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Middle Grades in Southern Appalachia: Developing a Thanksgiving Themed Cross Curricular Approach to Teaching the International System of Units

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ABSTRACT (Times New Roman typeface and 10 points)
In the United States, the continued reliance on non-SI (International System of Units) measurements presents a challenge for students in STEM-related fields. This disconnect can hinder conceptual understanding and career readiness. This study explores how a multidisciplinary, culturally grounded approach to teaching unit conversion can enhance student engagement and comprehension. Conducted in the Southern Appalachian region, the project integrated math, science, English Language Arts, and history through a cross-curricular lesson centered around a widely celebrated national holiday. By incorporating local recipes and cultural traditions, the lesson demonstrated the real-world relevance of SI measurements. The study was guided by three research questions focused on conceptual understanding, instructional opportunities, and the challenges of designing culturally responsive, interdisciplinary curriculum. This work contributes to the fields of STEM/STEAM education and interdisciplinary pedagogy and offers a replicable framework for integrating SI instruction into regionally relevant lessons.

Keywords: Interdisciplinary Education, STEM/STEAM Pedagogy, SI Units. Culturally Responsive Teaching, Southern Appalachia

Introduction

Rational and Purpose of the Study

In an increasingly globalized world, it is essential for students to be familiar with the International System of Units (SI). The International System of Units (SI) is a system of standard measurements utilized by much of the world, but it "is now common knowledge that the U.S. is one of a handful of countries that still use non-SI measurements in our daily lives and in many commercial transactions." (Lippa, 2025) This disconnect between systems of measurement that students use at home versus what they are expected to use in STEM fields can cause confusion and lack of career readiness.

This study addressed the issue by creating a multidisciplinary lesson incorporating the core subject areas of Math, Science, English Language Arts, and History. Multidisciplinary, or interdisciplinary, teaching creates a holistic, in-depth approach that engages students. (Mishra, N., & Aithal, P. S., 2023; PRASAD, N. N., 2024; Braskén, M., & Pörn, R., 2021; Cohen, E., Novis-Deutsch, N., Kashi, S., & Alexander, H., 2024) Traditional methods of teaching tend to isolate Math from other subject areas. This study adopted a STEM/STEAM pedagogical approach in order to address the International System of Units (SI) and incorporate the necessary mathematical concepts across the disciplines.

The United States' use of non-SI measurements can also be viewed through a cultural lens. This study was conducted in the foothills of Southern Appalachia and made use of a popular national holiday to demonstrate the applicability of SI measurements in the students' daily lives. Studies show that incorporating real-world projects in STEM/STEAM lessons – even in the digital age – have a positive impact on student learning. (Boss, S., & Krauss, J., 2022; Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F., 2021) This study incorporated regional recipes associated with the national holiday of Thanksgiving to engage students, show respect to local traditions, and demonstrate the application of SI measurements.

Research Questions

The following questions guided this study:

1. How can a multidisciplinary approach to teaching unit conversion support deeper conceptual understanding across subject areas such as math, science, ELA, and history?
2. What instructional opportunities emerge when measurement and conversion skills are embedded in a culturally grounded, cross-curricular lesson?
3. What challenges and possibilities arise when designing interdisciplinary curriculum centered on real-world, seasonal, or regional contexts?

Significance of the Study

This study contributes to the growing field of multidisciplinary education and STEM/STEAM education. Of particular interest is this study's geographical location of Southern Appalachia, a region whose cultural traditions and seasonal practices provide meaningful opportunities to connect measurement and unit conversion to lived experience. While integrated STEM/STEAM models are not new, this study offers a unique contribution in several ways:

- **Regional and cross-cultural grounding:** The lessons connect Southern Appalachian/United States methods of measurement with Korean/International methods of measurement, creating a culturally responsive and globally aware context.
- **Food and holiday context:** By using recipes and holiday traditions as the entry point, students explore measurement in authentic, meaningful ways.
- **Human story origin:** The lesson emerged from a genuine dialogue between a Korean graduate student and a U.S. professor, embedding relational and experiential dimensions into the curriculum.
- **Replicable process:** The model can be adapted to other holidays, cultures, and regions, providing a generalizable approach for interdisciplinary, culturally grounded instruction.

By situating a cross-curricular lesson in these contexts, this research demonstrates how interdisciplinary design can create deeper conceptual understanding and richer instructional opportunities. This approach addresses both the possibilities and challenges of designing culturally responsive STEAM curriculum.

Literature Review

The purpose of this study was to contribute to the field of STEM/STEAM education in Southern Appalachia. The creation of a culturally relevant, cross-curricular lesson for middle grades students is no easy task. A review of the literature is presented here to provide a background on multidisciplinary curriculum design, the region of Southern Appalachia, use of the International System of units, and the importance of Thanksgiving as a regional holiday.

Cross curricular/Multidisciplinary Design

Multidisciplinary instruction is often referred to using related terms such as interdisciplinary instruction, integrated teaching, thematic instruction, cross-disciplinary teaching. It involves integrating multiple subjects into teaching to foster a deeper understanding of complex issues, offering students a holistic learning experience (Drake et al., 2004). This approach has demonstrated significant effectiveness in secondary education. For example, Stathopoulou et al. (2014) implemented interdisciplinary teaching in an 11th grade mathematics classroom by integrating language, social study, history and science. This study revealed that students not only enhanced their creativity in this process but also transformed their perceptions of mathematics. As a result, they developed a greater appreciation for the role of mathematics in society.

