While using both Ohio Science Standards and the English language standards are a key component in this science curriculum, the investigative science perspective needs to be used throughout. Engaging students and their curiosity is key to learning, and when we use grade-level textbooks there is a high vocabulary demand which can lead to a loss of interest (Groves, 2016). To support ELLs in learning new grade-level vocabulary there need to be plenty of visuals with labels and concise definitions. The teaching moment for the vocabulary being taught can occur at the beginning of the lesson (frontloading), during the experience of a lab or a project, or at the end of the lesson through student explanation. Providing this vocabulary support throughout the lessons help the students interpret the new concepts and to use the new vocabulary. They are also given opportunities to interact with the concepts and vocabulary that will build a stronger connection and understanding of new ideas.

Connecting Language and Content Standards

Students are expected to have an understanding of different science concepts each year, which are based on the Next Generation Science Standards (NGSS). Knowing what students should know guides teachers towards teachers of where to start and where they are heading next. At the end of a lesson or activity, educators can assess if their students have mastered the targeted goal. Assessments allow the eductor to provide feedback to the students on their explanations and abilities to demonstrate their understanding (Bybee, 2014). Using assessments as a tool to see a students' growth and meeting a target goal, helps identify any topics that need to be retaught before moving on.

Providing language standards to support the content standards, stated orally and displayed clearly, helps the students and teachers know the direction and goal of the lesson (Echevarria, Vogt, & Short, 2008). Since ELLs are also learning the English language, the English Language Proficiency Standards need to be incorporated throughout the lessons. ELLs need support with both language development (Echevarria, Vogt, & Short, 2008) and content information, so providing standards from both areas make it clear they are both needed to work together.

Overall

These critical needs areas require meaningful accommodations that will support teachers in reaching their ELLs in their classrooms. The SIOP Model points out critical language pieces that support ELLs. The 5E and IBL are both science related models, where 5E helps to provide structure within a science-content lesson and IBL supports the fluid curiosity of the class. Providing a 5E structure gives students the opportunity to construct and refine science concepts and other skills (Bybee, 2014). IBL supports student's curiosity and motivate them to discover science concepts using hands-on activities.

Analysis of Critical Needs Categories and Frameworks

Framework	**Prior Knowledge**	**Higher-Level Comprehension**	**Frontloading Information**	**Vocabulary**	**Connecting Language and Content Standards**
SIOP	- Links made explicitly between past and new concepts - Language and content objectives clearly identified	- Ample Opportunities to understand concepts - Scaffolding techniques - Variety of Questions or tasks - Frequent opportunities for interaction and discussion - Grouping configurations - Hands-On materials or manipulatives - Sufficient wait time - Activities to integrate language skills with content	- Clear explanation of tasks - Key vocabulary emphasized - Supplementing materials - Language and content objectives clearly defined	- Key vocabulary emphasized - Opportunities to clarify key concepts - Activities to integrate language skills - Speech at appropriate level and pace	- Content and Language objectives clearly defined, displayed and reviewed - Content and Language objectives clearly supported by lesson delivery
5E	- Challenge students' current conceptions - Find misconceptions - Engage and Explore phases	- Instructional sequence - Explore, Explain and Elaborate phases	- Instructional sequence - Explore phase	- Explain and Evaluate phases	- Explain and Evaluate phase
IBL		- Active, hands-on learning - Group activities - Opportunities to have discussion with group and ask questions	- Scaffold sequence of completing a task - Scientific practices being used	- Use scientific vocabulary to explain conclusion	- Authentic communication about science concepts
MALP	- Interconnectedness - Cultural background	- Oral and written modes of learning - Group and independent accountability	- Immediate relevance - Using familiar language and content to build new knowledge	- Oral and written modes of learning	

The present curriculum will aim to connect both science and English language standards in a structured format, SIOP and 5E, to support ELLs through inquiry-based learning. Science lends itself to promote curiosity and exploration which is the central point of the IBL idea. The MALP framework supports student's cultural background to help with immediate relevance, and the ability to use familiar language. These aspects are also found in SIOP where educators can support those aspects found in MALP with prior knowledge using SIOP. For this reason, the curriculum will emphasize SIOP over MALP. The frameworks that were discussed in Section Two address these critical areas and are analyzed in the previous table.

SIOP

This table breaks down how each framework supports the different needs of ELLs in the classroom. The first framework, SIOP, has many strong supports for ELLs in all critical needs categories. Echevarria, Vogt, and Short (2008) wrote the text for SIOP which goes into great detail of what the 30 features are and how they can be applied to any lesson. For activating students' prior knowledge, there are features that make links explicitly between past and new concepts. The teacher can ask questions to generate a class discussion which they can lead to the new concepts of what they can expect to see in their science activity. Making sure that the language and content objectives are clearly identified as their goal, which students should achieve by the end of the lesson, provide students with an end goal in mind.

Echevarria, et al. (2008) show how the SIOP method also includes higher level comprehension by providing ample opportunities to understand concepts where teachers can provide different activities and labs that connect to the same concepts. SIOP supports the ability to scaffold techniques that can be more simplistic or more advanced based on the learners' abilities. Providing a variety of questions or tasks that students are to complete can be differentiated for different student ability levels. Having students work in groups gives them the opportunity to interact and talk with peers about the science phenomena they are experiencing together. Teachers can also group students by ability, or native language, to help each other in thinking more deeply of the concepts. This supports the integration of language and science content, where students are using their language skills to talk about and explain science concepts. Giving students a sufficient amount of wait time, helps them take the time to make strong connections between language and the science concepts. The SIOP method also supports the use of hands-on activities that use materials and manipulatives to gain a deeper understanding of a new concept.

By using the SIOP framework there are features that support frontloading information, such as explicitly identifying the key vocabulary words that will investigated through the activities (Echevarria, et al., 2008). A way to frontload information is to provide a clear explanation of the tasks (Bergman, 2013) and materials that will be used in the investigation. Another important piece to include is the clear expectation of the objectives, both language and content, as the goal of the activity. The last critical needs category is the connection of the of language and science content standards where in the science class language content is being reinforced in the lesson. The SIOP method clearly supports the connection between both language and science content standards, where features from both contents are identify and connected within clearly supported lesson deliveries and activities.

