Curriculum Units by

Fellows of the

Yale National Initiative

Guide

2019

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Preface

In March 2019 the Yale National Initiative to strengthen teaching in public schools® accepted teachers from eighteen public school districts in ten states and the District of Columbia to participate in five national seminars held at Yale University. The Initiative is a long-term endeavor to influence public policy on teacher professional development, in part by establishing exemplary Teachers Institutes for high-need schools in states around the country.

Teachers Institutes are educational partnerships between universities and school districts designed to strengthen teaching and learning in a community's high-poverty, high-minority public schools. Evaluations have shown that the Institute approach exemplifies the characteristics of high-quality teacher professional development, enhances teacher quality in the ways known to improve student achievement, and encourages participants to remain in teaching in their schools.

Thirty-two of the teachers, named Yale National Fellows, were from school districts that are planning or exploring the establishment of a new Teachers Institute for Chicago, IL; the Diné Nation, AZ and NM; the District of Columbia; Pittsburgh, PA; Richmond, VA; San José, CA, and Hearne, TX. Other National Fellows came from existing Teachers Institutes located in New Castle County, DE; New Haven, CT; Philadelphia, PA; and Tulsa, OK. Overall, more than half of the National Fellows were participating in national seminars for the first time.

The National Fellows attended an Organizational Session of the seminars held in New Haven on May 3-4. The seminars reconvened during a ten-day Intensive Session from July 8-19 and concluded in mid-August when the Fellows submitted their completed curriculum units. The five seminars were:

- "Reading for Writing: Modeling the Modern Essay," led by Jessica C. Brantley, Professor of English;
- "Energy Sciences," led by Gary W. Brudvig, Benjamin Silliman Professor of Chemistry;
- "The Problem of Mass Incarceration," led by James Forman, Jr., J. Skelly Wright Professor of Law;
- "Perimeter, Area, Volume, and All That: A Study of Measurement," led by Roger E. Howe, William R. Kenan Jr. Professor Emeritus of Mathematics; and
- "American Democracy and the Promise of Justice," led by Ian Shapiro, Sterling Professor of Political Science.

The purposes of the program are to provide public school teachers deeper knowledge of the subjects they teach and first-hand experience with the Teachers Institute approach to

high-quality professional development. This reinforces their leadership in an existing Teachers Institute or prepares them to lead the development of a new Teachers Institute. Each teacher writes a curriculum unit to teach their students about the seminar subject and to share with other teachers in their school district and, through the website at teachers.yale.edu, with teachers anywhere. The curriculum units contain five elements: content objectives, teaching strategies, examples of classroom activities, lists of resources for teachers and students, and an appendix on the district academic standards the unit implements. In these ways the curriculum units assist teachers in engaging and educating the students in their school courses.

The curriculum units National Fellows wrote are their own; they are presented in five volumes, one for each seminar. We encourage teachers who use the units to submit comments online.

The Yale-New Haven Teachers Institute® is a permanently endowed academic unit of Yale University, which undertook the National Initiative in 2004.

James R. Vivian

New Haven
August 2019

I. Reading for Writing: Modeling the Modern Essay

Introduction

Following on the model of English 120, a venerable Yale nonfiction course, this seminar was designed to draw connections between reading and writing, between how we analyze a writer's craft and how we create our own persuasive pieces of prose. The readings assigned in a composition course often give students something to write about, but they rarely serve as a direct model for students' own writing. For example, students read novels and write expository essays about them. Even when they read nonfiction, they write analyses that take up the same topics or questions without necessarily taking on the same rhetorical strategies. The 2019 Yale National Initiative seminar *Reading for Writing* explored ways of teaching writing through reading models and practicing craft.

Because extensive and thoughtful reading is always the basis for good writing, the seminar read and analyzed a large number of essays to serve as examples of excellence in the writer's craft. In a range of genres of creative nonfiction, we explored how talented writers shape personal experience to create public argument. Genres included: personal essays, profiles, cultural criticism, political argument, op-eds, humor, and reviews. Writers included: Virginia Woolf, George Orwell, Joan Didion, Frederick Douglass, E. B. White, Jhumpa Lahiri, Annie Dillard, Atul Gawande, Brent Staples, Chang-Rae Lee, David Foster Wallace, and Henry Louis Gates, Jr. As we read each essay, we asked ourselves in great detail how its writer had constructed it. Where were the "snaps," or moments of surprise? How did the essay begin and end? What kinds of local imagery or metaphor expressed the author's ideas? Most importantly, how did each author communicate the "public point" of a personal narrative?

After practicing this kind of analysis—reading "for craft"—we also explored the value of the workshop environment to crafting good and effective writing. After our introductory session in May, each Fellow wrote a 1500-word essay between May and July according to one of our models. These were personal essays, but each one at moments also tipped more or less towards other genres such as cultural criticism or humor. All of them had a public point that made an individual experience interesting and meaningful to readers who might not ever know the writer personally. Fellows arrived in July ready to circulate first drafts of their essays—not really "drafts," but best first attempts. We workshopped these first versions together, and, by this important process of reading and discussing our writing, learned to teach each other to become better writers and better teachers of writing. At the same time, Fellows were writing their curriculum units: a very different writing task. These curriculum units were designed to replicate the experience of our seminar in whatever way would be most valuable in the K-12 classroom, whether that meant asking high school students to participate in workshops just like ours, or showing kindergarteners how they can choose adjectives as carefully as the authors of the books

they are reading. Final drafts of the Fellows' own essays, perhaps revised even as they taught their units, were to be shared at the October conference meeting.

The curriculum units that came out of *Reading for Writing: Modeling the Modern Essay* are linked by methodology, even while they vary widely in topic. In each case, teachers seek to show students how asking "how?" rather than "what?" as they read a piece of writing can be valuable both as an interpretative strategy and also as a source of empowerment. Modeling offers young writers strategies for communicating their ideas powerfully and also implicitly invites them, even as they are learning, into a community of professionals.

Akela Leach, for example, reads Trevor Noah's *Born a Crime* with her class, not only to open their eyes to recent South African history, but to show them how they can admire and replicate Noah's storytelling skill. Ray Salazar's main goal for his high school students in Chicago is to show how professional models can help and inspire them as they develop their own writerly voices. Simon Edgett asks his high school students to keep in mind their purpose in writing and the audience they are writing for, analyzing essays according to those two criteria to find models. Sheilvina Knight uses diverse professional stories to inspire her younger students to express their individual identities through their writing. And LaKendra Butler analyzes the perennial favorite *Alexander and the Terrible, Horrible, No Good, Very Bad Day* in order to show her students how they too can use adjectives in a way that will charm their readers.

Many of the Fellows sought to use their writing units to address the problem of students' dislike or even fear of writing. Brandon Barr declares "The Death of the Five Paragraph Essay" as he asks his students to write more freeform profiles or personal experiences. Liz Isaac seeks to foster a love of writing in environments where most students' experience has been discouraging, and Jennifer Frasher encourages good writing by valuing risk above rigor. Lauren Freeman hopes that her students' learning experiences will transform them from caterpillars into butterflies while Debra Jenkins reassures (and also challenges?) her students, offering the freedom to code-switch knowingly in "You ain't gotta write like you speak." Finally, keeping in mind the importance of a "public point" even in a personal essay, Lisa Yau shows her students that even though writing is a personal, individual, enterprise, it also (conversely) comes from and speaks to community.

The seminar community that produced these curriculum units helped all of us involved to become more sensitive readers and more thoughtful writers. I hope that the units themselves help to convey that sense of common writerly purpose to K-12 students all over the country.

Jessica Brantley

Synopses of the Curriculum Units

19.01.01
The Death of the Five Paragraph Essay: Reading and Writing the Modern Essay in Middle School, by Brandon Barr

In this unit, students will be introduced to the genre of profile and personal experience essays. Students will read four pieces: "Learning to Read," by Frederick Douglass, "From An American Childhood," by Annie Dillard, "On Dumpster Diving," by Lars Eigher, and "Under the Influence," by Scott Russel Sanders. For each piece of literary nonfiction, key passages are explored, and supplemental web resources are provided to help frame the analysis. By the end of the unit, students select whether to write either a profile or a personal experience essay using class readings as models.

This unit is designed for sixth grade students to build knowledge of writing craft by exploring literary nonfiction. The conversations that revolve around each passage scaffold the type of writing that is expected of students as they write independently. The unit could be used in middle school or high school art, humanities, or English classes. It assumes little-to-no background knowledge in literary nonfiction.

(Developed for Language Arts, grade 6; recommended for English, grades 6-12)

19.01.02
Pen to Paper with Alexander: The Writing Process for No Good, Very Bad Days, by LaKendra Butler

Writing has always been one the most expressive forms of communication for me, an avenue to convey my feelings, emotions, or ideas. In times where orally expressing myself has failed me, words down on paper has always been my saving grace as it is the most comfortable for me. Because writing is such an important life skill, it is crucial to teach children at an early age the basics to build a strong foundation that will be beneficial to them all of their lives.

It is my greatest hope that as an educator I can help my students develop a love for writing at an early age, so that one day they may grow up to be the screenwriters, editors, authors, or songwriters of their generation. I have the honor of serving the community and children at Elizabeth D. Redd Elementary in Richmond, Virginia. Redd is an inner-city, Title I school with grades K-5. We have approximately 500 students, and the majority of them come from low-income households. Our students are predominately African-American and Hispanic. Many are new to the country from Honduras, Guatemala, and El Salvador and speak English as a second language.

My unit, “Pen to Paper with Alexander: The Writing Process for No Good, Very Bad Days”, will bring one of my favorite picture books as a child, *Alexander and the Terrible, Horrible, No Good, Very Bad Day*, into the writing process for my students. The unit will be based upon the book by Judith Viorst, which tells the story of Alexander who from the time he wakes up with gum in his hair, has a day full of unfortunate events that makes him want to move away to Australia. I would love for my third graders to hear Alexander’s story and use it to gather their thoughts and write about a bad day of their own.