Multidisciplinary teaching often involves thematic instruction, which offers a number of advantages. Ye and Xu (2023) found that interdisciplinary thematic teaching enhanced middle school students' creativity, communication, and collaboration. By using real-world themes, students became more engaged and demonstrated improved problem-solving skills. This

approach has also shown effectiveness in boosting student academic performance compared to traditional teaching methods (Barancová et.al, 2024). Furthermore, learners integrate knowledge and modify their worldviews or perspectives as they engage in cross-disciplinary teaching. Billingsley et al. (2018) discussed how interdisciplinary teaching can develop children's epistemic insight-understanding the nature of knowledge, and how disciplines interact-and how this approach enables students to integrate knowledge across fields and reconsider their perspectives on complex issues.

Math

Multidisciplinary instruction in the math class was achieved by covering transformation between imperial and SI units, which is the central theme of this project. Goos, Carreira, and Namukasa (2023) pointed out that mathematics should not be used merely as a tool but should retain its disciplinary integrity in multidisciplinary instruction. In this math class, the integrity of mathematics is preserved by going beyond simple unit conversions and expanding to algebraic expressions and their substitution, which strengthens both procedural and conceptual understanding (Taylor & Hwang, 2021). Since unit conversion is usually expressed using variables, it is natural to connect algebraic expression to conversion between SI and imperial units, further supporting academic vocabulary and mathematical thinking for all learners, including those with learning disabilities (Cho & Kim, 2023). Additionally, the Universal Design for Learning (UDL) framework was applied throughout the curriculum to support diverse learners by incorporating multiple means of representation, engagement, and expression, in line with current best practices for STEAM education and inclusivity (Thoma et al., 2023).

Science

Integrating multidisciplinary learning in science education brings significant benefits to students' cognitive and emotional growth. Paugh and Wendell (2021) showed that adding disciplinary literacy to an elementary engineering unit, guided by Systemic Functional Linguistics (SFL), improved students' mechanistic reasoning and understanding of engineering concepts. This approach helped students make informed language choices, leading to deeper engagement with scientific content. Similarly, English (2023) found that sixth-grade students who engaged in multidisciplinary modeling during a tsunami investigation were able to effectively apply mathematics, science, and statistics to real-world problems. The study emphasized the importance of giving students opportunities to create their own models, which fosters creativity and a stronger grasp of STEM practices.

Additionally, Güven and Alpaslan (2022) explored how interdisciplinary science activities impacted fifth-grade students' creative problem-solving and 21st-century skills. Their research revealed significant improvements in students' ability to manage knowledge, solve problems, and apply what they had learned to everyday situations. The study highlighted the role of interdisciplinary teaching in enhancing students' cognitive, emotional, and socio-cultural skills. Together, these studies underscore the value of multidisciplinary learning in science, showing how it promotes critical thinking, creativity, and the ability to apply knowledge in various contexts. By implementing these approaches in elementary education, we can equip students with the essential skills to handle complex real-world challenges.

Social Studies

Research shows that providing students with a cross curriculum environment helps better them for the real world. Within the Social Studies classroom, lesson designs including ELA, Mathematics, or Scientific elements allow students to create stronger connections. Erie Team describes how cross-curricular integration "…is the process of connecting a topic which is traditionally taught as a stand-alone subject (EiE Team, 2023)." Lauren Chiangpradit explains how the combination of subjects within the classroom allow students to find interests in subjects they may not be as interested in by integrating it with a subject they do have interests in (2023). The combination of different subjects allows students to collaborate in the classroom. Students are gaining the necessary skills to be able to effectively work with others which will carry with them into the real world (2013). Cross-curriculum strategies in the classroom allow students to further knowledge in areas while combining with their subject. It allows for skills to be built that will follow students throughout their professional careers.

English Language Arts

Prior research shows that incorporating multidisciplinary learning into English Language Arts (ELA) classrooms can have positive impacts on student comprehension and engagement. Burke and Peterson (2007) found that through multidisciplinary units, students "developed a deeper appreciation…established a real emotional connection…[and] drew on and furthered their extensive knowledge of visual elements." In addition, Burke and Peterson also noted that the ability of students to read texts in secondary curricula was heightened by cultivating development of print and visual literacies. ELA curricula can incorporate visual and hands-on elements in order to connect student learning to other disciplines. Interdisciplinary learning is achieved through the implementation of real-world experiences and themes. Building upon concepts learned in different content areas enables students to make authentic connections.

Southern Appalachia

The Appalachian region has captured the attention of researchers since 1898. The historical, and unfortunately still prevalent, view of Appalachia has been that of a subculture of poverty (Walls, D. S., & Billings, D. B. 1977). While the "Appalachian context is often described through a deficit model approach," there are studies being conducted that celebrate the contributions and resilience of the region (Childers, G., & Elz, H., 2022). As a subregion, Southern Appalachia is unique in that it encompasses aspects of both Appalachia and the South, blending traditions, histories, and identities in ways that distinguish it from other parts of the region (Ulack, R., & Raitz, K.,1981;Griffin, L. J., & Thompson, A. B., 2002; Ford, T. R. (Ed.).,2014). This dual identity offers a particularly compelling lens through which to examine the issues and development of education in the region today.