5E Model

A science-focused framework that provides effective structure to the lessons is the 5E model. In the table above each phase is in one or more of the different critical needs categories. Rodger Bybee (2014) explains each phase where the first phase, Engage, starts the lesson with a demonstration or question to get students to activate prior knowledge. To do this the teacher helps students think about what they already know and how to explain the demonstration or answer the question. Teachers can provide frontloading support and introduce some new vocabulary and let students know when and where they use these new terms.

The second phase, Explore, is where students go through a lab activity to use their prior knowledge to generate new ideas (Bybee, 2014). This is also where misconceptions are identified and a change is occuring by going through the scientific processes throughout the activity. Teachers can provide higher-level thinking in this phase by grouping students, based on native languages, or providing different levels of the same activity, based on level of understanding the new concepts. In the third phase, Explain, students have the opportunity to share what they found. Teachers can directly reinforce the front-loaded concepts and vocabulary to what they are experiencing. Educators become facilitators and can guide students to have higher-level of thinking by asking questions or having students use the new vocabulary in their explanations. This also addresses and supports connecting the language and science content standards.

The fourth phase, Elaborate, is where teachers provide students with new, additional experiences where students can develop a deeper understanding of the concepts (Bybee, 2014).

This supports the higher-level thinking of the concepts. The fifth and last phase in the cycle, Evaluation, is where teachers are able to assess students understandings of the targeted concepts and vocabulary (Bybee, 2014). There can be differently leveled assessments, depending on students abilities, where key vocabulary is being assessed. This is connected to both the language and science content standards, showing or explaining what they know using science content knowledge and vocabulary.

Inquiry-Based Learning

When looking at the Inquiry-Based Learning approach, we can see that it supports higher-level thinking through the use of hands-on learning. When students work within an activity and discover the concepts, ELLs are not burdened with the language aspect (Lee, Maerten-Rivera, Penfield, LeRoy, & Secada, 2008) since they are interpreting the concept by completing the activity. Students are also grouped to complete activities where they can share with each other what they are learning. This supports the integration of science and language concepts, where students can express what they are learning using scientific vocabulary.

We see front-loading information from IBL in a slightly different way where the teacher is scaffolding the steps to perform the activity (Ernst, Hodge, & Yoshinobu, 2017). The teacher can also explain the scientific process that will take place to be sure to complete all of the steps of the investigation. Something we do not see with IBL is activating prior knowledge, since this model focuses on what is happening throughout the lesson.

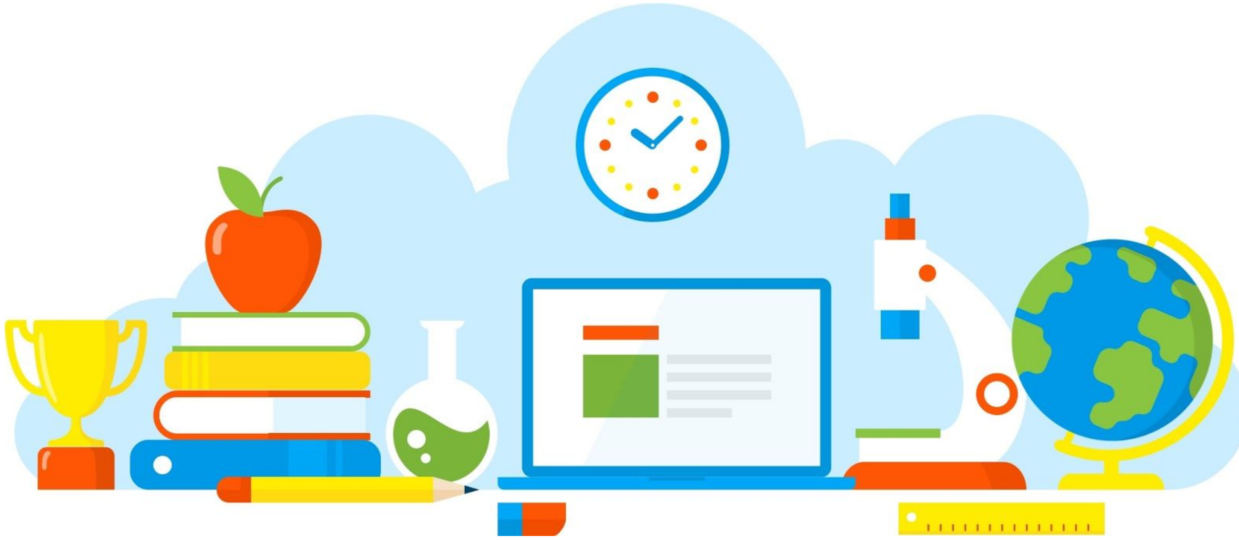
MALP

When comparing sheltered instructions, SIOP supports learners in a variety of ways as listed above, but MALP focuses mostly on the cultural backgrounds of students. Supporting students' cultural backgrounds is important this aspect can also be supported by other frameworks that activate prior knowledge. MALP primarily focuses on cultural background and how to bridge students from their native culture to the U.S. schools' culture (DeCapua & Marshall, 2011). There are not as many supporting factors for MALP as there are for SIOP, which is why the present curriculum will have SIOP.

Current Curriculum Model

The proposed science curriculum for emergent English learners has the framework of the SIOP method, 5E science model, and inquiry-based lessons that incorporate both the Ohio Science Standards and English Language Standards. While MALP provided cultural support, we can also see this in SIOP where educators prepare lessons and activate prior knowledge of their students, so MALP is not explicitly used in the curriculum. The methods and standards give structure to creating the most successful lessons in reaching ELLs. This will include an outline of creating new lessons as well as science-content lessons based on this research-based framework and specific examples of what can be used with ELLs in a middle school science classroom.

SECTION FOUR



Integrated Science-Language Curriculum for ELLs

Incorporating researched-based frameworks

Allison Simpson

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Introduction

The population of students identified as English Language Learners (ELLs) has been the fastest growing subgroup of students enrolling in school (Garcia et al., 2008; Flynn & Hill, 2005; Kindler, 2002; Echevarria, et al. 2006). Teachers need to make accomodations in their classrooms to ensure ELLs success.

Outline of a Lesson Description

This outline identifies areas to support ELLs in any content classroom. This outline includes the critical need areas that can be used for any subject and there will be specific areas to support the science content area.