I selected the book Alexander because I remember how much I loved it as a kid. It is a funny story and I feel it will keep the students engaged as they will be able to relate to Alexander and his very emotional day. In addition to using Alexander as our main text for lessons on the writing process, we will have several mini-lessons using various mentor texts to introduce students to concepts such as synonyms, grammar, adjectives, author’s purpose, voice, and dialogue etc. We will also use 3rd grade nonfiction reading passages. These will all allow us to focus on and highlight key points in identifying the author’s craft. This will give students the confidence and background knowledge they need to create a personal narrative about a terrible, horrible, no good, very bad day.

(Developed for Language Arts, grade 3; recommended for Language Arts, grades 2-3)

19.01.03
To Whom It May Concern: Considering Audience and Purpose in Writing, by Simon Edgett

For students in high school, one of the more difficult aspects of writing is consideration of audience and purpose. This is made especially difficult by the fact that students in high school are very often not asked to write for an audience beyond the teacher or a purpose beyond a grade. This unit aims to use mentor texts—professional essays on the topic of reading, writing, and/or language—to guide students through the process of responding to a specific real or imagined audience in their own writing. In this three-week unit, students begin by looking at the ideas of audience and purpose in their own usage, move to analyzing the way professional writers address audience and purpose in their writing, and finally attempt to incorporate what they have learned into their personal essays on the value of reading, writing, and/or language in their own lives. In developing this unit, I have paid special attention to how it will be taught in my tenth-grade classroom, but I intend to use it, in a modified form, in all of the grades I teach, tenth through twelfth.

(Developed for English, grades 10-12; recommended for English, grade 9)

19.01.04
Writers Use Risk before Rigor – Essays by Example, by Jennifer Frasher

The unit will focus on identifying desired features of quality mentor essays or books to assist educators in making level appropriate selections to then explicitly teach these same features to students. Through a workshop approach, both teacher and students will then use the mentor essays to guide their own writing. The intent is to establish familiarity with author's craft through building and using a mentor text library while engaging in an authentic writing process. Additionally, writing work will be shared across grade-levels to increase engagement and provide audience and authentic purpose to the student authors. Rigor is achieved through exposure to, and practice with, the processes used by proven, published writers' work.

(Developed for Language Arts/Writing, grades 4-5; recommended for Language Arts/Writing, all grades)

19.01.05
Becoming Butterflies: A Transformative Writing Unit, by Lauren Freeman

Students across the nation today are faced with a continual metamorphosis in writing; from summaries, to responses and text-dependent analyses to reports. These are usually thought of by the children as bland pieces that are only completed for the teacher and a very important grade. With letter writing and "snail mail" a thing of the distant past, you would think that writing has become the same. However, in the midst of it all, the youth today are a generation that actually writes the most, with minute to minute texting, tweeting, posting and snapping!

This curriculum unit will guide students in the intermediate elementary level toward change. The change is aimed at transforming the writing process and outcomes in the minds of the children as well as the artifacts produced. Through the use of mentor texts, collaborative writing and sharing, as well as crafting a multitude of essays that include personal experience, profile and memoir, the students will emerge, stronger than ever, in their writing style, technique and thought process. In the end, the children will be able to reflect on the stages of this transformation through the use of daily journals they have kept along the way.

(Developed for Reading, Writing, English and Grammar, grade 3; recommended for Reading, Writing, English and Grammar, grades 3-4)

19.01.06
The Voice in You- A Form of Expression through Writing, by Elizabeth Isaac

Creating an exceptional essay or writing from the point of view of the author can be difficult. Every writer writing a personal narrative should be able to be heard through their writing. This unit is intended to make any writer's voice be heard through his or her writing. The reader will feel connected with the writer's expression. This is a journey through a writer's workshop to create a personal narrative piece that will leave any reader astounded and amazed as if one had been the one to experience the writer's story. The unit is intended to make one enjoy writing and understand how to become an effective and creative writer. Activities will involve teachers to share literary and non-fictional texts in support of vocabulary development and to produce exceptional writers in creating extraordinary essays. The activities and strategies are effective and provide a backbone that builds a strong foundation of great writers. Students will be involved in analyzing a text through group discussions about the personal experiences and issues, read fiction and nonfiction stories as well as essays from well-known authors and finally produce writing as true writers.
(Developed for Reading, Writing, and English/Grammar, grade 3; recommended for Reading, Writing, and English/Grammar, grades 3-4)

19.01.07
You Ain't Gotta Write Like You Speak: Talking White, While Livin' Brown, by Debra Jenkins

This unit stems from the seminar with Jessica Brantley, "Reading for Writing: Modeling the Modern Essay" which directly addresses the third grade reading and writing standards for Texas (Texas Essential Knowledge and Skills). This unit will incorporate essays from the seminar, articles I researched, and children's picture books I vetted, with intentional focus on the spoken language, to parallel that of the students I teach. The focus is to have students read (or have read to them) narrative essays, books, and stories. Students will then produce a narrative essay of their own. It is my hope that by pairing children's literature, known essays, and articles from online journals, it will enhance their writing. I teach a population of students who are mostly considered to be at risk. This dialect is often looked at as a social dilemma, resulting in being rated as students who are less than credible because of how they speak. (Andrew C. Billings) My students sometimes do not recognize their audience or are too familiar with their audience, which affects their writing. If I aspire for them to reach middle-class status then this unit suits them perfectly. It will provide them with the tools they need in order to discern between social distance and social proximity to the audience in which they are both speaking and writing to.
(Developed and recommended for Reading/Writing ELAR, grades 3 and 4)

19.01.08
Writing through Reading, by Sheilvina Knight

One of the foundations of learning is writing, and in the United States this is one area where students are having a very difficult time. The ability to write about your goals, dreams, memories, and stories are vital to all students in school and society. To make sure that students are successful in writing, students need to begin writing meaningful work early on. One form of writing that allows for students to explore meaningful life experiences is the personal experience essay.

This unit, intended for grades K-2, will focus on the craft of writing a personal experience essay. Genre characteristics of the personal experience essays will be explored in professional texts as well as mentor texts for students such as *Each Kindness*, *Owl Moon*, and *Mango Moon*, and *Jabari Jumps*. These texts model the craft of personal experience essay writing are very diverse in authors, characters, and storyline. Teachers considering using these texts to model personal experience essay writing will benefit from having specific passages highlighted to prepare students to write their own essays.

(Developed for Writing, grade 1)

19.01.09
Personal Essays and Storytelling: Trevor Noah, Nelson Mandela, and Nadine Gordimer, by Akela Leach

In this unit we will use the memoir *It's Trevor Noah: Born a Crime* by Trevor Noah as a mentor text to teach personal essay writing. Mentor texts are examples of great writing that teachers use as models for students. Students will study memoirs and personal essays, which are closely related genres of writing. Memoirs are collections of personal essays or stories written by an author, interlacing specific themes throughout the novel. Students will analyze writing techniques, and identify the plot progressions, literary elements, and major themes. Using journaling entries and plot mountain diagram prewriting strategies, students will develop their own personal essay as the culmination of this unit.

Noah's memoir uses dynamic storytelling to share stories of his childhood in South Africa. Noah grew up as a biracial child and was raised by his mother. Because interracial couples were prohibited, his mere existence was illegal during apartheid. While Noah's memoir will be the main text in this unit, other notable South African writings are featured. Students will read and study excerpts of Nelson Mandela's memoir "*Long Walk to Freedom*" and essays written by Nadine Gordimer. By studying writings by Mandela and Gordimer, students will learn other styles of writing as well as gain deeper knowledge into the recent history of South Africa.

(Developed for English Language Arts, grade 5; recommended for English Language Arts, grades 6-12)

19.01.10
How High-School Students Can Echo Professional Writers in Their Own Personal Essays, by Raymond Salazar

Reading should not be about skimming to the end of a text. Yet, in today's digital world, our reading experiences become shorter and more superficial. Almost always, the conversation about or the reaction to a text focuses on *what* was said. Rarely do we converse about *how* it was said. Because of this focus on information and minimizing of structure, reading mistakenly equals zooming over the screen or page for keywords. With the prominence of high-stakes multiple-choice tests, students, too, train themselves--or educators erroneously train them--to search for information that can be pulled out to answer a question.

This toolkit of sorts for high-school writing teachers helps engage students with complex texts beyond the literal level. Guided mostly by William Zinsser's *On Writing Well*, teachers will find approaches to helping students include "echoes" in their writing to produce eloquent, sophisticated essays that go far beyond the rudimentary five-paragraph essay.

Mentor texts examined include an essay on race by Ta-Nehisi Coates, as well as other essays by other writers about alcoholism and consumerism.
The ideologies and practices compiled here will help students identify the structure of a text at the paragraph and sentence level, practice it, and mirror it in their own original writing. Furthermore, my hope is that this toolkit encourages teachers to select socially conscious, thought-provoking essays to challenge high-school students to engage in conversations about contemporary issues that teachers sometimes refrain from because of professional insecurity or administrative skepticism.

All of this is guided by a belief in the idea that students must be socially conscious, highly skilled writers addressing meaningful issues in order to amplify their voices and challenge social systems that limit young people's opportunities.