International System of Units

The International System of Units (Système International d'Unités, SI) serves as the globally accepted standard for measurement, utilized extensively across scientific, industrial, and educational domains worldwide (Bureau International des Poids et Mesures [BIPM], 2019; BIPM, 2023). The SI system traces its roots back to the metric system established in France during the late 18th century. It was officially adopted by the 11th General Conference on Weights and Measures (CGPM) in 1960, aiming to unify and simplify the global measurement

standards (BIPM, 2019). Over the decades, the SI has undergone significant revisions to improve precision and universality, notably in 2019, when four of the seven base units—the kilogram, ampere, kelvin, and mole—were redefined based on fixed values of fundamental physical constants (BIPM, 2019). This landmark revision enhanced the stability and reproducibility of SI units, eliminating reliance on physical artifacts.

The SI system is built upon seven base units that correspond to fundamental physical quantities, which are combined to define derived units used across scientific disciplines (BIPM, 2023). The base units include:

Table 1. International System

Physical Quantity	Unit Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric Current	ampere	A
Thermodynamic Temperature	Kelvin	K
Amount of Substance	mole	mol
Luminous Intensity	candela	cd

Also, derived units such as newtons (N) for force and joules (J) for energy are expressed in terms of these base units, facilitating consistent and coherent representation of all measurable quantities.

The adoption of the International System of Units (SI) plays a vital role in ensuring consistency, precision, and global interoperability in science, education, and industry. By offering a standardized measurement framework, the SI system reduces errors and miscommunication in international collaboration and facilitates a clearer understanding of scientific concepts among students. A well-known example illustrating the consequences of inconsistent measurement systems is NASA's Mars Climate Orbiter mission failure in 1999, which resulted from a conversion error between imperial and metric units, ultimately leading to the spacecraft's loss (Wilford, 1999).

Despite these risks, the United States remains one of the few countries that has not fully adopted the SI system in everyday life, continuing to rely on customary units such as inches, pounds, and Fahrenheit in commerce and daily activities. This dual-system environment poses educational challenges, as students must navigate between informal exposure to non-SI units at home and the expectation to use SI units in academic and professional STEM contexts. Consequently, researchers and educators emphasize the need for integrated, culturally responsive instruction that bridges this divide and promotes fluency in SI-based measurement to ensure students' scientific literacy and global career readiness.

Research Design and Methodology

Who

This research method allowed for an exploration of specific and meaningful context: the implementation of a curriculum designed by teacher education students for middle grades learners in Southern Appalachia. As Janesick (2004) notes, the first question a researcher must address is, who? In this study, "who" refers not only to the individuals who designed and implemented the curriculum, but also to the students who engaged with it in the classroom setting.

This study involved six students—two undergraduate and four graduate students—each pursuing degrees in secondary education. Among the participants, four identified as female and two as male. The two undergraduate students were both female, while among the graduate students, two were male and two were female. These students collaboratively developed a curriculum as part of their coursework, with guidance and mentorship from two faculty members in the education department.

The curriculum they created was implemented with middle grade students located in the Southern Appalachian region. The middle grades students are not the primary focus of the study, but they are important to understand the context in which the curriculum was delivered. Their engagement and responses shaped how the curriculum was experienced and refined.

Purposeful sampling was used to select participants for this case study. The teacher education students were chosen based on their enrollment in a course that integrated curriculum development with field-based implementation. Similarly, the middle grades classroom was selected due to its accessibility, the teacher's willingness to collaborate, and its relevance to the regional focus of the study.

Why

It is essential to articulate why any study is undertaken. As Neale, Thapa, and Boyce (2006) explain, studies are often selected because they are exemplary, effective, or of special interest. This project reflects that notion in several meaningful ways.

This study was conducted to demonstrate the power of multidisciplinary curriculum design. In a time when STEM and STEAM education dominate the conversation around curriculum innovation, this project affirms that social studies and English Language Arts belong in that conversation. The integration of content across disciplines shows that students benefit from learning that reflects the complexity of the world around them.

The study is significant because it places Southern Appalachia at the center of the narrative. This region holds a rich cultural, historical, and intellectual tradition but is often overlooked. By situating the curriculum in Southern Appalachia, the study challenges deficit narratives and affirms that this region contributes to the broader educational landscape.

The "why" for this study is simple. This study matters because it helps reimagine what curriculum can look like when disciplines are not siloed, when underrepresented regions are given voice, and when teacher preparation is connected to the real work of schools and communities.

Where

This study was situated in Southern Appalachia, a region often underrepresented in education research. It was conducted at a regional university known for its strong teacher preparation program and commitment to research. The curriculum design process took place within this university setting, while implementation occurred in a local middle grades classroom. These settings grounded the project in both theory and practice.

The participants brought a global perspective to a local context. The two undergraduate students and one of the faculty mentors are from the United States. The four graduate students are from the Republic of Korea and were enrolled in a master's program housed at the university. The second faculty mentor is from the People's Republic of China. This diversity of backgrounds enriched the curriculum design process and contributed to a broader, more inclusive perspective on teaching and learning in the Southern Appalachian region.