Science-Language Lesson Description

After the outline there will be specific sixth grade science lessons that incorporate the high-need areas for ELLs with science content. These lessons will connect identifying mass, volume and density science content standard with language standards using researched based frameworks, such as SIOP, 5E model, and IBL.

5 Critical Areas of Need Within a Lesson

Specific Needs	What you will see in the lessons
Prior Knowledge	• Asking questions at the beginning and throughout a lesson • Using a demonstration to help students make connections • Finding out what students already know about a topic • Looking at the tools they will be using in the science activity to see when they have used/seen them before • Predicting and prepare for misconceptions and learning gaps
Frontloading Information	• Looking at words they will be using to see where they have seen or heard them before • Explaining steps, in clear, concise language • Supplementing materials
Vocabulary	• Providing key vocabulary at the beginning with simple, concise definitions • Only using a few key words • Speaking at appropriate level and pace • Giving examples of appropriate vocabulary use
Higher-level Comprehension	• Providing a pace that allows more wait time to complete the activity • Grouping students by native language or educational level • Providing active, hands-on learning activities • Guiding students in using science vocabulary to explain their experiences • Guiding students in using language skills
Connecting Language and Content Standards	• Making both language and content standards clearly defined, displayed and reviewed • Ensuring Language and content standards support one another throughout the lesson • Meeting grade-level standards • Assessing students in a variety of ways to know they understand the concepts

Introduction

Using the outline as a guide to ensure the educators meet the needs of ELLs in the classroom, the lessons will focus on linguistic needs as well as the science content of mass, volume and density. You will see each critical need area listed below with a short description of what it is and examples of how it would look in the classroom.

Prior Knowledge

Activating prior knowledge is important so that students are using what they already know to build new information on. The prior knowledge of ELLs, who are from diverse backgrounds, will have different experiences and educational backgrounds that affect what they already know. When starting a new concept, a good way to determine what they already know, is to ask informal questions. This can also lead you to find out what misconceptions they might already have about the topic.

Teacher Example Question: “Raise your hand if you have boiled water to make noodles, maybe for pasta?” Showing a picture of a pot on a stove with boiling water and steam rising would help. If you have access to a pan, water and a hot plate you could demonstrate this.

Student response: “I have done that, it’s hot.” “My mom makes our dinners, so I have seen that before.”

Teacher response: “Great! So you have see the water heating up, and turning into a gas. This is called evaporation. Where else have you seen this happen?” Example of student answer: “In the shower, over a lake.” Misconception: “I’ve seen it coming from factories or out of houses.” In this case this is called pollution which is smoke and other gasses, not evaporation.

Frontloading Information

When we frontload information we want to make sure we are providing the students with the most important vocabulary and steps to conduct the experiment. This helps students have an overview of what and how they’re learning.

*Teacher example of introducing vocabulary in bold: “Today you will be investigating **mass**. We can think of mass as how many atoms are packed into* *something. So here we have a wooden cube and to measure its mass we place it on the **electronic scale**. The way we do this is we turn on the scale, make sure it's measuring **grams**, place the object on the scale and then read the number. Remember: grams is the **unit**, it's what goes next to the number. That number is the mass of the wooden cube." Demonstrate this as you're explaining using the vocabulary throughout the process.*

Vocabulary

Using grade-level vocabulary helps students build their knowledge of new English words to use in an authentic context, such as a class activity. Providing visuals or a demonstration when introducing new words helps create a strong connection to help students remember. This can be done at any time throughout the lesson.

Teacher example: "When we look at parts of a cell, we can think of the cell as a factory." Pull up a picture of a factory, talk about what factories do and if they've ever seen one. Pull up pictures to show what factories look like, inside and out. "Factories have many different jobs so that it can produce the product. There's a boss, or manager, there's someone who helps clean up the workplace and collects the trash, there's a place for the workers to go and eat their lunch."

Make a T-chart (to organize ideas) labeled factory jobs on one side and cell parts (organelle) on the other and create a list as a class of jobs that are found within a factory. Read aloud the grade-level text, of one organelle at a time placing it in the next column to match up with the factory job it best fits with. "Let's see what job this organelle would match up to: Nucleus - tells everything else in the cell what to do. Who in the factory tells everyone else what to do?"

Student response: "The boss or manager."

Teacher response: "Yes, the nucleus is like the boss or manager because they both do the same job, telling everyone else what to do." Write in nucleus on the other side of the T-chart under cell part (organelle). This T-chart can be a reference throughout the unit for students to use to remind them of the function of each organelle in the cell.

Higher-level Comprehension

There are several ways to help students reach a high-level of comprehension. To complete a lab or project, students can be grouped based on native language or ability, depending on how the educator wants to support the learners. The conversations that students can have in their groups supports authentic learning of new concepts and vocabulary. The use of diagrams, graphic organizers, and providing hands-on activities and projects will support higher-level comprehension. Diagrams can typically be found in their textbooks or examples found online to visualize the concepts. Using graphic organizers can be used to organize new knowledge and can be completed as a class. Providing hands-on activities and projects help students physically see and handle science concepts.

Teacher example: "I will be putting you into groups for this project. Be sure to help each other to complete the project." As they're working walk around and ask questions. If a student can explain it, have them explain it to their group (either in English or their native language).

Teacher example: "Let's open our book to page ___, and take a look at the diagram." Either holding up the textbook or projecting an electronic version on the board, have the page pulled up. "This picture is showing us the layers of the Earth. The outermost layer is labeled Crust. The next middle layer is called the Mantle. The innermost layer is the core. What else do we know has an outside layer, middle and inner layer?"

Student response: "Apple, Hard-boiled egg, avocado, etc."

Teacher response: Bringing up pictures to show students how those are examples of other things having layers. "Yes, we can see the shell of an egg is like the crust, the white part is like the mantle and the yolk is like the core. Now that we know where these layers are, let's talk about what the rocks are like in these layers." This can lead into creating a graphic organizer of the different types of rocks we have on Earth. Providing pictures to identify each process of rocks forming on Earth will help visualize this concept. Label each process and identify which rock is formed from each process, creating the rock cycle.

Connecting Language and Content Standards

Connecting language and content standards supports the learning of English skills along with the science content. A lesson that supports both language and science content is critical for students that are still learning English. This provides a goal of what they should be able to do regarding both the English language and concepts within science. This relates to the assessment to help provide feedback for students.