(Developed for AP English, grade 11; recommended for any High-School level English class teaching personal essays, grades 9-12)

19.01.11
Right Our World as Writers Who Are Readers: Acts of Resistance in Personal Memoirs and Public Arguments, by Lisa Yuk Kuen Yau

Read. Write. ReRead. ReWrite. *On and on and On 'til the night is gone*. That is how iconic writers like Benjamin Franklin and Frederick Douglass taught themselves how to read and write: *On and on and On 'til the night is gone* (lyrics by Swedish group ABBA). Rooted on the concept of *reading for writing*, this YNI curricular unit utilizes "modern essays" to help students – especially English Language Learners who may rightfully feel marginalized – to write two types of political essays. First, students will read exemplar memoirs. With the support of notebook-keeping and writer workshops, each student will complete a memoir to investigate how sharing who they are could empower themselves and their readers. On a separate route, students together will read, research, debate and write ONE argument about a political injustice such as deportation of children or gun violence in school as they develop a collective voice of readers, thinkers, writers and speakers. Such democratic writing process is akin to how the U.S. Constitution was written and ratified. Throughout the unit, students will read nonfiction essays from *The Norton Reader* and discuss writing tips from *On Writing Well*. Developed for English Language Arts and Social Studies. 4th to 8th grades.

(Developed for ELA and Social Studies, grade 4; recommended for ELA and Social Studies, grades 4-8)

II. The Problem of Mass Incarceration

Introduction

What does it mean to live in the most incarcerated nation in the world? Our seminar focused on issues like the war on drugs, gun control, racial disparities, mandatory minimum sentences, and stop and frisk policing. The curriculum units didn't stop with defining the problem; instead, Fellows focused on how to reform the current system, including how students can become involved in the movement to dismantle mass incarceration.

Mass incarceration is an enormous topic, and no curriculum unit can tackle it all. Fellows limited the scope of their units in two ways: each chose a specific aspect of mass incarceration (e.g., police, prosecutors, juvenile justice) and a specific locality (in each case, the city or state where the Fellow teaches). **Brett Plavchak** examines the history of police militarization with a focus on Pittsburgh, Pennsylvania. **Laura Gillihan** studies police brutality and its effects on children in Chicago, Illinois. **Sally Cannizzaro** looks at the war on drugs and sentencing (including mandatory minimums) in Oklahoma, while **Krista Waldron** examines the juvenile justice system in that same state. **Alex de Arana** studies the history of the criminal justice system in Philadelphia, Pennsylvania through the lens of that city's reform-minded District Attorney Larry Krasner.

While all of the units emphasize opportunities for reform, **Anette Norona** does so most explicitly, through her examination of how California youth mobilized to combat overcriminalization. In a similar vein, **Trace Ragland** seeks to equip her Washington, D.C., students with the tools to reduce and resist the violence pervading their lives. Finally, **Jolene Smith** reminds us that restorative justice, sometimes described as a fresh alternative to prison and punishment, isn't new at all. To the contrary, it has deep roots in the Diné Nation.

Together these units tell a compelling story about one of the most profound human rights challenges of our time. They are unflinchingly honest about the scale of the crisis, while resolutely hopeful about the possibility for change.

James Forman Jr.

Synopses of the Curriculum Units

19.02.01
Confronting Mass Incarceration in Tulsa, by Sally Cannizzaro

Mass incarceration negatively affects so many lives, but what can be done about it? This curriculum unit aims to prepare students to tackle this community plague. This unit will bring statistics, local groups, and passion together to help students advocate for change. Students will begin by using a protocol to analyze data on general population statistics for the United States, Oklahoma, Tulsa, and other countries, as well as for specific populations, such as those for race and gender. Next they will look at these same statistics, for the incarcerated population and compare the two sets. These conversations will allow students to begin to ask questions about what they are seeing, how the statistics evolved to the level they are at, and what needs to be done to alleviate the impacts of any and all inequities they see. After learning about the events that led to our current "war on crime", students will evaluate initiatives that aim to stem the harmful effects of mass incarceration. Students will begin to develop their own ideas on what ideas they can improve or expand on. The unit concludes with teenage activists proposing fully-developed ideas to local groups, ready to positively impact the community.

Keywords
Mass incarceration, Tulsa, Oklahoma, gifted and talented, equity, project-based learning, critical reading, writing, community outreach, student activism

(Developed for Gifted and Talented, grades 6-8; recommended for Gifted and Talented, grades 6-12, and Language Arts and Civics, grades 8-12)

19.02.02
On Criminal Justice Reform: Studying Philadelphia's New, Reform-Minded District Attorney through a Historical Context, by Alexander de Arana

This curriculum unit examines the trends and attitudes that shaped today's criminal justice system. Students read and analyze key texts such as *Charged: The New Movement to Transform American Prosecution and End Mass Incarceration* and articles from *The Philadelphia Inquirer* to inform themselves of the rise of new, reform-minded prosecutors throughout several cities across the United States. Students consider the role of the prosecutor in creating and addressing the problems of mass incarceration by studying the election of District Attorney Larry Krasner in 2017. The origins of "tough on crime" attitudes, the War on Drugs, and the rise in incarceration rates during the 1990s are closely reviewed as they relate to the history of Pennsylvania's and Philadelphia's criminal justice systems. At the end of this unit, students are required to engage in a dialogue that demonstrates their knowledge of the problem of mass incarceration by creating two podcast episodes.

Key Words:

Mass incarceration, criminal justice, tough on crime, War on Drugs, prosecution, district attorney, Larry Krasner, Philadelphia, Pennsylvania, Charged: The New Movement to Transform American Prosecution and End Mass Incarceration, The Philadelphia Inquirer, podcast

(Developed for Civics, Government, Politics, and Social Studies, grade 12; recommended for Civics, Government, Politics, Social Studies, Law, and Philosophy, grades 9-12)

19.02.03
Rethinking Policing: Origins of Brutality, the Impact and Reform, by Laura Gillihan

Police officers are expected to protect members of the community, but different realities are often lived by many Americans, including my students. Through examining the origins of policing and the rise of police militarization and police brutality, we can begin to understand how this reality came to be. We can then offer insight into how we can improve relationships amongst police and members of our community by acknowledging the trauma it has caused and working to restore relationships that have been damaged.

This integrated unit incorporates social studies goals as well as social emotional learning goals. It was designed to ignite local community student-led activism through the use of restorative practices as a means to mend and forge positive relationships with police officers and the community. Essential questions like, "what is the role of the police," "what role did laws play in the militarization of police," "what is police brutality," and "how can citizens rebuild communities after trauma," are explored through activities such as hypothetical situations and debates, independent journaling, and the use of restorative practices like talking and peace circles. This unit explores themes such as racial disparities, police militarization, police brutality, restorative practices, empathy and healing from trauma.

Key Words

- Police brutality
- Policing
- Police militarization
- War on drug
- Trauma
- Healing
- Restorative practices
- Building relationships

- Racial disparities

(Developed for Social Studies and Social Emotional Learning, grades 4-5; recommended for Social Studies, Language Arts, History, and Social Emotional Learning, grades 4-12)

19.02.04
Understanding and Challenging the Overcriminalization of Youth of Color, by Anette Norona

This unit focuses on understanding and challenging criminalization of young people of color in America. Students will analyze the influence of racist and classist ideologies on the creation of the juvenile justice system, on school polices, on the policing of urban ethnic neighborhoods, and on voter repressive laws. The second half of the unit will cover youth activism and empowerment; students will analyze how young people, schools, and community organizations can help in disrupting and dismantling the system. Students will dissect the success of different youth-led campaigns or programs. The unit's final component will ask students to engage in a Youth Participatory Action Research Project (YPAR). Students will conduct on the ground research through surveys and interviews to understand the school needs. Through discussions, analysis of primary and secondary sources, and YPAR, students will come up with a set of proposals (programs and policies that will be adopted if approved by the student senate and school staff) that will help address school-specific issues.

(Developed for Ethnic Studies, grade 9; recommended for Ethnic Studies and Sociology, grades 9-12, and Government, grade 12)

19.02.05
Who Watches the Watchmen? How Police Militarization Has Subverted the Constitution, by Bret Plavchak

This unit will examine the role police militarization has played in undermining the United States Constitution. To begin, students will analyze the Third, Fourth, and Fifth Amendments to determine what inspired their creation and the role they play in determining police behavior. We will then examine the history of policing in America and how the fervor and zealotry of the War on Drugs initiated a trend towards militarization and warrior policing, both nationally and in the city of Pittsburgh. To that end, students will investigate how policymakers and the Supreme Court have supported the spread of SWAT teams, civil asset forfeiture, and no-knock raids. Finally, students will research and debate the efficacy of current ideas such as community policing, civilian review boards, and procedural justice as ways to begin demilitarization of our law enforcement agencies.

This unit is designed for an English Language Arts classroom but can be adapted according to the teacher's discretion. The unit will require students to read and discuss primary documents, historical nonfiction, research findings and a novel. Students will also be required to produce argumentative writing and participate in a mock civilian police review board trial.

(Developed for English 3 PSP, grade 11; recommended for English Language Arts and Social Studies, grades 9-12)

19.02.06
Equipping Students with Tools for Positive Change, by Trace Ragland

After investigating violent crime data and consequences of its resulting trauma in their local communities, students learn about risk and protective factors of violent victimization and perpetration. Students research tools that will help weaken risk factors and strengthen protective factors, ultimately developing projects to affect positive change in both their personal lives and their communities.

(Developed for English Language Arts, grades 9-10; recommended for English Language Arts, grades 8-12)

19.02.07
A History of Peacemaking and Incarceration with the Dine People, by Jolene Smith

Peacemaking, a method the Navajos used since early 1700 to 1800s. Peacemaking is a Native American traditional way to resolve issues within a band, a way for individuals to reconcile and not punish. All participants contribute and help the wrongdoer correct the action and for the wrongdoer to know the incident is fulfilled and is a better person. The sudden mass incarceration of the Dine people caught the bands off guard. The U.S. generals, colonels, and soldiers captured many men, women, and children. The forced march is known as "Long Walk," to the reservation, Bosque Redondo. The loss of Navajo lives and prison suffering led to the breakdown of the band community. The peacemaking structure replaced by Western society's format of governing the prisoners, which is to punish. Today, the Navajo correction facilities use the cultural concept of K'e to help the detainees pray, sing, and cleanse their body, mind, and spirit to think about how to correct the wrong. The K'e model is a restorative justice program to help the inmate feel good about the mediation. The two entities work collaboratively to develop a system of justice that benefits the Navajo people.