How

The current project adopts an interdisciplinary framework to design a series of six lesson plans for sixth grade classrooms. Rooted in students' real-life contexts, the lesson plans integrate content from math, science, language arts, and social studies, aiming to examine how students synthesize knowledge from diverse disciplines to address complex problems. To support effective learning, the lessons incorporate evidence-based strategies, such as graphic organizers, which enhance comprehension while fostering critical thinking and problem-solving skills (İlter, 2016; Cho & Kim, 2023). Additionally, the lessons also embed cross-cultural awareness to prepare students for a globalized world, helping them become more adaptable, inclusive, and engaged, and better equipped to navigate an interconnected and diverse society.

Confliction of Interest Statement

The faculty members involved with this study provided guidance and mentorship to the graduate and undergraduate student participants during the curriculum development process. They did not influence the reporting or interpretation of outcomes, and the authors declare no conflicts of interest.

Data Collection

English Language Arts

Standards

The Alabama Course of Study Standards for English Language Arts (2021) were taken from the Alabama State Department of Education and used in the designing of this curriculum. The standards used in the ELA lessons are as follows:

ELA21.6.R1- Utilize active listening skills during discussion and conversation in pairs, small groups, or whole-class settings, following agreed-upon rules for participation.
ELA21.6.7- Produce clear, coherent narrative, argument, and informative/explanatory writing in which the development, organization, style, and tone are relevant to task, purpose, and audience, using an appropriate command of language.

These standards provided the foundation for the course goal in the ELA lessons, which allowed students to grasp the objectives of the curriculum.

Course Goals

Course goals were created in the curriculum to ensure alignment with the Alabama Course of Study Standards. For the ELA lessons, students reconstructed a Southern Appalachian Thanksgiving recipe and created a recipe for peanut butter and jelly sandwiches in order to produce specific written directions. In addition, students expressed their opinions in whole group discussion to utilize active listening and discussion skills, constructed a peanut butter and jelly sandwich to follow written directions, and provided constructive peer review feedback in order to produce specific informative writing. These course goals laid a framework for the design of the lesson.

Science
Standards

In middle school science education (Grades 6–8), the Science and Engineering Practices (SEPs) help students understand how scientific knowledge is developed. Students engage in quantitative investigations, distinguish between correlation and causation, and apply basic statistics and error analysis to interpret data. They also use mathematical and computational thinking to identify patterns and support scientific explanations. Crosscutting Concepts (CCCs) link scientific ideas across disciplines, fostering a deeper understanding of natural phenomena. A key CCC in Grades 6–8 is *Scale, Proportion, and Quantity*, through which students learn unit conversions (e.g., speed, mass, volume), proportional reasoning, and scientific representation using formulas and ratios (Alabama Course of Study: Science, 2023).

These concepts are related with the following standards:

SC23.6.4 – Analyze and use data to determine scale properties and characteristics of objects in the solar system including sizes, distances, orbital periods, basic composition, and ability to support life.
SC23.6.8a – Plan and carry out an investigation to determine the differences in rates of energy transfer from the Sun to air, land, and water via conduction, convection, and radiation.

Course Goals

The goal of the lessons was to emphasize the importance of understanding both imperial and SI (metric) units within the context of science, building on concepts students had learned in other subject areas. By making real-world connections, the lessons aimed to help students see

the relevance of unit conversions in everyday situations. According to Jones and Cook (2017), the "SI-gap" not only hinders teachers' efforts to engage students in science, technology, engineering, and mathematics (STEM), but also limits students' ability to accurately assess the validity of their own results. To actively participate in integrated STEM fields, students must be fluent in using and converting SI units. National standards, including those outlined by the National Council of Teachers of Mathematics (NCTM, 2015), stress the importance of structuring curricula to develop students' proficiency in measurement. Therefore, the objective was to ensure students could understand how units are applied in scientific contexts and become fluent in converting between units related to key concepts such as weight, volume, speed, and distance.

History

Standards

For the social studies section of this project, the 9th grade, seventh standard was used as the students participating in the study proved to be more advanced in their studies after observations of these classes were conducted. The seventh standard for 9th grade in the Alabama Course of Study states that students should be able to "describe the impact of the French Revolution on Europe, including political evolution, social evolution, and diffusion of nationalism and liberalism" (Alabama Course of Study, pg. 68). Within the additional content that was required, the students were taught the causes of the French Revolution. This standard was used throughout the entire lesson to explain to the students the French Revolution. Students were taught the causes of the war while using graphic organizers. The lesson itself was an interactive lecture that allowed the students to be interactive with each other as well as with the teacher. The teacher walked through the effects of the war and explained how the international system of units came to be through the feelings and thoughts after the French Revolution. It was during this section of the lesson that the teacher was able to incorporate the multidisciplinary portions of the next lessons to come from ELA, math, and science. There was an emphasis on the importance of the SI system and the role it continues to play throughout the students' daily lives.

Course Goals

The course goals for this specific lesson were for students to understand the importance of the French Revolution. This was done by conveying causes and effects of the war. One of the outcomes of the war that was emphasized was the ideas that emerged post-war. This was done in order to highlight the cross-curricular aspect of the lesson and incorporate themes from science, math, and ELA lessons that would follow the social studies section. It allowed for a perfect set-up for the multiple lessons to follow in which the students would be engaging with the SI system through various subjects.