Teacher example: "Today our goal is to match the correct term to the matching picture. Here are the pictures of all the different ways matter changes state. Here are the words. I'll read these then you can draw an arrow to the matching picture. The words are: melting, freezing, evaporating, and condensing. Let's start with melting, we know melting is when a solid, like ice, melts into a liquid, like water. Which picture is showing us that?"

Student response: "The one of the ice cube turning into water, pointing to the picture."

Teacher response: "Yes, that's correct. So, let's draw our arrow from melting to the picture that shows something melting. Let's do the next one." I would go through each one with them. The assessment would be similar to this activity to identify the terms of the processes. You can also include the language content by using sentence starters or fill-in-the-blank sentences and students would identify the definition or word to go into those sentences.

Mass Science-Language Lesson

Overview and Purpose

Students will be able to identify that matter is composed of small particles called atoms and all matter has mass, volume, and density.

Standards

6th grade Physical Science, Ohio Science Standard

6.PS.1: Matter is made up of small particles called atoms. Matter has mass, volume and density and is made up of particles called atoms.

Ohio English Language Proficiency Standards (ELP)
SP3: Plan and carry out investigations
SP4: Analyze and interpret data
SP8: Obtain, evaluate, and communicate information
EP1: Support analysis of range of grade-level complex texts and evidence
EP6: Use English structures to communicate context specific messages

Objectives

Content Objectives: Students will be able to determine the mass, volume and density of several items and liquids. These measures all go back to measuring the matter within an object or substance.

Language Objectives: Students will be able to ask questions, carry out investigations, interpret data, and explain what the data shows. They will do this while they move through the investigation, and work within their groups, where they can explain what they are seeing and defend their answers using the data. They will be able to use English structures to present their knowledge using their data and text, finding appropriate science vocabulary.

Materials

- Triple Beam Balance or Electronic Scale
- Different solid objects: wooden cube, iron nail, and larger rectangular prism

- Graduated Cylinder
- Different Liquids: Vegetable Oil, Water, and Corn Syrup
- Lab worksheet with data tables to complete and conclusion questions to answer.
- Pencils
- Calculators

Lesson

5E Framework	SIOP Framework	Lesson/Activity
	Prepare	Obtain materials needed for the activity Think of misconceptions students may have (for example, mass and weight are the same). Prior knowledge is sometimes limited, so prepare additional background knowledge, ideas, vocabulary, demonstrations, pictures, etc. based on what you know about your particular class.
Engage	**Building Background**	Demonstration: two balloons (one blown up and one deflated) taped onto a straw/stick. Hold the middle of the straw/stick and show how the one inflated balloon goes down and the other deflated balloon goes up. Say *"Today, we will discover why this is happening."* (They might already be able to say there's more inside the inflated balloon)
Explore	**Comprehensible Input, Strategies, Interaction**	1. Pass out lab worksheet, while explaining that they will be working in partners or in groups of 3. 2. They will be given different items and substances (listed in materials) and they will need to find the mass of each.
Explain	**Interaction, Lesson Delivery**	1. Demonstrate how to find the mass of an object and one of the liquids. Walk students through each step of how to do this. Designate part 1 as finding the mass of just the solids and part 2 as finding the mass of just the liquids. 2. Be sure to include science vocabulary in your delivery. 3. Example: *Today you will be measuring **mass**. We can think of mass as how many atoms are packed into something. So here we have a wooden cube and to measure its*

		*mass we place it on the **electronic scale**. The way we do this is we turn on the scale, make sure it's measuring **grams**, place the object on the scale and then read the number. Remember: grams is the **unit**, it's what goes next to the number. That number is the mass of the wooden cube. We need to record this in our data table next to wooden cube." Demonstrate this as you're explaining use of the vocabulary throughout the process.* 4. Be sure they record their masses as they find each one, filling up the table. 5. Then call the class back together to explain how to find the mass of the liquids. 6. *Example: "Now, to find the mass of liquids, this is a little tricky. We need to know how much **mass** the **graduated cylinder** is first. So, place the EMPTY graduated cylinder on the scale and measure its mass.* (Do this with the class) *Record that in your data. Then for each **liquid** place the same amount, 25 mL, into the graduated cylinder and place it on the **electronic scale**. Record this mass. You're not done yet! You need to subtract, or take away, the mass of the graduated cylinder. Then, the number left over is the mass of just the liquid inside.* (Complete the math for your example) *Record that in your data table."* 7. *"At the end of the lab, your table should be filled up with the mass of each item. Then, we will be able to see which one has more or less mass. If the number is bigger it has more mass, and if the number is smaller it has less mass."* 8. *"Your goal is to complete the data table with your group and answer the conclusion questions together."* 9. Give students time to complete the lab, walking around to support students where needed.
Elaborate	**Practice and Application**	• Students conduct this activity, measuring the mass of both solids and liquids. • Students should be able to compare

		masses as one being more massive than another. Identifying the most massive and the least massive items. ● Now that we know the mass of these objects let's predict what the mass would be of another object or substance - provide other things for students to make predictions and then finding the mass.
Evaluate	**Review and Assessment**	Having students choose another object, see if they can accurately measure the mass and compare it to another object as having more or less mass. Also, they should be able to define the term, mass.

Volume Science-Language Lesson

Overview and Purpose

Students will be able to identify that matter is composed of small particles called atoms and all matter has mass, volume, and density.

Standards

6th grade Physical Science, Ohio Science Standards

6.PS.1: Matter is made up of small particles called atoms. Matter has mass, volume and density and is made up of particles called atoms.

Ohio English Language Proficiency Standards (ELP)
SP3: Plan and carry out investigations
SP4: Analyze and interpret data
SP8: Obtain, evaluate, and communicate information
EP1: Support analysis of range of grade-level complex texts and evidence
EP6: Use English structures to communicate context specific messages

Objectives

Content Objectives: Students will be able to determine the mass, volume and density of several items and liquids. These measures all go back to measuring the matter within an object or substance.

Language Objectives: Students will be able to ask questions, carry out investigations, interpret data, and explain what the data shows. They will do this while they move through the investigation, and work within their groups, where they can explain what they are seeing and defend their answers using the data. They will be able to use English structures to present their knowledge using their data and text, finding appropriate science vocabulary.