Keywords: Native American; Dine; Navajo; Peacemaking; Police; Courts; Long Walk; Hweedli; Bosque Redondo; Naa't'naani; band; community; Restorative Justice;

(Developed for Social Studies - History, grade 5)

19.02.08
Learning the System to Overcome the System: Juvenile Justice for High School Students, by Krista Waldron

This unit about juvenile justice addresses five essential questions: Why are prisons our main tool of punishment? What is the role of race in juvenile incarceration? What does effective juvenile justice look like? How do Tulsa County's and Oklahoma's juvenile systems stack up against the rest of the country? What can citizens—especially young people—do to improve our criminal and/or juvenile justice systems? We begin by looking at prisons, the traditional assignment for criminal behavior, to understand how prisons came to be and how they work—or don't work. Next is the topic of juvenile justice nationally and in Oklahoma. These systems have followed hard-on-crime policies over the last forty years and share the persisting problem of racial disparity with adult justice systems. The last sections look at Tulsa County's juvenile history, and then problems and solutions that advocates, especially students, can tackle to bring attention to these problems and to cause change. Strategies include simulations, Socratic seminars, field trips, and exercises in critical reading and writing. We will use greatly varied materials including the graphic novel, political cartoons, journalism, and literary essays. This unit may work best in urban schools.

(Developed for English Language Arts, grades 9-10; recommended for English Language Arts, grades 11-12, and Current Affairs and U. S. History, grades 9-12)

III. American Democracy and the Promise of Justice

Introduction

The demand for democracy in America was born of an acute sense of the injustice of British rule in the American colonies. This history has inevitably tied American democracy to the people's expectations about justice, so that when they experience injustice they routinely demand reforms of the democratic system to create, as the preamble to the United States Constitution says, "a more perfect union."

A premise of the seminar that informs all the units in one way or another, is that people usually have a much keener sense of what they regard as unjust than they do of what justice requires. The example of the constitution makes the point. The founders articulated grievances in the Declaration of Independence and devised a political system to address them, yet within a few short years they found it necessary to replace it with a new one. That new constitution contained innovations and compromises intended to hold a disparate union together, yet seven decades later the country was riven by a civil war that ushered in far-reaching constitutional amendments that would themselves soon come under attack.

This American experience is not unusual. Victims of South African apartheid could give compelling chapter-and-verse accounts of its injustices, but they had much less well-developed notions of what a just South Africa would be like. Three decades later, many of them are alienated and disappointed by the persisting racial inequality and endemic corruption that plagues the country, and they are demanding fundamental reforms. A comparable story can be told about the collapse of the USSR and subsequent evolution of its successor states. People have much clearer ideas of what is unfair and unacceptable than what would be fair and acceptable. And because all democratic systems are imperfect, there is invariably room – and demand – for reform.

The curriculum units developed in this seminar held at Yale in the spring and summer of 2019 explore the evolving relations between American democracy and the demands of justice since the Founding, through the writing of the Constitution; battles over slavery culminating in the Civil War; Reconstruction, its failure, and Jim Crow; the Progressive era; the New Deal, the Great Society; the Civil Rights and Voting Rights acts; and debates about democratic reform since the 1970s. The central focus of all the units the U.S., but they are informed by insights from the seminar about other democratic systems, particularly in Britain and Western Europe, to see how they manage the tensions between demands for justice and democratic government.

The units deal with the tensions and accommodations between demands for democracy and the promise of justice in a number of different arenas of American life – historical and contemporary. Two of the units explore similarities, differences, and interactions

between the U.S. and Navajo tribal law. Two deal principally with urban contexts, one focused on bussing and the other on restrictive covenants and other forms of de jure segregation in housing. One compares democracy with other systems of governance, to help students understand their effect on the distribution of benefits and burdens within society.

A number of the units deal with injustice as it relates to fights for civil rights for African Americans and other vulnerable minorities over the course of U.S. history and in our contemporary politics. Three deal with the Civil Rights Act of 1964 and the Voting Rights Act of 1965, two setting them in the context of earlier struggles for racial justice in U.S. history and one exploring the implications for the subsequent struggle for transgender rights. Another unit focuses on the changing ideologies defended by – and the evolving relationship between – Martin Luther King Jr and Malcolm X, with particular attention to their convergence during the early 1960s.

Most of the units are focused on classes taught to middle and high school students, but several are aimed at primary school students—even including first graders. Some might assume that this is difficult material to teach to such young students, but the teachers have devised ingenious ways to present material to them, including use of various games developed by game theorists to help students experience, and so come to understand, what fairness and unfairness mean to people in their everyday lives, and to whom they should be looking in thinking about rectifying the injustices they see around them.

Ian Shapiro

Synopses of the Curriculum Units

19.03.01
Fight the Power: Teaching Research Skills Through The Study of American Protest Movements, by Ludy Aguada

This curriculum unit is designed to teach students in 11th-grade Advanced Placement English Language & Composition who have little to no experience how to conduct academic research and produce a paper supported by reliable sources. Beginning with the Abolitionist movement, the unit traces the history up to and leading to the passage of the Civil Rights Act of 1964 and the Voting Rights Act of 1965, using them as the framework to analyze the elements that produced those two landmark pieces of civil rights legislation. Then in small groups, students will identify and research more recent or current social justice movements. They will analyze the movements' successes, or, for current movements, the likelihood of their successes. The final products will be formal presentations of their findings and well-documented, well-supported, and properly-formatted research papers.

(Developed for AP English Language, grades 11-12; recommended for College Prep English, grades 11-12)

19.03.02
The Right to Vote: Empowerment and Civic Engagement in our Democracy, by Cinde Berkowitz

In this curriculum unit, written for a 9th-grade history class, students will study and learn about the foundational principles of American democracy. This unit will focus on historical and cultural events. Fundamentals of democracy, The Civil War, Reconstruction, Jim Crow, civil rights, and significant constitutional voting rights amendments will be studied throughout the unit. The historical foundations of voting rights in the United States will be taught through the analysis of primary sources (documents, speeches, bills, laws and the Constitution).

These frameworks will lay the groundwork to teach about the right to vote and civic engagement in our democracy. Voting rights and civil rights are hotbed issues right now with the approaching Presidential Election in 2020. Now more than ever in our history, it is so important for students to be educated on our government policies at the local, state, and national levels. Students will study what constitutes a democracy. Further, we will explore apparent inequalities in our system of government and the "coexistence of democracy with substantial inequality."

A voting rights timeline will be included in the unit as a historical and visual guide. The unit will culminate with a "get out the vote" campaign and the need to be informed and

educated on the issues. Essential questions are, how did voting rights transform America and create the cornerstone of today's democratic society? How can the right to vote continue our democracy in the future?

(Developed for U. S. Government/Civics, grade 9, and U. S. History, grade 10; recommended for U. S. Government, grade 9, and U. S. History, grade 10)

19.03.03
Understanding Democracy in the Elementary Grades, by Carol Boynton

Young children often have a natural inclination to problem-solve through fairness. But the question arises, what is fairness? How is equity determined and by whom? This six-week unit introduces a variety of governmental structures with the plan for students to role-play each as they organize and determine the rules of classroom. They will explore monarchy, anarchy, dictatorship, communism and finally, democracy with the hope that they will discover the advantages of governing through a core set of values, combining individual choice and equal opportunity, and striving for the common good.

The learning begins with two foundation-setting picture books: *Let's Chat about Democracy: Exploring Forms of Government in a Treehouse* by Michelle A. Balconi and *We the Kids: The Preamble of the Constitution of the United States* by David Catrow. The experience provides knowledge about the democratic system along with an opportunity for students to decide how our classroom might run like a democracy. They will work like the founding fathers to create an age-appropriate, student-designed constitution that will guide our classroom throughout the year.

The essential questions, *What makes a good citizen? What makes a good leader? How do members of a community help each other? Why do we need rules?* provide some specific context as the students explore government.

(Developed for Social Studies, grade K; recommended for Social Studies, grades K-3)

19.03.04
Grade Level Gavel Student Court: Justice for All, by Taryn Coullier

Grade Level Gavel Student Court: Justice for All, is a student-centered approach to learning history and understanding identity. This Curriculum Unit consists of three major components: Introductory Ancestry Project, Student Courtroom Debate and Discussion Setting and a Culminating Writing Project.

Students will begin the academic year with a three-week structured beginning segment on ancestry, wherein they will be completing a rubric based, research and presentation project exploring a chosen Ancient Kingdom of Africa once they have learned about and

explored each one. Students will complete the project by completing a display board, accompanying essay and a presentation for this content.
The students will then be participating in a Student-Centered Courtroom wherein they will study, discuss and debate specific historical events following a timeline. Students will facilitate writing of discussion rules for the courtroom as it will serve as the vehicle for the History Curriculum. The debates will be focused on the premise Justice vs. Injustice to the people.

Finally, the students will be participating in a Culminating Writing Project. Students will use their reflections of the class debates that will be housed in notebooks, to develop and complete a collaborative writing piece.

(Developed for History and Geography, grades 4-12; recommended for History and Geography, grades 4-12)

19.03.05
Current Refugee and Immigrant Policy in the United States: How Do They Impact Your Community? by Lynn Gallo

This unit is designed for middle school students, but could be modified for high school students. Students will read the novel *Refugee* by Alan Gratz, along with excerpts of other books, and look at the laws that have influenced today's immigrant and refugee policies in the United States. Students will write an informational essay or project about an aspect of today's legislation on immigrants or refugees, such as DACA or Presidential Proclamation 9645 (commonly known as the Travel Ban). The goal of this unit is for students to learn more about the communities they are part of, and begin to think about their larger roles in the world, their rights, and the legislation that directly impacts them. Learning objectives include SL.7.1.A, WHST.6-8.7, and WIDA's English Language Development standards.