Math

Standards

The lesson aligned with the 2019 Alabama Course of Study standard MA19.6.15, which emphasizes writing, reading, and evaluating algebraic expressions in which letters represent numbers in real-world contexts (Alabama State Department of Education, 2019). This standard is particularly relevant to the topic of unit conversion, as such conversions are commonly represented using variables in algebraic expressions. For instance, the conversion formula

between Fahrenheit and Celcius, C=(F-32)59 and F=(C95)+32, are expressed using variables C and F. By engaging with these types of formulas, students not only practice algebraic reasoning but also gain an understanding of how variables and expressions are used to solve practical problems, thereby reinforcing the importance and applicability of algebra in everyday life.

Course Goals

The course goal for the math class was as follows. Students will focus on weight and volume, emphasizing unit conversion and solving related problems through practical applications. Students can understand and use the expression of the conversion between Fahrenheit and Celsius in order to convert between Fahrenheit and Celsius as used in recipes and weather in real-world scenarios.

IRB Protocols

Institutional Review Board (IRB) approval is not required for this curriculum design project because it does not involve human subjects research. According to federal regulations (45 CFR 46.102), research requiring IRB oversight includes studies involving "a living individual about whom an investigator... obtains information or biospecimens through intervention or interaction,
and uses, studies, or analyzes the information or biospecimens." This project does not meet these
criteria for the following reasons:

1. No Human Subjects Involvement
2. No Collection of Identifiable Data
3. Focus on Materials, Not Individuals.

Analysis

English Language Arts

Lesson Design

Students interacted with the parts of a recipe by reconstructing a Southern Appalachian Thanksgiving recipe and creating a recipe for peanut butter and jelly sandwiches. Students also expressed opinions on the importance of recipes to various cultures in whole group discussion and then constructed a peanut butter and jelly sandwich. The lesson design of the ELA curriculum was created using a teaching model that focuses on four learning styles to increase engagement in the classroom. According to a study conducted at the collegiate level, researchers found that the application of this method “increased learner motivation and engagement, and provided students with greater opportunities for practice and application of their learning in settings outside of the classroom” (Nicoll-Senft & Seider, 2010). The ELA lessons use this model to help students engage with and appreciate the writing process. Each activity within the curriculum was designed to appeal to one of the four types of learners: imaginative, analytic, common sense, and dynamic. At the conclusion of the final lesson, students engaged in peer review. At the conclusion of the lesson, students were given a peer review worksheet to provide feedback on their partner’s recipe. Completing a peer review allows students to reflect on their own writing abilities, as well as their partner’s. Students provided two “glows” and one “grow,” giving their partner positive, yet constructive feedback.

Reflection

After designing and teaching the curriculum came the opportunity for reflection. The nature of this study was such that the lessons were taught to two separate sixth grade classes. In each classroom, management strategies differed based on student needs. Strategies such as giving specific verbal praise, calling all students by name, and having students verbally repeat directions were all implemented into the ELA lessons. These management strategies allowed the activities to run more smoothly, further encouraging student engagement. The levels of comprehension also varied from student to student, which made the use of the implemented teaching model extremely relevant. The comprehension levels also changed the pacing of the lessons in each class, requiring adaptation to the activities in order to keep students engaged throughout the lesson. Students effectively incorporated prior knowledge from the first ELA lesson to complete activities in the second lesson. The incorporation of the Thanksgiving holiday also engaged students, since the holiday is a familiar one. The inclusion of peer review at the conclusion of the lesson also provided students with the opportunity to reflect on their own work, further emphasizing the real-world connections made within the lesson.

Science

Lesson Design

To introduce the lesson, the students were presented with two chocolate chip cookie recipes—one using the imperial system and the other using the metric system. The students were asked which recipe felt more familiar to them; most identified the imperial system, citing units such as cups, teaspoons, and pounds. This provided a natural transition to introducing the metric system, particularly the use of grams. The importance of understanding both systems was emphasized, noting that in science—especially in chemistry—grams are used to measure the mass of atoms and molecules. Since the students were in sixth grade, the explanations were simplified to ensure accessibility and engagement.

To introduce the concept of moles in chemistry, the students were given an analogy they could relate to: atoms were compared to Lego pieces, and moles to dozens of eggs. This helped them grasp the idea that a mole is simply a standardized quantity of particles, similar to how a dozen refers to twelve items. To reinforce the concept, they practiced converting the mass of one mole of various elements, such as carbon, copper, and zinc, between pounds and grams.

The focus was then shifted to volume measurements by revisiting the conversion between fluid ounces and liters. To create a culturally relevant and engaging context, the students from the United States were introduced Galbi, a traditional Korean dish often served during Korean Thanksgiving. It was recommended that the students try it if they had the opportunity and used its recipe as a real-life example of why accurate unit conversions matter—particularly when interpreting international or scientific recipes. This linked it to the scientific importance of liters, which are used to measure the volume of liquids and gases in chemistry.