Materials

- Ruler
- Different solid objects: wooden cube, iron nail, and larger rectangular prism

- Graduated Cylinder
- Water to measure displacement of irregular-shaped objects
- Different Liquids: Vegetable Oil, Water, and Corn Syrup
- Lab worksheet with data tables to complete and conclusion questions to answer.
- Pencils
- Calculators

Lesson

5E Framework	SIOP Framework	Lesson/Activity
	Prepare	Obtain materials needed for the activity Think of misconceptions students may have (for example, you can measure volume with a ruler for both liquids and solids). Prior knowledge is sometimes limited, so prepare additional background knowledge, ideas, vocabulary, demonstrations, pictures ect. based on what you know about your particular class.
Engage	**Building Background**	Explanation: *"When we measured the mass (in the previous lesson) of the different liquids, we made sure to pour 25 mL of each. What is the 25 mL measuring? We know it's not mass, so then what must it be?"* Demonstration: Pour 25 mL of water into a graduated cylinder, then hold it up and ask *"How much water do I have in here? How much space is this water taking up inside the graduated cylinder? How do I know it's not more or less than 25 mL?"*
Explore	**Comprehensible Input, Strategies, Interaction**	1. Pass out the lab worksheet, while explaining that they will be working in partners (if it's a smaller class) or groups of 3 (if it's a larger class).. 2. They will be given different items and substances (listed in materials) and they will need to find the volume of each. 3. Identify the two types of solid objects as regular-shaped (ex. wooden block that has smooth, flat, measureable surfaces) and irregular-shaped (ex. Rock that has rough, bumpy surfaces that cannot be measured with a ruler). Holding an example up and

		explain why one is regular and the other is irregular.
Explain	**Interaction, Lesson Delivery**	1. Demonstrate by doing an example together of how to find the volume of water, for the engagement. Walk students through each step of how to do this. Designate part 1 as finding the volume of just the liquids and part 2 as finding the volume of the solids. Then demonstrate finding the volume using a ruler, using centimeters starting at the edge of the ruler or at zero. 2. Be sure to include science vocabulary in your delivery. 3. Example: *Today you will be investigating* ***volume****. We can think of volume as how much space something takes up. The first part will be looking at different colored liquids, in different sized graduated cylinders. We need to make sure we are at eye level with the* ***graduated cylinder*** *on the table as we measure the volume of each colored liquid.* (Read through the lab paper together) *When we measure volume of a liquid it's measured in* ***millimeters*** *or mL, which is the* ***unit*** *that goes next to the number. We need to record this in our data table next to the matching color."* Demonstrate this as you're explaining using the vocabulary throughout the process. Have four stations set up of each part of this lab. 4. Be sure they record their volumes as they find each one, filling up the table. 5. Then call the class back together to explain how to find the volume of regular-shaped solid objects. 6. *Example: "Now, to find the volume of a* ***regular-shaped object****, you need to use a* ***ruler****. With the ruler we need to measure the length, width and height.* (Show a diagram where these parts are being measured of an object so they can see this.) *Let's do one together, everyone should have a ruler and a block. First, we can measure the* ***length****, and write that down. Next, measure the* ***width***

		*and write that down. Finally, measure the **height** and write that down."* To help measure these sides, you can mark the objects you plan to use, so students know exactly which side to measure. Doing this together as a class and recording as the example in their data table. *"Now that we have these three numbers, we need to multiply them together to get a volume. Our **unit** for a solid object is cmXcmXcm so it's **cubic centimeters or three centimeters**."* 7. Show how to use the **calculator** on how to do this, either projecting it on the board or holding one up. Be sure to show the "X" symbol as the multiplication button and the "=" to find the final answer. Give them time to complete two regular-shaped objects with their partners. The blocks should be labeled with a letter to identify which block they're measuring. 8. Make sure they are recording their data in their data tables. 9. Finding volume of **irregular-shaped objects**. *"When we wanted to find how much space a regular shaped object would take up, we easily used a ruler and found the volume. If we have an irregular-shaped object, like this rock, we cannot use a ruler since the sides are not smooth, flat surfaces. So, we use what we call the **displacement method**. We fill a **graduated cylinder** up (enough for the object to be submerged) and record the starting volume. Then, place the object in the water and record the ending volume. **Subtract** these two volumes to get the volume of the solid object."* Demonstrate on the calculator. 10. At the end of the lab, their data table should be filled up with the volume of each object. *"We will be able to see which one has more or less volume. If the number is bigger it takes up more space, and if the number is smaller it takes up less space."* 11. Give students time to complete the lab, walking around to support students where

		needed. Ask questions to guide their thinking through the investigation.
Elaborate	**Practice and Application**	• Students conduct this activity, measuring the volume of both solids and liquids. • Students should be able to compare volumes of each object and liquid as one taking up more space than another. • *"Now that we know the mass of these objects let's predict what the volume would be of another object or substance."* Provide other things for students to make predictions and then find the volume.
Evaluate	**Review and Assessment**	Having students choose another object, see if they can accurately measure the volume and compare it to another object as taking up more or less space. Also, they should be able to define the term, volume.

Density Science-Language Lesson

Overview and Purpose

Students will be able to identify that matter is composed of small particles called atoms and all matter has mass, volume, and density.

Standards

6th grade Physical Science, Ohio Science Standards

6.PS.1: Matter is made up of small particles called atoms. Matter has mass, volume and density and is made up of particles called atoms.

Ohio English Language Proficiency Standards (ELP)
SP3: Plan and carry out investigations
SP4: Analyze and interpret data
SP8: Obtain, evaluate, and communicate information
EP1: Support analysis of range of grade-level complex texts and evidence
EP6: Use English structures to communicate context specific messages

Objectives

Content Objectives: Students will be able to determine the mass, volume and density of several items and liquids. These measures all go back to measuring the matter within an object or substance.

Language Objectives: Students will be able to ask questions, carry out investigations, interpret data, and explain what the data shows. They will do this while they move through the investigation, and work within their groups, where they can explain what they are seeing and defend their answers using the data. They will be able to use English structures to present their knowledge using their data and text, finding appropriate science vocabulary.