(Developed for ELA, grade 7; recommended for ELA, grades 8-9)

19.03.06
Expanding Rights in American Democracy – Coalitions, Conflict, & Controversy, by Mark Hartung

This unit deals with the difficulties in creating and expanding rights in a democratic society where majority rule exists. It discusses difficulties caused by factions and how coalitions form. Included is a discussion outlining the elements of successful coalitions. Present day and historical examples are used. The Transgender rights movement provides a contemporary example while historical examples from the 19th Century include the Abolition movement and Women's Rights movement. How these groups worked together

(or didn't) is the student learning goal. Students should be able to demonstrate learning by using the provided framework of elements to analyze reform movements.

The unit as written is intended for 8th grade and connects to several CA content standards. It is, however, certainly adaptable and this unit in whole or in part could be used in senior year government classrooms when discussing the development of the constitution or the 19th century reform movements. Some of the content and simulations described could also be useful in later year elementary classrooms as well. An annotated bibliography that will give teachers a sense of what other materials are available to them to review and study for their own uses is also included.

(Developed for Social Studies, grade 8; recommended for U. S. History, grade 11, and U. S. Government, grade 12)

19.03.07
The Different Types of Government and The Vote, by Kimberly Jim

My unit will explore the historical implications of voting rights and inequalities. The way the United States government is set up in comparison to the Navajo Nation government. I will also talk about the Navajo people and how they have their government set up similar to the United States government. Then, I will talk about the Navajo Nation, the tribal government, and the Navajo Nation president. Finally, the state tax revenue and the Navajo Nation tax laws. Also, the literacy and language barriers. This unit is made for elementary kids in first grade. This unit is geared towards those who teach on or near Native American reservations. I truly believe that not a lot of young kids know too much about their own government. It is very important that kids who live on or near reservations are exposed to the kind of government that they have governing them. By knowing so, then they can have the knowledge of what the laws are on their reservation and the law of their neighboring cities. It is very important that the younger generation know the laws because one day they will be the adult living there and knowledge is power.

(Developed for Social Studies, Writing, and Reading, grade 1; recommended for Social Studies, Writing, and Reading, grades 1-3)

19.03.08
Álchíní Bi Beehaz'áanii: Applying Navajo Fundamental Law to Preserve Cultural Heritage, by Irene Jones

This curriculum is a historical account of how Indian policies that affects Native American tribes, especially laws and policies involving children. The relationship between Indian tribes and federal government have gone through period of progress and setbacks. This unit explores and explains the historical account of how Navajo tribe

persevered, while other tribes struggled. Furthermore, it explores how Native Americans finally achieved sovereignty status, but still have to abide by laws of the country. In addition, the unit discusses the importance of children in Native American tribes, especially Navajo tribes, and how Indian Child Welfare Act effects the outcome of children who need to be adopted. Navajo Justice System has established Navajo Children's Code (Ałchíní Bi Beehaz'áanii Act, ABBA) using Fundamental Law to protect Navajo Children.

This unit is intended for students in grades 3rd – 5th to reintroduce content rich curriculum unit using a topic that effect the students' everyday lives. The unit is intended to teach comprehension skills using American Indian History and Social studies.

(Developed for Social Studies, grades 3-5, and Navajo Social Studies, grades 4-6)

19.03.09
The Different Shades of the Yellow Bus, by Sean Means

Busing was a strategy to close the gap in American education and create a more equitable environment for all of America's children. The following unit examines why America felt the need to integrate its public school systems through a federal mandate via busing. The unit tells the story of the opposition civil rights leaders faced as they pushed far beyond the Supreme Court's initial ruling that Separate was Equal and how that leads into Brown v. Board of Education. After students examine the various steps taken to achieve a unanimous decision in the Brown v. Board ruling, they will then find that the transition to integrate schools was not a smooth one. In locations such as Boston, Pittsburgh, and Alabama, we find that there was a great deal of resistance to integrate schools. Moreover, the unit examines a few schools in Pittsburgh and focuses on the large gap in resourcing schools that still exist today. Lastly, we see how busing is connected to race, privilege and power. This unit is a more focused follow up to last year's unit, "The American Dream: For Members Only," as it focuses on the education system, the gross inequities within the system, and how one race of people stand to benefit while others remain second class citizens.

(Developed for Social Justice, grade 12; recommended for Social Justice, grades 11-12; U. S. History, grade 11; African American History, grade 12; and Sociology, grades 10-12)

19.03.10
Chasing the Dream: The Civil Rights Movement and Desire for American Equality, by Matthew Menschner

This unit is designed to review the history of the American civil rights movement. Specifically, the actions, rhetoric and ideologies of Martin Luther King Jr. and Malcolm

X. Many students understand that both men played prominent roles in the movement, but they do not understand to what extent their political philosophies influenced their actions. Furthermore, both men were products of their environments, with Martin symbolizing the Southern black middle class, and Malcolm the Northern urban poor and destitute. Beginning with an overview the black integrationist and black nationalist philosophies, the unit will examine critical periods in the civil rights movement, weaving the actions and words of Martin & Malcolm in throughout. The unit encompasses landmark moments of the civil rights movement such as *Brown v. Board of Education*, the Montgomery bus boycott, the Civil Rights Act and Voting Rights Act, and the assassinations of Martin King and Malcolm X. Rhetorical analyses will provide students with opportunities to reflect on how language and action were directly related during the civil rights movement. The culminating activity for the unit tasks students with leading a class-wide debate on the topic of the American dream as it related to African Americans during this period. Students will incorporate a variety of primary sources and unit materials as evidence to support their arguments in the debate.

(Developed for Social Science, grade 11; recommended for U. S. History, AP U. S. History, Civics, and Government, grades 9-12)

19.03.11
A City Divided: Housing Segregation in Chicago and Beyond, by Lea Stenson

To bring about sustainable social change, we must first raise awareness of the systemic oppression at the root of injustice. This unit explores the history and legacy of residential segregation in the United States, with a focus on Chicago and other Northern cities. When we think about segregation in the North, we often think of de facto segregation, or segregation by common practice and individual choice. But by taking a closer look at housing policy in Chicago and other cities, we see a long history of *de jure segregation*, or segregation by law. Federal, state and local governments collaborated with banking institutions, insurance companies and real estate associations to enact policies designed to create and maintain residential segregation.

Students will learn about redlining, the process by which banks refused to offer mortgages, or offered worse rates to customers in African American neighborhoods. They will explore exclusionary zoning laws, segregated public housing projects, discriminatory lending practices and racially restrictive housing covenants, which were contractual agreements within a home's deed that prohibited African Americans from purchasing the home.

After learning about various forms of de jure segregation that are rarely discussed in history books, students will learn of the intentionality behind these policies. They will learn about the relationship between segregation and issues such as educational inequity, the racial wealth gap, concentrated poverty, under-resourced neighborhoods,

unemployment, public health, crime rates, racial profiling, police brutality and mass incarceration. They will no doubt react strongly to the systemic racism that has long existed in their city and elsewhere in the Northern U.S., running contrary to the prevailing narrative that state-mandated segregation is a strictly Southern phenomenon. As a culminating project, students will channel their newfound knowledge and passion into public works of art that will shed light on a history that has been ignored for far too long.

(Developed for Social Studies, grade 8; recommended for Social Studies, U. S. History, Sociology, and English/Language Arts, grades 7-12)

IV. Energy Sciences

Introduction

With concerns about the impact on the environment of our current use of fossil fuels and our national energy security, energy is in the news on a daily basis. Many students are familiar with some of the issues relating to energy use, but they may not know much about the science related to energy. The aim for this seminar was to discuss the science related to current sources of energy and potential future sources of energy. We can learn much about sustainable energy use by studying natural processes. Nature has solved the renewable energy problem through the process of photosynthesis that is carried out by green plants. Plants are amazing chemical factories and provide a working example of renewable solar energy conversion, but this is often not appreciated. By understanding how plants carry out the processes of solar energy utilization, we can obtain some answers to the question of how we can harvest solar energy by using processes of artificial photosynthesis.

My own interest in science stems from my hands-on experiences as a child. Therefore, many demonstrations were included in this seminar – at least one demonstration, and frequently 2-3, in each seminar meeting. These demonstrations were chosen so that they could actively involve the students and at the same time illustrate the scientific principles related to energy.

The books by David Walker entitled “Energy, Plants and Man” and by David J. C. MacKay entitled “Sustainable Energy – without the hot air” were used as the primary technical books for the seminar. We also read Daniel Yergin's “The Quest: Energy, Security and the Remaking of the Modern World,” a fascinating but not highly technical analysis of our energy use. The beginning of the seminar focused on energy, light and photosynthesis. The seminar began with a discussion of how plants use light to convert carbon dioxide and water into sugar and oxygen gas. This included discussions on the nature of light and the fundamental steps by which light is absorbed by plants and converted into chemical energy. Demonstrations of the colors in light using diffraction glasses aided these discussions. A connection was made between natural photosynthesis and the excess production of biomass that has been buried to form the “fossil fuels” that provide most of our current energy. Next, we delved into various forms of energy, including hydroelectric, biofuels, wind, geothermal, solar and nuclear. A highlight of the seminar was the production of biodiesel fuel from cooking oil that culminated in the combustion of biodiesel fuel in an oil furnace burner. The seminar also included a discussion of energy use in the future that included progress in development of systems for artificial photosynthesis and fuel cells.