Building on this, the topic of phase changes was introduced—a concept students had previously encountered—and connected it to the role of volume in different states of matter. Students demonstrated a strong understanding of the relationship between intermolecular forces and volume in solids, liquids, and gases. The exception of water expanding when it freezes was addressed, briefly explaining the role of hydrogen bonding. To reinforce learning, students practiced converting between volume units (e.g., fluid ounces to liters and vice versa), using familiar visual aids such as images of water bottles to support comprehension.

Reflection

While preparing these lessons, one of the graduate students was reminded of their first visit to the United States. During a grocery shopping trip, the graduate student found it challenging to decide how much of a vegetable to buy because the items were measured in pounds, instead of the more familiar grams. This experience highlighted the importance of understanding measurement systems—especially as a science teacher. Many countries, including South Korea, use the metric system, which is also the standard in scientific disciplines. As a student, the graduate student had little difficulty learning scientific measurements because it was already the familiar units of measurement. However, since the United States primarily uses the imperial system, the graduate student realized that helping students become comfortable with both systems could support their learning and make science more accessible.

The goal was for students to explore how metric units are used in scientific measurements and understand how these units connect to real-world situations. The graduate student explained the concepts, provided practical examples, and guided students through hands-on unit conversion exercises. Although some students initially struggled with complex calculations and working with decimals, they gradually developed confidence as their understanding deepened. By the end of the lesson, most students demonstrated a clear grasp of the importance and application of unit conversions. This lesson was personally meaningful, as it allowed one of the graduate students to connect their own experience with their teaching practice. It also influenced the way that the graduate student will approach future lessons—reinforcing the importance of unit conversions when teaching scientific measurement to help bridge students' understanding between academic content and everyday life.

Math #1
Lesson Design

Building on the preceding history lesson, in which students explored the origins of the International System of Units (SI), the first mathematics class was intentionally designed to deepen conceptual understanding of SI units through authentic, cross-curricular instruction. The lesson situates algebraic reasoning and unit conversion within the culturally relevant context of Thanksgiving-themed recipes, making mathematical concepts accessible and meaningful for middle-grade students in Southern Appalachia. This design not only supports disciplinary learning but also fosters interdisciplinary connections and cultural awareness (Goos, Carreira, & Namukasa, 2023).

Central to the lesson's instructional approach was the application of the Universal Design for Learning (UDL) framework, which informed both the structure and delivery of activities. UDL was operationalized by providing multiple means of representation (e.g., visual graphic organizers and unit conversion tables), multiple means of engagement (e.g., culturally relevant recipes and collaborative problem-solving), and multiple means of expression (e.g., group discussions, written reflections, and verbal explanations). Incorporating UDL principles into STEM/STEAM instruction has been shown to enhance accessibility and engagement for students with diverse needs, including those with disabilities (Taylor & Hwang, 2021; Thoma et al., 2023). By intentionally embedding UDL, the lesson accommodated varied learning preferences and promoted equitable participation, ensuring all students could access rigorous mathematical content (Cho & Kim, 2023). The instructional sequence commenced with an

activating task in which students examined various weights presented in both customary U.S. and SI units, prompting reflection on the real-life significance and utility of standard measurement systems. This introduction was intended to stimulate curiosity and establish a foundation for inquiry-based learning centered on the relevance of SI units in everyday contexts.

The core instructional activities began with the whole class working collaboratively to construct and interpret equations for converting between customary and SI units, such as converting fluid ounces to milliliters and ounces to grams. Through this process, students focused on understanding the algebraic structure of conversion formulas and how these equations are applied in real-world scenarios (Taylor & Hwang, 2021). Building on this foundation, students then worked in teams to apply the conversion equations to a practical context by converting ingredient amounts in the "Grammy's Creamed Potatoes" recipe. This group activity reinforced both procedural fluency and conceptual understanding through cooperative problem-solving (Cho & Kim, 2023). Finally, each student individually practiced additional unit conversions using a peanut butter and jelly sandwich recipe, allowing for further differentiation and adaptation to class pacing and individual needs. Throughout the lesson, the instructor consistently modeled mathematical reasoning, provided explicit explanations for each procedural step, and fostered peer teaching by encouraging students to articulate their problem-solving strategies. This approach, combined with UDL strategies, not only minimized misconceptions but also supported metacognitive development and ensured all students had access to the learning objectives (Thoma et al., 2023).

Importantly, this mathematics lesson was deliberately sequenced to serve as a foundation for subsequent science instruction. By providing students with opportunities to learn and practice key mathematical concepts—specifically, unit conversions and algebraic reasoning—this lesson equipped students with the skills necessary to meaningfully engage in later science activities involving measurements and physical changes. In practice, students were able to apply the mathematical concepts acquired in this class directly to the science lesson that followed, demonstrating effective transfer and functional integration across subject areas (Taylor & Hwang, 2021). The lesson concluded with a reflective summary, wherein students articulated what they had learned and considered the practical implications of mathematical concepts in real-life contexts. Formative assessment was embedded throughout, with student understanding evaluated via activity outcomes and peer explanations, allowing for targeted feedback and support.