Materials

- Ruler
- Electronic Scale

- Different solid objects: wooden cubes, iron nail, rubber stopper and other solid objects
- Graduated Cylinder
- Water to measure displacement of irregular-shaped objects
- Different Liquids: Vegetable Oil, Water, and Corn Syrup
- Lab worksheet with data tables to complete and conclusion questions to answer.
- Pencils
- Calculators
- Elaborate and Evaluate Density of Water Lab

Lesson

5E Framework	**SIOP Framework**	**Lesson/Activity**
	Prepare	Obtain materials needed for the activity Think of misconceptions students may have (For example, the density will change if you change the mass or volume of an object). Prior knowledge is sometimes limited, so prepare additional background knowledge, ideas, vocabulary, demonstrations, pictures ect. based on what you know about your particular class.
Engage	**Building Background**	Explanation: *"When we measured the mass of the different liquids, we made sure to pour 25 mL of each. What is the 25 mL measuring? We know it's not mass, so then what must it be?"* Demonstration: Pour 25 mL of water into a graduated cylinder, then hold it up and ask *"how much water do I have in here? How much space is this water taking up inside the graduated cylinder? How do I know it's not more or less than 25 mL?"*
Explore	**Comprehensible Input, Strategies, Interaction**	1. Pass out lab worksheet, while explaining that they will be working in partners (if it's a smaller class) or groups of 3 (if it's a larger class). 2. They will be given different items and substances (listed in materials) and they will need to find the density of each. 3. Review mass and volume, have students share what they remember about measuring each. To start show them a golf

		ball and a table tennis ball and ask them to compare the mass and volume of those two objects.
Explain	**Interaction, Lesson Delivery**	1. Demonstrate: place a golf ball and a table tennis ball into a pitcher of water. Pull them out and ask them *"Why did one sink and the other float?"* Point out same volume but different mass. (At the end of the lesson calculate the density of each.) 2. Be sure to include science vocabulary in your delivery. 3. Example: "*Today you will be investigating **Density**. We can think of density as how much mass is inside a certain volume, or space. We need to be able to calculate density so we will need to use the **equation M/V** (mass divided by volume). Let's complete this example together."* Demonstrate using a regular-shaped object to calculate volume and measure mass, then calculate density and use the vocabulary throughout the process. Have stations set up with materials (or provide each group with a set of materials) to find the mass, volume and density of each substance or object. 4. Be sure they record their masses, volumes and densities for each one, filling up the table. 5. At the end of the lab, their data table should be completely filled with data. *"We will be able to see which one has a higher or lower density. If the number is bigger it has a higher density, and if the number is smaller it has a lower density."* 6. Give students time to complete the lab, walking around to support students where needed. Ask questions to guide their learning throughout the investigation.
Elaborate	**Practice and Application**	• Students should be able to compare densities of each object and liquid as more or less dense than another. • Go back to the golf ball and the tennis table ball and find densities - provide other things

		for students to make predictions and then finding the volume. ● Have students find the density of water, using different amounts to determine the density of each amount. Comparing the results the students should see that water's density stays the same throughout, no matter how much you have of the substance. (This can also be used to evaluate or assess students understanding of density.)
Evaluate	**Review and Assessment**	Having students choose another object, see if they can accurately measure the density and compare it to another object as being more or less dense than another. Also, they should be able to define the term, density. A final overall assessment could be to complete the water density lab, where they need to find the density of water through the investigation.

Name____ Date________________

Measuring Mass

Liquids, Regular and Irregular Shaped Objects

In this activity, we will learn how to measure the mass of liquids, regular and irregular shaped objects. We will measure how many atoms are packed into a certain area for each liquid and object.

Materials:

- water
- regular and irregular shaped objects
- graduated cylinder
- electronic scale
- triple-beam balance - to use in a demonstration

Part 1: Finding the Mass of Liquids

Procedure:

1. Find the mass of the **empty** graduated cylinder, record this in your data table.
2. Place your eye level with the water level in the graduated cylinder and make sure to measure 25 mL (milliliters).
3. Place the graduated cylinder with the liquid on the scale and record the mass.
4. Take away the mass of the empty graduated cylinder from the mass of the graduated cylinder and liquid. Record the amount in the mass of the liquid only.

Data Table

Liquid	**Mass of Empty Graduated Cylinder**	**Mass of Graduated Cylinder and Liquid**	**Mass of the Liquid Only**
Water			
Vegetable Oil			
Corn Syrup			
Choice Liquid			

Part 2: Finding the Mass of Regular and Irregular Solids

We will be looking at both regular and irregular solids to find the mass of each solid.

Procedure:

1. Turn on electronic scale and make sure it is at 0 (zero) and in the unit g for grams.
2. Take one object at a time and place it on the electronic scale.
3. Record the mass for each object in the data table.

Data Table

Station #	**Solid Object**	**Mass (g)**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Conclusion Questions:

1. What is the definition of mass?

___Mass is ____

2. What tool did you use to measure the mass?

___The tool I used was ____

3. Can objects have the same volume but different mass?

___If an object has the same volume as another object, both objects mass will be __

____

4. What did you learn about volume from this activity?

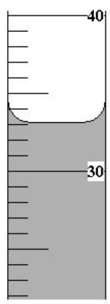
___I learned ____

Name____ Date________________

Measuring Volume

Liquids, Regular and Irregular Shaped Objects

In this activity, we will learn how to read the volume of a liquid in a graduated cylinder measuring milliliters (mL). When most liquids are placed in tall, narrow containers, the liquid creeps up the walls of the container. This causes the liquid to look curved. The bottom of this curve is known as the **meniscus,** and best represents the actual volume of the liquid in the cylinder. We will also learn how to measure the volume of regular and irregular shaped objects.



← Meniscus

Materials:

- different colored liquids
- regular and irregular shaped objects
- graduated cylinder

Part 1: Finding the Volume of Liquids

Procedure:

1. Place your eye level with the water level in each graduated cylinder.
2. Find the volume of the liquid in the graduated cylinder by looking at the bottom of the curve of the liquid.
3. Record the volume of the liquid in the table labeling it milliliters (mL).

Data Table

Station #	**Volume of Liquid (mL)**
1 (yellow liquid)	
2 (blue liquid)	
3 (red liquid)	
4 (green liquid)	

Part 2: Finding the Volume of Irregular Solids
We will be looking at five irregular solids and finding the volume of each solid.

Procedure:

1. Fill the graduated cylinder with 15 mL, the amount of water on the data table.
2. Put the irregular solid into the water. Record the volume of the water plus the object.
3. Now take away the volume of the water alone (15 mL) from the volume of the water plus the object.
4. Write your answer in the last column.