The curriculum units developed from this seminar are suitable for elementary to middle school to high school students. In all of the units, the science content is integrated with language arts, mathematics and social studies to provide a balanced program that meets the literacy requirements of the school system. The Fellows have prepared extensive lists of materials that can be used in the classroom or as resources. These materials include books that the students can read, textbooks that the teachers can use, demonstration sourcebooks, suppliers of equipment and many addresses of sites on the world wide web. The Fellows have developed units around a theme or activity related to energy, including units on energy transformations, energy transfer through an ecosystem, the chemistry of batteries, building a wind turbine, sustainable energy production on an island, and the impacts of the coal industry. Other units are related to comparisons of current sources of energy based on fossil fuels with the renewable energy sources, analyses of carbon footprints, and radiation related to nuclear energy and medicine. Information on the responsible use of current sources of energy to lower our carbon footprint, as well as the impact of our energy use on the planet Earth, is also provided in many of the curriculum units. The units include a number of excellent activities that will engage the students' interest and teach them about energy sciences.

I would encourage all teachers of elementary through high school students to review these curriculum units. These materials provide a valuable resource for incorporating topics of science and society related to "Energy Sciences" into the classroom.

Gary W. Brudvig

Synopses of the Curriculum Units

19.04.01
Driving in the Future: How Far Will that Battery Take You? by Cristobal Carambo

Worldwide demand for energy has surpassed the 17.4 TW threshold predicted in 2015. Our unabated demand for energy has so devastated our planet's natural resources and ecosystems that we are on the brink of the planet's 6th mass extinction event. Increasing global temperatures have catalyzed a complex set of climactic changes that threaten the survival of all life on Earth. Elevated concentrations of greenhouse gas (GHG) emissions are the root cause to this rise in temperature. A large body of scientific evidence supports the conclusion that carbon dioxide produced by the combustion of fossil fuels is the principal cause of global warming.

A change from fossil fuels to green sustainable energy sources is warranted if we wish to halt climate change. Technologies that convert energy from renewable sources (solar, wind, geothermal, and hydro) to electricity are central to this transition. A central component of any sustainable energy policy are the storage devices that will help harness and store electrical energy.

The goal of this two-week unit written for the high school chemistry class is to explore the chemistry of the rechargeable batteries that are part of our lives, and to explore future applications of this technology and the green energy future we so desperately need.

Keywords:

- Climate Change
- Global Warming
- Renewable Energy
- Greenhouse Gases
- Rechargeable Battery
- Fossil Fuels
-

(Developed for Chemistry, grades 10-11; recommended for Environmental Science, grades 10-11)

19.04.02
Acids and Particulate Matter and Mercury, Oh My! An Examination of the Major Impacts of Coal on the Environment, by Michael Doody

This two-week unit on the environmental impacts of coal is written for AP Environmental Science and satisfies the following learning objectives set forth by the College Board in the most recent version of the course and exam description: identify

types of fuels and their uses, describe ecological impacts of natural resource extraction, describe the use of fossil fuels in power generation, describe the effects of fossil fuel use on the environment, identify the sources and effects of air pollutants, and describe acid deposition and its effects on the environment. Within this unit, students pay special attention to acid-mine drainage, particulate matter pollution and its impacts, and how mountaintop removal mining has altered the landscape of the nearby Appalachian region. Students complete several hands-on activities to advance their knowledge, including demonstrating the effects of acid-mine drainage and acid-deposition on plant life, measuring particulate matter pollution, and demonstrating the impacts of coal mining using a model system. Finally, as part of their AP exam preparation, students are charged with writing, answering, and scoring a Free Response Question as their summative assessment for the unit.

(Developed for AP Environmental Science, grades 11-12; recommended for Environmental Science Issues, grades 10-11)

19.04.03
My Future, My Home: Building a Greener House for Tomorrow, by Melissa Duran

Ravenous fossil fuel consumption and inefficient energy use have been persistent human practices for more than 250 years, resulting in global warming and other catastrophic consequences that threaten the sustainability of life on Earth. This unit focuses on the disastrous environmental effects our abuse of fossil fuels have caused while covering the benefits of green energy sources and ways to adopt environmentally-friendly life habits.

Over the course of the unit, students will create their own ecological self-portrait, develop ways to increase their positive impact on the environment, research the increase of greenhouse gases in the atmosphere as a result of fossil fuel consumption and design a future home that incorporates clean energy resources to produce a minimal carbon footprint. Although the unit includes strong ties to the California locale, it can be modified to include features from other regions. The unit is designed for middle school students and includes both individual and collaborative group work.

(Developed for Integrated Science, grades 6-7; recommended for Science, grades 6-7)

19.04.04
Transfer of Energy through a Food Chain, by Joseph Jackson

If there were no plants, there would be little life on this planet. This unit covers the energy transfer through an ecosystem in three parts for fifth grade students. Electromagnetic radiation is energy created by the sun. Plants transform this energy into matter and store it as food. Finally, this food created by plants is the energy that the rest of the organisms on this planet use to sustain life.

First, life on Earth comes from the energy of the sun. We will discuss the electromagnetic spectrum putting emphasis on visible light, ROYGBIV, transverse waves, wavelengths, and frequencies. We will also explain the relationship between a photon and a wavelength.

Next, photosynthesis is the only process that can harvest the energy of the sun and store it into a chemical bond. We will cover photosynthesis in a secondary sense and explain it in a fifth-grade application. We will also discuss where it is made in the leaf and its uses as the main producer of food for all the life on this planet.

Then, we discuss the transfer of energy through plants producing it, consumers eating it, and decomposers recycling it. We will cover energy pyramids and relate them to food chains.

Last, we will use this information for a culminating activity for students to create a project with a diorama or power point explaining an organism of their choice modeling energy transfer through a food chain.

(Developed for Science, grade 5; recommended for Science, grades 5-8)

19.04.05
Prototyping a Wind Turbine and Measuring Performance, by Drew Katti

In this unit, we are going to cover the challenges in meeting global energy consumption and the driving forces that have led to the growth of renewable energy. Specifically, this unit will cover the concept of what is energy and how can wind be transferred into a renewable source of energy. The abstract concepts in understanding electricity and magnetism will be covered through experimental discovery. A final design project to make a wind turbine will be completed.

This unit is for sophomore or junior high school students interested in pre-engineering. Students will work in teams of two or three on the experimental bench work. There will be class activities in understanding vocabulary and in verbalizing the concepts of wind and renewable energy.
The standards covered are working collaboratively, developing language skills, meeting content needs surrounding energy.

(Developed for Principles of Engineering, grades 10-11; recommended for Physics, grades 10-11)

19.04.06
Assessing Chicago's Carbon Footprint One Step at a Time, by Taissa Lau

Carbon dioxide emissions have been on the rise since the Industrial Revolution and the invention of the steam engine. Scientists almost inarguably agree that there is a correlation between carbon dioxide emissions and climate change. Without incorporating mitigation techniques and strategies, the world as we know it could suffer drastic consequences by the end of this century due to these greenhouse gas emissions produced by the burning of fossil fuels. In this curriculum unit, my goal is to introduce energy principles, energy sources and implications for the environment from using those sources. Specifically, the unit focuses on carbon dioxide emissions, evaluating current uses of energy and proposals to reduce environmental impacts from those uses.

The unit starts by introducing students to energy in its different forms: kinetic energy and potential energy in addition to the forms that fall into those categories. It then progresses to understanding the behavior of energy through conservation and transformation. Students must understand these behaviors in order to understand how humans harness energy from different sources. The unit will also introduce nonrenewable and renewable sources of energy to students to complement how humans use energy. After understanding the sources of energy, students dive deeper into exploring the greenhouse effect and carbon dioxide emissions caused from harnessing energy from fossil fuels. The unit culminates with students assessing Chicago's carbon dioxide emissions, researching the current energy policy proposals and assessing their effectiveness in reducing carbon dioxide emissions.

(This unit was developed for Physical Science and Earth Science, grade 8.)

(Developed for Physical Science, grade 8; recommended for Earth and Space Science, grades 6-8)

19.04.07
Islands and Their Energy Needs, by Krystal Medina

The unit titled *Island's and Their Energy Needs* is a unit that is intended to expose high school environmental science students to energy resources available throughout the world, the effects of human-induced climate change, the effect climate change has on islands, and how islands can become self-sustaining leaders of the world by utilizing alternative energy sources. Students will conduct research to receive an overview of each renewable and non-renewable source of energy that also includes the impacts they have on the environment, human health, and economy. Students will learn this by designing and creating a hands-on, engaging museum exhibit that includes background, an interactive activity, and an exit ticket. From here, students will participate in a stations activity where they will build models of a windmill, hydroelectric plant, and a solar

generator. Lastly, students will organize a debate to defend a renewable option to fuel the energy needs of an island. This will give students an understanding of energy, its use, and its effect on the environment.

(Developed for AP Environmental Science, grades 10-12; recommended for General Science, grade 8, Environmental Science and Earth Science, grades 9-12)

19.04.08
Analyzing Energy Efficiency Through Energy Transformations, by Zachary Meyers

Our modern electrical infrastructure transforms a myriad of energy sources (i.e., fossil fuel, solar, wind, tidal) into an electric current to provide our 21st-century amenities. Discussions surrounding the complexities of sustainable energy and energy consumption often lack clarity or reference to the law of conservation of energy and the physical constraints that govern energy efficiency. This 3-4 unit seeks to provide enrichment opportunities for 11^{th} and 12^{th} grade students about energy transformations with reference to the law of conservation of energy and thermodynamic principles. Student will examine electric devices at home and in the classroom to deconstruct the variety of energy transformation involved in its utility. In addition, students will construct their own flashlights and measure energy efficiency.

(Developed for Honors Physics, grades 11-12; recommended for Physics, grades 11-12)

19.04.09
Demystifying Radiation, by Vanessa Vitug

Radiation is a word synonymous in people's minds with images of a mushroom cloud over Hiroshima, rubble over Chernobyl, and floods at Fukushima. This unit attempts to show that radiation is as unavoidable as the sun, and provides benefits beyond generating electrical power. High school Anatomy and Physiology as well Biology and Health Science students will develop a foundational knowledge regarding the electromagnetic spectrum (EMS), chemical bonds in DNA damaged by ultraviolet radiation, and how radiation is measured. As the unit develops, students will understand that a nuclear reactor producing nuclear energy is not the only use of high energy radioactive materials. Through hands-on-learning activities and a mock Environmental Protection Agency committee hearing, students will connect today's medical technology including X-rays, CT scans, and radiotherapy to the EMS and radioactive particles. Finally, students will articulate that the hazards of radiation exposure are outweighed by the benefits radioactive materials provide to society.