Reflection

In the first mathematics class, instruction centered on constructing equations to convert recipe ingredient units into SI units, followed by substituting given x-values to solve for corresponding y-values. Each procedural step was explicitly explained with underlying reasoning, and similar problems were solved collaboratively to reinforce students' understanding and enable them to articulate the logic behind each step. Although calculator use was permitted, some students encountered difficulties performing fractional calculations. To address this, one member from each group was asked to present their solution strategy to their peers. This practice facilitated metacognitive reflection, enabling students to identify both correct conceptual understanding and potential misconceptions, thereby reducing computational errors.

In a subsequent class with a different group, the lesson was adapted to employ alternative instructional strategies aimed at fostering greater student interaction. This adjustment was informed by the varying levels of rapport between instructors and students, as well as prior consultation with the homeroom teacher regarding differences in mathematical ability. Across all classes, students generally reported that the allotted time for responding to questions was sufficient; however, many found SI units to be an unfamiliar concept, presenting initial challenges. By approaching the topic from multiple perspectives throughout the day, students became increasingly comfortable with SI units, ultimately meeting the instructional objectives.

Moreover, this mathematics lesson was integrated into a broader, Thanksgiving-themed cross-curricular project spanning mathematics, science, English language arts, and history. Students participated in a full day of interconnected lessons, each reinforcing the role and relevance of SI units across disciplines. This integrated, culturally responsive approach enabled students to recognize the interconnectedness of academic content, promoting both deeper understanding and greater engagement with abstract mathematical concepts (Thoma et al., 2023). By anchoring algebraic reasoning and unit conversion in authentic, culturally significant contexts and by employing the UDL framework to address diverse learner needs, this lesson design advances the research aim of making mathematics both accessible and meaningful for middle-grade learners in Southern Appalachia, while also serving as a replicable model for multidisciplinary STEM/STEAM education.

History

Lesson Design

Throughout the history lesson design, students were instructed to login into NearPod, an interactive lecture site. It was here that the teacher instructed students to pass around a graphic organizer where they could complete the sections that would be covered through the lesson. Throughout the lecture, students were able to discuss the causes of the French Revolution. This section had a corresponding part on their graphic organizer where they were able to fill this part in. Next, the teacher and students walked through the effects of the French revolution which was included on the graphic organizer. The last section of the lesson gave students an insight of what was to come throughout the remaining lesson of the day through Math, Science, and ELA. Students discussed the importance of the ideas that emerged from the French Revolution, which allowed for the creation of the International Systems of Units. After the closure of the lesson, students were instructed to look over their graphic organizer one last time before a short review game began. This game allowed the students to test their knowledge and the teacher to see the progress that was made. It also allowed the teacher to gauge each students' comprehension of the material that they were presented with during the lesson through this game. The site that was used for the lesson allowed the teacher to have a log of the students and their score by the end of the game.

Reflection

The goal for the students was to be able to build foundational knowledge prior to the lessons from Math, Science, and ELA. The students were able to learn and understand the history of the International System of Units. The graphic organizer allowed for the students to reflect back on the material throughout the lessons that were to come in order to fully understand.

Science

Lesson Design

From the beginning of the lesson, the intention was for students to reflect on the units they use in their daily lives or have learned in science class, such as oz, fl oz, kg, mL, L, km, mile, °F, and °C. In particular, the goal was for them to deepen their understanding of units of length, especially the meter. The daily objective for this lesson was to help students understand the relationship between kilometers and miles. It began by asking the students if they were familiar with the units of length commonly used in the United States, such as inches, feet, yards, and miles—and most students were. Then were then asked if they knew what a kilometer was. Although they had learned about kilometers in class and were somewhat familiar with the concept, it seemed less intuitive to them. To illustrate the difference, they were shown an image of a sign in the desert: it indicated that there was water 1 mile to the left and 1 kilometer to the right. The students were asked, "Which way should we go?" About half of the students chose the left, while the rest chose the right. A caption was added explaining that 1 kilometer is approximately 0.62 miles, and students quickly realized which distance was shorter. The teacher reminded the students once again that 1 mile is approximately 1.6 kilometers, and 1 kilometer is about 0.62 miles. To make this concept more relatable, the class imagined walking to the nearby football stadium and practiced converting that distance from kilometers to miles.

Next, they worked through another real-world example, calculating the distance to the airport for a Thanksgiving trip to visit relatives. We also converted the speed limit from miles per hour (mph) to kilometers per hour (km/h). After this activity, I wanted to give students a chance to engage in critical thinking. I shared that only about 5% of the world's population, including people in the United States, Myanmar, and Liberia - they still primarily use the imperial system. However, I also explained that some industries, such as aviation and display manufacturing, still use units like feet or inches regardless of the country's measurement system. Then, I posed a question: What if we converted all length measurements in our daily lives to the metric system? Students shared their thoughts, and we discussed the pros and cons of such a change.

Reflection

Part of the inspiration for this project began with a conversation between one of the graduate students and one of the faculty mentors. Coming quite literally from a different system of measurement, the graduate student initially found it difficult to intuitively grasp U.S. customary units such as Fahrenheit and the yard-pound system. The graduate student realized that if students in the United States were to visit or live in another country, they might experience the same confusion and challenges. The graduate student made it a goal to help students develop literacy in units and approached the lesson in a way that would make these concepts more accessible and meaningful to them. Throughout the process, the graduate student also identified areas for improvement—for example, having students convert their own height into meters, incorporating more scientific principles, or strengthening cross-curricular connections with other subjects. These reflections led the graduate student to consider how similar lessons could be adapted and applied more broadly across different grade levels in the future.