Data Table

Station #	Irregular Solid	Volume of **Water** in Graduated Cylinder	Volume of the **Water plus the Irregular Solid (mL)**	Volume of the Irregular Solid Alone (mL)
1	Rock	15 mL		
2	Marble	15 mL		
3	Iron Nail	15 mL		
4	Rubber Stopper	15 mL		
5	Choice Object	15 mL		

Part 3: Finding the Volume of Irregular Solids
We will be looking at five regular shaped solids and finding the volume of each solid.

Procedure:

5. Using a ruler measure the length, width and height of the object.
6. Record the measurements and multiply.
7. Record the final number in the last column, using the cubic centimeters unit (cm3).

Data Table

Regular Solid	Length, Width and Height (cm)	Volume of object (cm3)
Block R	___ x ___ x ___ =	
Block X	___ x ___ x ___ =	
Block U	___ x ___ x ___ =	
Block Z	___ x ___ x ___ =	
Choice block	___ x ___ x ___ =	

<u>Conclusion Questions:</u>

1. What is the definition of volume?

___Volume is ____

2. What is an irregular shaped object?

___An irregular shaped object will not have ____________________________________

3. How do volume and mass differ?

___Volume is measuring ____

___Mass is measuring ____

4. If an object has more volume does it always have more mass?

__If an object has more volume, the mass will be ______________________________

5. What did you learn about volume from this activity?

___I learned ____

Name____ Date________________

Measuring Density

Liquids, Regular and Irregular Shaped Objects

In this activity, we will discover the density of different liquids and solids. Using what we know about finding the mass and volume, we will use those measurements to find the density.

Reference Chart

Measuring	Mass	Volume	Density
Tools	Electronic Scale	Ruler or Graduated Cylinder	Both: Electronic Scale and Ruler or Graduated Cylinder
Solid	Place on scale and read number	Using a ruler Length x Width x Height	Mass divided by Volume
Units for Solids	g, grams	cm3, cubic centimeters	g/cm3, grams per cubic centimeters
Liquid	Graduated cylinder with liquid in it - empty graduated cylinder	Read graduated cylinder at the meniscus (bend)	Mass divided by Volume
Units for Liquids	g, grams	mL, milliliter	g/mL, grams per milliliter

Materials:

- electronic scale
- regular and irregular shaped objects
- graduated cylinder
- water
- different liquids
- ruler

Part 1: Finding the Density of Solids

Procedure:

1. Measure the mass of each object, by placing it on the electronic scale.
2. Find the volume of each object, either measuring it using a ruler (length x width x height) or using water in a graduated cylinder (final liquid amount - beginning liquid amount).
3. Record the mass and volume of each object in the data table.
4. Using the mass and volume divide (M/V) and use the unit g/cm3 to find the density of each.

Data Table

Station #	**Solid Object**	**Mass (g)**	**Volume (cm3)**	**Density (g/cm3)**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Part 2: Finding the Density of Liquids
We will be looking at five different liquids and finding the density of each.

Procedure:
1. Write the liquid you are using for each station.
2. To find the mass you need to measure the empty graduated cylinder first then fill the graduated cylinder with 15 mL of that liquid.
3. Using the mass and volume, divide mass by the volume to find the density of each liquid.

Data Table

Station #	**Liquid**	**Mass (g)**	**Volume (mL)**	**Density (g/mL)**
1			15 mL	
2			15 mL	
3			15 mL	
4			15 mL	
5			15 mL	

Conclusion Questions:
1. What is the definition of volume?

___Volume is ____

2. What is an irregular shaped object?

___An irregular shaped object will not have ________________________

3. How do volume and mass differ?

___Volume is measuring ____________________________________

___Mas is measuring _______________________________________

4. What did you learn about volume from this activity?

___I learned ____

Name____ Period_____ Date______________

Density of Water Lab

I can...

- ...define density.
- ...calculate density using mass and volume.
- ...plot data to construct a mass vs. volume graph.

Question:

Do different amounts of water have the same density?

Materials:

- Graduated cylinder, 100 mL
- Water
- Triple beam balance or electronic scale
- Calculators

Procedure:

1. Find the mass of an empty graduated cylinder. Record the mass in grams in the data table.

2. Pour 100 mL of water into the graduated cylinder. Make sure the meniscus, the bottom of the curve, is right at the 100 mL mark.

3. Find the mass of the graduated cylinder with 100 mL of water in it. Record the mass in grams.

4. To find the mass of the water only subtract the mass of the empty graduated cylinder from the mass of the graduated cylinder and the 100 mL of water. Record the mass of 100 mL of water in the chart.

5. Use the mass and volume of the water to calculate density. Record the density in g/cm^3 in the data table.

6. Pour off water until you have 50 mL of water in the graduated cylinder. If you accidentally pour out a little too much, add water until you get as close as you can to 50 mL.

7. Find the mass of 50 mL of water. Record the mass in the data table. Calculate and record the density.

8. Next, pour off water until you have 25 mL of water in the graduated cylinder. Find the mass of 25 mL of water and record it in the data table. Calculate and record the density.

Data Table:

Finding the density of different volumes of water			
Volume of water	100 milliliters	50 milliliters	25 milliliters
Mass of graduated cylinder + water (g)			
Mass of empty graduated cylinder (g)			
Mass of water (g)			
Density of water (g/cm^3)			

Conclusion Questions and Graph:

1. Look at your density for each amount of water in your chart.

Density for 100 mL = ________ Density for 50 mL = ________ Density for 25 mL = ________