Keywords: radiation, electromagnetic spectrum, bond energy, ultraviolet, nuclear energy, X-rays, radiotherapy

(Developed for Physiology, grades 11-12; recommended for Biology and Health Science, grades 9-12)

19.04.10
Harnessing the Wind Like William Kamkwamba: Building Model Windmills in a 4th Grade STEM Lab, by Jason Ward

This unit aligns with 4th grade Next Generation Science Standards (NGSS) related to the topic of energy. Students will learn the science behind how a windmill can be used to generate electricity. It is inspired by the story of William Kamkwamba, a 15-year-old farmer from Malawi who built a windmill in his village to bring power and water during a time of famine. Kamkwamba's story rose to fame in 2006, when a local newspaper wrote about the boy who created a windmill to power his home and irrigate his family farm. His story is featured in a memoir, a 2019 Netflix drama, and the adapted (and 4th grade appropriate) version of his autobiography, titled "The Boy Who Harnessed the Wind."

This curriculum unit is the result of my work in the 2019 Yale National Initiative seminar titled Energy Sciences. This two-week intensive, teacher-led summer institute was led by Dr. Gary Brudvig, Yale Professor of Chemistry, Molecular Biophysics and Biochemistry and director of the Yale Energy Sciences Institute. I have 18 years of experience as an elementary teacher at the time of this writing, and I have been developing and teaching K-4 STEM curriculum in New Haven, CT for the past five years.

The background knowledge section provides a summary of energy and energy resources. Then, like Kamkwamba, students will construct a scale model wind turbine and use an electrical generator to provide power to a light and a buzzer. They will learn the science behind and the engineering skills related to each step of the process. In addition to student models, instructions are also provided for building a more substantial, 7-foot tall model that can be used as a classroom demonstration piece.

(Developed for STEM Lab – Energy Science, grade 4; recommended for Energy Science, grades 3-5)

V. Perimeter, Area, Volume, and All That: A Study of Measurement

Introduction

The seminar *Area, Perimeter, Volume and All That* was intended to be a general survey of the issues of measurement, but in fact most of the Fellows of the seminar were interested in area, perimeter and volume, so we focused on those topics, and most of the units deal with them.

Several of the Fellows were concerned that, in standard instruction, students do not grasp that area and perimeter are quite distinct quantities, and that some students think that shapes with the same area will have the same perimeter. To counter this sort of misconception, we discussed two strategies.

First, one can study situations in which one of area and perimeter is fixed, and see how the other behaves. For example, rectangles with sides of length 1 and 9 inches, or 2 and 8 inches, or 7 and 3 inches, or 6 and 4 inches, or 5 and 5 inches, will all have a perimeter of 20 inches. However, their areas will be 9, 16, 21, 24, or 25 square inches, respectively. The 5 by 5 square has more than two and a half times as much area as the 1 by 9 rectangle. With larger perimeters, the variation in area will be even more dramatic.

Second, one can go beyond rectangles and contemplate more complex shapes. To do this, we worked with polyominoes – shapes made by putting unit squares together, subject to a couple of simple rules. The number of possibilities increases remarkably rapidly with the number of squares used. You can have a lot of fun with polyominoes, but to cut to the chase: you can create polyominoes of area, say, 8 (aka *octominoes*), with perimeters that vary from 12 to 18. A large number of these octominoes have the same perimeter as a rectangle of area 20. Thus, polyominoes can build student intuition about the possible complexity of shapes, and at the same time, help them refine their understandings of area and perimeter.

Polyominoes turned out to be an attractive topic for many of the Fellows, and were incorporated into most of the units, even being featured in the titles of five units, ranging from kindergarten to middle school.

The units also incorporated the individual perspectives of the Fellows. The units of Jamie Griffin and Dennis Williams integrated gardening with geometry. The units of Marnita Chischilly and Andrea Thomas investigate Native American culture (architecture and farming, respectively). Joseph Parrett's unit uses polyominoes to create novel counting challenges for his kindergarten students. Ricardo Moreno uses Chicago architecture to motivate volume calculations. Tina Berry will have students create sculptures based on polyomino ideas. Kathleen Gormley will utilize the addition and multiplication tables to engage in some systematics, as sketched above. Lianne Aubert Sanfeliz will have her

students measure schoolyard structures, and have her students create sensory pathways in the school halls. Trisha Williams seeks to give her second graders a leg up through an early study of area and perimeter.

The remaining two units have somewhat different themes. Valerie Schwarz investigates the common special classes of quadrilaterals, and shows that they are described well in terms of symmetry. Tierra Ingram seeks to adapt the interpretation of multiplication in terms of rectangles to develop the box model for multiplication, and to extend this to multiplication of polynomials. As a whole, the units display well the diversity and creativity of the Fellows.

Roger E. Howe

Synopses of the Curriculum Units

19.05.01
A Pathway to Understanding Area and Perimeter, by Lianne Aubert Sanfeliz

The concepts of area and perimeter are essential components of the mathematics curriculum in primary grades not only because they can be illustrated by "real-life' situations, such as describing the perimeter of a fence around the playground, or the area covered by the classroom rug, but also because they are closely related to other mathematical concepts like addition and multiplication, surface area, and volume.

However, the typical treatment of these concepts in the mathematics curriculum is confusing and challenging for some students. The introduction of procedures and area formulas before the proper conceptual understanding is developed, the lack of comprehension of the differences between linear and squared units, difficulties to relate multiplication arrays with the area of rectangular figures, and the tendency to believe that rectangular figures with the same perimeter must have the same area and vice-versa are some of the rationales for the misunderstanding of area and perimeter.

In this unit, students will be able to explore what happens to the perimeter and area of a rectangular figure when the rectangle is changed by removing unit squares. They will also compare the areas of rectangles with the same perimeter and vice-versa. The focus of the unit is to deepen students' understanding of perimeter and area while concluding the relationships and differences between the two concepts. Students will be able to communicate effectively through drawings and numbers, work cooperatively in small groups, and successfully apply their comprehension about area and perimeter in a real-life situation.

(Developed for Mathematics, grade 3; recommended for Mathematics, grade 3)

19.05.02
SmArt Math: Paper Polyominoes and Ceramic Tetradic Cuboids, by Tina Berry

Math and art skills are combined in this SmArt Math unit. The unit is based on 7th grade art and math standards, but could easily be adjusted and used in any grade in math or art class. Students use measuring tools (ruler, yardstick, and tape measure) after a brief review of how to use them and unit squares to measure perimeter, area, and volume. Manipulatives will be used to create polyominoes and nets for hands-on experiential learning. Students will learn how 2-Dimensional shapes can be folded to make 3-Dimensional forms using nets. The replication of the area of a square shape to form the planar surface area of a cube will be investigated. Art skills will be used to add texture and color to a student created net that will then form a cube. Students will work in groups with their cubes to form tetradic cuboids. They will then choose a tetradic cuboid

to create a net template of, then use it to cut out clay slab pieces. Finally, students will piece together and create a ceramic tetradic cuboid based on the paper cube arrangements. Steps for integrated differentiation are included in the unit activities.

(Developed for Art, grades 7-8; recommended for Math, grades 5-10, and Art, grades 6-9)

19.05.03
Native American Geometric Community, by Marnita Chischilly

Geometry has been a part of Native American history for centuries, and has been embodied in the architectural techniques of Native American dwellings. These dwellings are an important part of our heritage, a heritage that is fading from the memories of our youth. An approach to reconnecting students to their heritage is to embed cultural relevancy in the teaching of mathematics. This is also a recommended approach for closing the achievement gap. The objective of this unit is to teach some key topics in geometry using cultural relevancy to deepen the understanding of math concepts, and in the process passing on valuable components of cultural heritage. The key topics of geometry in this unit is the surface area of the three-dimensional shapes of cones, cuboids and hexagonal prism. These shapes are found in the architectural dwellings of Native American, which include the teepee from the nomadic tribes, the pueblo from the pueblo tribes and the hogan from the dine' tribe. The teepee is a conical shape, which is ideal for all weather and is easily transportable. The pueblo dwelling is cuboid shapes that are built adjacent to each other or on top of each other, for a family community of homes. The hogan is a hexagonal shape formed by stacked logs for easy assembly and withstands the desert weather. These homes were built with geometric mathematical skills using natural resources.

As part of our school district mandates, mathematics teachers are asked to seek activities that "model real-world phenomena to include cultural relevancy" and "to represent and analyze relationships using mathematical concepts, verbal rules, geometric strands, and common core standards". I intend to demonstrate how these types of activities can be incorporated into a geometry unit as a way of conveying that history can have a strong impact on motivating students in learning math. Students will examine the shapes of the homes in an and use their knowledge of shapes to find the surface area of cones, cuboids and hexagonal prism as they complete their architectural math activity project of a Native American Community.

(Developed for Math/Geometry, grade 8; recommended for Math/Geometry, grades 5-8)

19.05.04
Exploring Perimeter and Area with Third Graders, by Kathleen Gormley

This curriculum unit explores the concepts of geometric measurement, specifically perimeter and area. Using manipulatives and hands on activities, students will build connections between areas of rectangles and multiplication, and will solve real world problems. The unit starts with students using non-standard unit to measure various lengths. They then move to standard units, and understanding how to measure length using tools such as rulers, yardsticks and tape measures. Next, they will study area, especially how partitioning rectangles into arrays of squares gives rise to the standard formula for area as length times width. Study of irregular figures will help students learn to distinguish between area and perimeter, This unit is designed for a third grade class, but many of the activities and strategies can be easily adapted for younger or older grade levels. The purpose of the unit is to help students to develop a stronger awareness of number in a geometric context, and to build problem solving skills.