Math

Lesson Design

In the second math class, the lesson was introduced by recalling the recipe used in the ELA lesson. For this class, the ELA teacher introduced the recipe that included Celsius units. Pointing out the Celsius in the recipe, students were asked a question such as "how can we make the food on the recipe using the oven in Fahrenheit?" or "how can we make the food with the recipe in Fahrenheit in the other country where they use Celsius?" These questions helped students connect between different subjects and understand the needs for the unit conversion.

After introducing the lesson, students explored the conversion between units through connections to science and the real world. For the definition of Celsius and Fahrenheit for the conversion, the phase of the water is used which was covered at the previous science class. As Celsius and Fahrenheit are defined by phase change of water, students could use the definition of Celsius and Fahrenheit to derive out the degrees of Celsius and Fahrenheit when water is solid, liquid, and gas. Then the formula of the conversion is introduced using the definition. For the application of the conversion formula, real world context was used, which is comparing the temperature of Florence, AL and Seoul, South Korea on Thanksgiving Day and Chuseok. Students were asked to compare the temperature of Florence in Fahrenheit and Seoul in Celsius. To compare the temperature, students must convert the units. This activity allows students to try the formula in real-world contexts and get used to algebraic expressions.

At the end of the lesson, students wrote down what they learned about this lesson and project. By writing down what they learned on the project worksheet which is asked to write down at other classes in the project, students can reflect and metacognize the lesson and connect the lesson with other subjects in the project.

Reflection

The conversion between Celsius and Fahrenheit is covered in the second math class because its formula is more complex than those in the first math class. By placing the contents in order of complexity, students could approach algebraic expressions step by step. This strategy fits quite well and students seem to follow the lesson to achieve the goal.

Connectedness with other classes was the most considered component when designing this lesson and it was implemented successfully. Conversion between units connects to other classes as a main topic. The mashed potato recipe which was used to introduce the lesson connects to the ELA class. Students learned the formula for the conversion through phase change of water which was covered by the previous science class. The main theme, Thanksgiving Day, was also used by comparing temperatures of the U.S. in Thanksgiving Day and South Korea in Chuseok. These approaches enabled the mathematics lesson to connect to other subjects and made it a successful multidisciplinary lesson project.

Limitations and Implications

While this study contributes a culturally grounded, cross-curricular model for teaching unit conversion, several limitations should be noted. First, the research focused on two sixth-grade classes in Southern Appalachia, and the sample size was small. Although the purpose of this study was lesson design rather than measuring student outcomes, the specific age group and regional context may limit generalizability to other grade levels or geographic locations. Second, the study's methodology relied on the collaborative design and reflection of the research team rather than systematic student data. The team itself included eight

members - three from Southern Appalachia and five representing areas from around the globe - which may have introduced assumptions and perspectives that shaped the lesson design. Finally, while the lesson was grounded in specific holiday and food traditions, adapting it to other cultural contexts may require careful modification to ensure relevance and respect.

Despite these limitations, the study provides a replicable framework for integrating culturally responsive content into multidisciplinary STEM/STEAM lessons. Future research could explore adaptations for different age groups, regions, and cultural traditions, as well as the impact of such lessons on student learning outcomes and engagement. Additionally, the collaborative and cross-cultural nature of the research team highlights the value of diverse perspectives in designing interdisciplinary curriculum, offering a model for similar educational research efforts.

Conclusion

Throughout this multidisciplinary lesson, students became more aware of not just the International System of Units (SI), but also the importance of SI in a global world. This began as a conversation between a graduate student from the Republic of Korea and a professor from the United States and evolved into a lesson linking Korean and Southern Appalachian culture in a way that was relevant to sixth grade students. On a practical level, this research demonstrated the connections between English Language Arts, Social Studies, Math, and Science as a comprehensive STEAM lesson that is replicable in other classrooms. This integration illustrates how a multidisciplinary approach can deepen conceptual understanding by showing measurement and conversion not as isolated skills, but as ideas woven into culture, history, and global systems. While this research utilized the Thanksgiving holiday to emphasize the importance of SI, other holidays and other cultures can be used.

For example, this approach could be adapted to a range of holidays in which food plays a central role. Within a Southern Appalachian and United States context, recipes from Christmas, Easter, or Fall festivals provide opportunities to explore measurement through baking, canning, or cooking. Globally, traditions such as Korean Lunar New Year rice cakes, Indian Diwali sweets, Mexican Day of the Dead bread, or Jewish Hanukkah latkes also involve precise measurements that highlight cultural identity while reinforcing unit conversion skills. By situating lessons in these familiar and meaningful contexts, educators can connect abstract mathematical and scientific concepts to lived experiences across diverse cultures.
This demonstrates the instructional opportunities of grounding unit conversion in meaningful, culturally responsive contexts, while also raising challenges such as selecting contexts that are both respectful and accessible across diverse classrooms. Taken together, these outcomes directly address the guiding research questions by demonstrating how a multidisciplinary, culturally grounded approach to unit conversion reveals deeper conceptual understanding, creates rich instructional opportunities, and highlights both the possibilities and challenges of designing interdisciplinary curriculum.

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