What number are these closest to? **Circle one: 0/1/2/3**

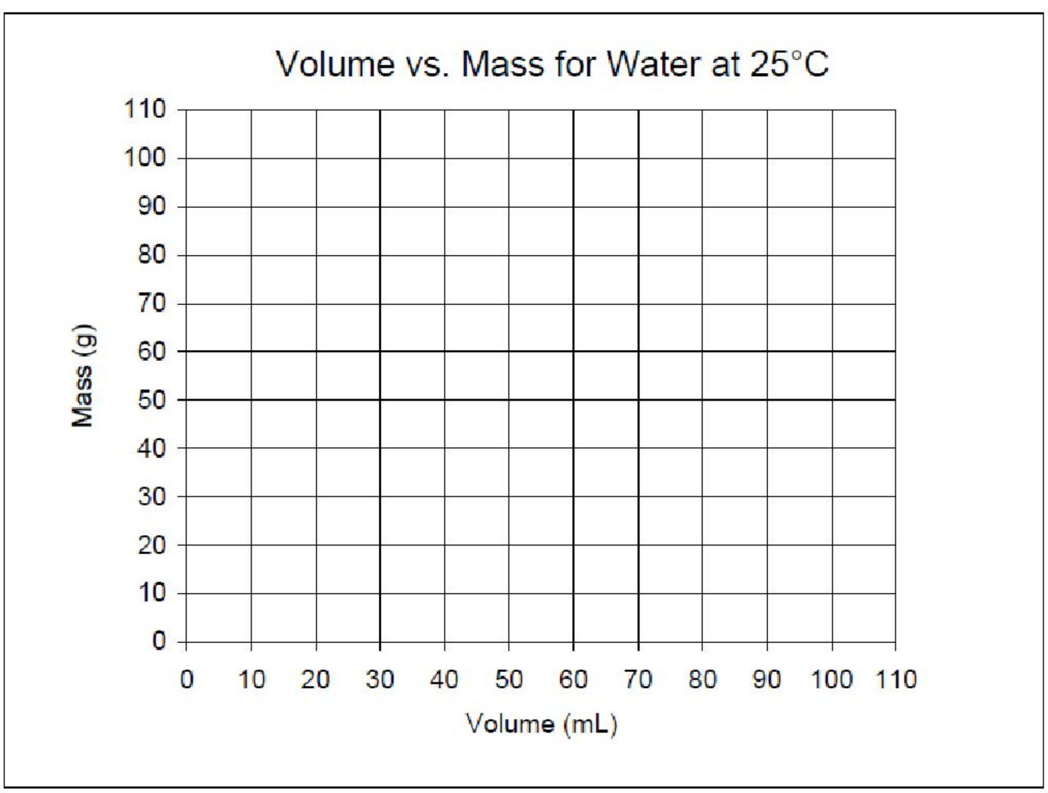
Does the density of the different volumes of water seem to be about the same? **Circle one: Yes/No**

2. What do you think is the density of water in g/cm^3?

The density of water is ___________________

Using the data from your chart, create a line graph using volume and mass for 100 mL, 50 mL, and 25 mL of water.

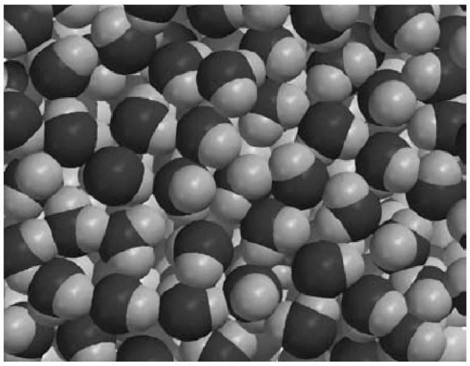
Volume vs. Mass for Water at Room Temperature



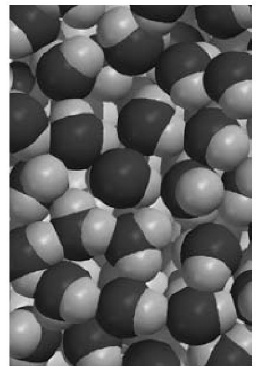
3. Use the graph to *predict* the mass and density. If you measured 40 milliliters of water, what do you think its mass would be? What would its density be?

Volume: 40 mL
Mass: ___________
Density: _________

4. Each water particle has the same size and mass. The water molecules are packed close together the same way in each sample of water.



Sample A



Sample B

Sample B is half the volume of Sample A.

1. Do the samples have the same mass? **Circle one: Yes/No**
2. Do the samples have the same density? Explain.

   ____Sample A and Sample B have (Circle one: the same/different) densities. I know this because ____

   ____

SECTION FIVE

Closing Thoughts

As our population of English Language Learners continue to grow, there will be a need for disciplinary curricula that have modifications to support ELLs. The purpose of this curriculum development project was to identify a science curriculum that included grade level-appropriate content, along with tlanguage modifications and support materials for both the students and educator. The research question that supported the development of this curriculum was, *How do we meet emergent ELL students at their level in the middle school science classroom?*

Through the literature review, there were two main lesson structures that effectively emphasized a focus on both the language and science content. The two frameworks were SIOP which supported the language development, with the 5E model, which supported the science content. The literature supports the use of inquiry-based learning, where students are investigating and using hands-on lessons to create their understanding of new concepts. Using these frameworks helped with the construction of the lessons plans, created for the present curriculum.

The curriculum development was informed by the research that was done to focus on the specific needs of this population of students. A few of the specific needs that this curriculum focuses on is the prior knowledge, frontloading information, vocabulary, higher-level thinking, and connecting language and content standards. Through the development of this curriculum I was able to create an emergent-level, middle school science curriculum that supports ELLs to be successful within the classroom.

I look forward to using this curriculum in my emergent ELL science classroom. As I was completing my research I started to make changes to the lessons I implemented this year and I can already see my students making stronger connections. I have been able to use the language connection with their science labs and activities to support their understanding and use of new content vocabulary. I will also be sharing this curriculum with colleagues within my building, since we are the only middle school that houses the emergent ELL program in our district.

The strengths of this curriculum are that it is specifically made for this emergent ELL population, focusing on needs and frameworks that are research-based and have shown student success. This curriculum provides information for the educator as well as materials that support ELLs in the middle school science classroom. Some weaknesses that I could see would be new students that come into the classroom midyear, might be overwhelmed with the activities. For these new students, attending school and interacting with peers who have different native languages may be something they have never experienced before. This can also be problematic if they do not have the foundational expectations of how a classroom runs throughout the day. This curriculum also does not include the safety rules that should be discussed before each lab. Safety rules should be explicitly taught before any lab to ensure the safety of all students in the classroom.

I would suggest to peers who would like to advance on this work, that they focus on incorporating ideas to bridge the cultural gap within a classroom. This curriculum was science focused but I know that many of my students struggle with working together and understanding the importance for science safety rules and in general school rules. These foundational expectations are critical to a classroom culture of collaboration.

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