(Developed for Mathematics, grade 3; recommended for Mathematics, grades 2 and 4)

19.05.05
Pentomino Garden: An Explorative Unit in Measurement, Manipulatives, and Gardening, by Jamie Griffin

This curricular unit focuses on measurement and will be taught after students have learned how to measure using non-standardized units. It reiterates the concepts learned while using non-standard units to measure such as the units must be edge to edge, not have gaps, and not overlap. The special emphasis of the unit is the relationship between geometry, measurement, and arithmetic. The main math concepts that will be focused on in this unit are the appropriate use of a ruler, the array structure of a rectangle, perimeter, and area of simple shapes such as squares and rectangles. This unit explores ways that students can interact with measurement through counting and various other strategies. By using specific, real-world applications of the math concepts students will realize the relevance of mathematics in their lives and how it exists all around them. The use of manipulatives, gardening, and math talks are critical for this unit. These strategies will bring the mathematics to life and engage the students in a new way. By creating different aspects of a garden through measurement students will see how measurement is related to arithmetic and geometry as well as related to their own lives. Furthermore, the measurement that takes place with a ruler in our garden demonstrates the importance of using standardized units even in primary grades.

(Developed for Measurement and Geometry, grade 1)

19.05.06
When Your Plan to Multiply Polynomials is FOILED, by Tierra Ingram

This unit has been devised to bridge the gap between arithmetic and basic numerical ideas, and the Algebra classroom. It intends to speak to the process of multiplying polynomials of various degrees, by using area models, and their schematic cousin, the box method, to elucidate the magnitudes involved when multiplying, first with base ten numbers, and then polynomials. By considering the distributive, extended distributive, commutative and associative properties of multiplication, students will make connections between the processes of multiplying polynomials and multiplying base ten numbers. These properties, and one of their notable consequences, the Law of Exponents (aka Product Rule), will allow scholars to justify their ability to multiply these algebraic terms in a variety of ways. Through a variety of activities students will explore the area model/box method way of multiplying polynomials, and participate in activities that will not only lessen their math anxiety, but enhance their growth mindsets and increase productivity in class. Scholars will be encouraged to cultivate their own ideas and allowed to show mastery in a variety of ways. This unit will act as an easily accessible resource or roadmap into some of the most complex algebraic ideas, and use basic elementary ideas to act as the GPS. Lastly, I hope that use of a geometric model to multiply polynomials will enable my scholars to continue to make associations in later algebraic studies.

(Developed for Algebra I, grade 8; recommended for Algebra I, grades 8-9, and Pre-Algebra, grades 7-8)

19.05.07
Area, Surface Area and Volume: From Misconceptions to Skyscrapers, by Ricardo Moreno

In my unit students will work hands on with two dimensional arrays and three dimensional rectangular prisms or boxes. Area is introduced with manipulative activities such as working with foam square units in composing and decomposing rectangular arrays. Surface area is understood as a way of product of columns and rows of units. The focus on volume will be centered on how cubic units occupy the space of solid prisms as layers and the concluding with how formulas are used

My aim is to bring clarity in such learning goals as visualizing arrays and how using rows and columns aid in the determination of area. How focusing on key terms such as compare, combine, and replicate feed into the strengthening of teaching strategies. The bulk of this unit's activities will focus on understanding the functions of rectangular arrays, geometric nets and rectangular prisms.

It is a privilege to be a teacher and be able to share the beauty of math with my students. I love the discovery of math concepts as an adult and the thrill I make with my students when a connection is made between teacher and student.

(Developed for Mathematics, grade 6; recommended for Mathematics, grades 5-7)

19.05.08
Measures and Counts and Shapes, Oh...Polyomino?, by Joseph Parrett

This is a kindergarten unit that will connect the mathematical strands of geometry, counting and cardinality, and measurement and data, through the use of the shapes known as polyominoes. The students will engage in hands-on activities to find, create, and record polyominoes. They will use these shapes to practice critical skills from the Common Core State Standards in Mathematics, including counting and writing numerals and the description of geometric attributes. They will then engage in measurement tasks that culminate in finding area and perimeter of polyominoes. The unique nature of polyominoes makes these advanced measurement practices totally accessible to kindergarten students. In the summative activity, students will engage in critical thinking exercises as they consider the polyominoes. They will sort the shapes into groups, and justify their groupings by referring to data collected about the attributes of the polyominoes. These activities will also strengthen student skills associated with multiple CCSS Math Practices. This unit will expose primary students to advanced learning, concepts and vocabulary, and at the same time they will be practicing critical kindergarten standards from across three mathematical strands.

(Developed for Mathematics, grade K; recommended for Mathematics, grades 1-2)

19.05.09
Measuring All Around, Inside and Out: A Unit about Perimeter and Area, by Valerie Schwarz

This curriculum unit connects geometry and measurement. Quadrilaterals, area, and perimeter are explored through hands on activities designed to teach a conceptual understanding of mathematics. Teaching methods will include tasks, hands-on activities, and cooperative groups. Students will explore the meaning of area and perimeter in squares and rectangles by covering surfaces with square units and tracing the outline using linear units, respectively. Once the students understand the meaning of measures and the corresponding units, they will explore if there is a relationship between area and perimeter through carefully designed problems. Once the basic relationships are mastered, students will work on more challenging area and perimeter problems. After they are quite familiar with rectangles and their properties, students will explore the properties of other families of quadrilaterals and the interrelationships between them. The unit will examine pairs of parallel sides, right angles, opposite sides with the same

length, and the diagonals and symmetries (reflections across a line, or across several lines, and rotations), using hands-on tools. Finally students will understand how to calculate the area and perimeter of different classes of quadrilaterals including parallelograms, trapezoids, and rhombi. The goal is to tie in geometry and measurement together in a way that fosters deeper knowledge that will lead to more success in middle school and beyond. This unit is written for fourth grade, but could easily challenge students in grade five through seven.

(Developed for Mathematics, grade 4; recommended for Mathematics, grades 3-6)

19.05.10
Area and Perimeter: Farming Polyominos on the Navajo Nation, by Andrea Thomas

The focus of my curriculum unit was measurement. Particularly, I wanted to develop my students understanding of the concepts of area and perimeter. As the Dine, or Navajo, are currently and traditionally an agrarian society I felt that a practical and culturally relevant platform for exploring these concepts would be through the model of farming practices in our communities. By using the cultivation of our sacred plants- squash, beans and corn- to illustrate area and perimeter problems I will also be able to pose real-world questions to my students about being able to responsibly allocate crop space to produce enough yield to feed their families through the winter months.

I will use a variety or exercises using polyominos, which are combinations of unit squares, to demonstrate increasingly complex area and perimeter problems. Using square inch tiles to generate, and then measure, increasingly complex polyominos, students will be provided with a hands-on approach to increasingly difficult area and perimeter calculations. Eventually they will apply these strategies to a farm production problem with real world applications. I will provide them with the expected area of land required to cultivate individual corn, bean, and squash and squash plants as well as the crop yield which will be required to sustain both an individual and family unit through the harsh winter months. They will use their understanding of polyominos and area and perimeter calculations to design farms which will most efficiently meet to supply needs set forth above.

(Developed for Mathematics, grades 3-5; recommended for Mathematics, Reteach, SPED, grade 6)

19.05.11
From Polyominoes to Planters: Using Manipulatives and Project-Based Learning to Explore Measurement, by Dennis Williams

From Polyominoes to Planters: Using Manipulatives and Project-Based Learning to Explore Measurement is a scaffolded curriculum unit built around open-ended instruction, direct instruction, and research-based manipulative practice. It is designed to take place over two to three weeks and is created for sixth-grade students receiving special education services in self-contained math classrooms. Its activities will provide students opportunities to explore in a rigorous manner the characteristics of rectangles and also three-dimensional rectangular prisms, and to build understanding of concepts of geometric measurement, including perimeter, area, and volume. This unit adopts the common practice in special education settings of using "manipulatives", i.e. hand-held objects that can be used to illustrate key concepts. All such uses are designed to be consistent with research-based best practices. In order to master geometrical concepts of measurement and to increase their spatial ability, students will engage in polyomino practice with unit square tiles and construct miniature vegetable planters to explore using cubes as units of volume.

(Developed for Mathematics/Geometry, grade 6; recommended for Mathematics/Geometry, grade 6)

19.05.12
Geometric, Classroom Object Calculations, by Trisha Williams

Geometric, Classroom Object Calculations includes an entire unit study that adheres to Virginia Standards of Learning covering the geometrical concepts of perimeter, area and volume. The process for the implementation of a Geometric unit study for second through fifth grade students is outlined.

There are modeled sample lessons with details on a student's perception of each geometric concept, as students should think of the linear edge of an object for perimeter, the inside two dimensional surface of an object for area, and the three dimensional layers of an object for volume. The importance of the terminology that students will use is indicated such as the term, "array". Common misconceptions that students experience are addressed and accompanied with interventions. Strategies are also featured within this unit, such as the use of manipulatives, anchor charts, journal writing, other visual aids, tools and methods. A method that is one of the focal points of this unit has to do with the manipulatives called pentominoes. The pentominoes are used to facilitate the differentiation between area and perimeter. A popular educational short story by Marilyn Burns called, *Spaghetti and Meatballs for All, A Mathematical Story* is another focal point of the unit including extended activities. Classroom activities such as: Geometrical Exiting before Lunch (questions are asked of the students detailing specific points which

are relevant to the geometrical concepts taught), Geometrically Creating Objects and Analyzing Classroom Objects to perform perimeter, area, and volume tasks are the culminating activities of this unit.

(Developed for Mathematics – Geometry, grade 2; recommended for Mathematics – Geometry, grades 2-5)