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Quantitative and Qualitative Differences in Science Writing With a Writing Template Intervention

By J. Gail Armstrong-Hall Ph.D.

Abstract

Eighty seventh grade middle school students were asked to write up an experiment. The pre-write-up occurred the first week of school in September and involved performing an experiment and asking the students to write it up (no writing template was introduced but the poster with the template was hanging up in the classroom). After the pre-write-up; each time students completed a lab they were encouraged to use a science writing template that they had attached with a staple to the inside of their notebook. In March they were again asked to do a lab write-up and the results from September were compared to the results in March. Both genders showed a significant increase in words, (93F); (78M). In addition to the number of words, both genders showed significant positive changes in writing quality; (6.875F); (6.5M).

Students were asked to write up two labs one in September and one in March and each writing sample was looked at for content (possible 14 points) and number of words written. Aside from a poster in the room the students had not been introduced to the science writing template in September they were just asked to, "Write up their lab". After the first lab the first week of school students were introduced to the science writing template3 and told to staple a copy to their notebooks. Each time we went to the computer lab to write up an experiment; students were encouraged to use their template. In March no mention was made of the template and students were asked to simply write up their lab in class. Words were counted for the pre and post labs and quality was determined by the following point scale: Title 1; Problem 1; Hypothesis 1; Methods 5; Conclusion 5; References 1; for a possible total of 14 points. Eighty students participated in the study and the following chart is the raw data for the qualitative and quantitative differences.

FEMALE RAW DATA CHART

# of Participant/ Gender	September # of words	March # of words	Difference between scores	September Quality Score	March Quality Score	Difference between Scores
1F	65	109	44	9	14	5
2F	55	255	200	12	14	2
3F	73	111	38	6	14	8
4F	124	191	67	4	14	10
5F	40	70	30	7	7	0
6F	60	135	75	6	14	8
7F	71	59	-12	1	7	6
8F	55	177	122	3	11	8
9F	80	109	29	7	13	6
10F	48	88	40	7	7	0
11F	34	121	87	4	9	5
12F	102	230	128	10	14	4
13F	75	146	71	12	14	2
14F	94	245	151	12	14	2
15F	66	200	134	7	14	7
16F	77	179	102	6	14	8
17F	72	163	91	12	13	1
18F	58	222	164	5	14	9
19F	178	258	80	5	13	8
20F	79	223	144	6	14	8
21F	93	209	116	4	14	10
22F	68	202	134	4	14	10
23F	66	176	110	10	14	4
24F	24	44	20	3	7	4
25F	82	180	98	6	14	8
26F	53	186	133	5	14	9
27F	42	148	106	4	13	9
28F	82	201	119	6	13	7
29F	60	127	67	4	13	9
30F	115	179	64	7	14	7
31F	76	169	93	6	13	7
32F	40	127	87	2	14	12
33F	61	150	89	6	14	8
34F	49	171	122	2	14	12
35F	79	140	61	6	14	8
36F	58	144	86	3	13	10
37F	95	129	34	5	14	9
38F	56	188	132	2	13	11
39F	84	227	143	6	13	7
40F	67	176	109	6	13	7
			3708/40			275/40
			92.7			6.875

MALE RAW DATA CHART

# of Participant/ Gender	September # of words	March # of words	Difference between scores	September Quality Score	March Quality Score	Difference between Scores
1M	27	38	11	1	1	0
2M	56	119	63	4	13	9
3M	49	30	-19	6	5	-1
4M	64	279	215	5	14	9
5M	64	133	69	5	10	5
6M	73	128	55	8	13	5
7M	86	116	30	4	10	6
8M	59	127	68	7	12	5
9M	39	102	63	2	13	11
10M	51	170	119	4	14	10
11M	47	117	70	2	7	5
12M	66	174	108	3	13	10
13M	72	190	118	9	14	5
14M	53	141	88	5	12	7
15M	54	107	53	4	14	10
16M	59	161	102	3	14	11
17M	50	113	63	4	9	5
18M	77	117	40	3	12	9
19M	48	33	-15	4	4	0
20M	54	81	27	10	12	2
21M	45	108	63	5	6	1
22M	55	149	94	7	13	5
23M	58	229	171	5	12	7
24M	34	52	18	7	3	-4
25M	22	60	38	3	7	4
26M	63	142	79	3	14	11
27M	30	60	30	4	14	10
28M	64	137	73	5	12	7
29M	42	119	77	5	12	7
30M	38	85	47	3	5	2
31M	74	123	49	5	12	7
32M	66	158	92	6	13	7
33M	46	230	184	3	13	10
34M	83	185	102	4	14	10
35M	49	148	99	3	11	8
36M	51	163	112	3	13	10
37M	65	184	119	2	14	12
38M	61	175	124	6	14	8
39M	43	146	103	5	12	7
40M	67	198	131	6	14	8
			3133/40			260/40
			78.325			6.5

Cumulative Chart Showing average differences for all students

Average Difference in Number of Words	85.5
Average Difference in Quality	6.6875

History

Many available templates for organization purposes in the fields of accounting, commerce, law and communications are found on the internet. One web site, www.persuasiveessayguide.com emphasizes the importance of templates when learning a language; their instructor emphasized using letter templates. It only makes sense that we should prepare writing templates for the content areas such as science, math and social studies. Early on scientists understood that science writing should have a standardized format so that information between labs could be shared globally.[1, 2] Dr. Armstrong-Hall's writing template expands upon the science writing template by including specific generic criteria for the methods and conclusion sections.[3]

Conclusions

What is particularly remarkable about this study is that the quality of writing improvement was the same for both genders, about 7 points better on a scale of 14 points this result is significant. The females had more words than the males but not by much they averaged 93 words more after the intervention and the boys averaged 78 words more after the intervention. Students on the low end and high end were queried about how comfortable they felt using the intervention and those at the high end said they felt very comfortable (on a scale of 1 to10 with 10 being the most comfortable) they were all 9 and 10. Those on the low end reported scores between 5 and 7. Overall the average difference in the number of words for all students was 85 words and the average difference in quality was 7 points. A science template appears to encourage more writing and better quality writing amongst 7th graders.

References

Toavitsainen, I., Pahta, P. (2004) Medical and Scientific Writing in late medieval English, Cambridge Press.

Harmon, J.E., Goss, A.G. (2007) The Scientific Literature: a guided tour, The University of Chicago Press.

Armstrong-Hall, J.G. (2011) Formula Science Writing, MSTA Newsletter, November issue 4, volume 63.

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My sincere thanks to all my students who showed a lot of patience during the data collection period without their support and help this study could not have been completed. In particular these students helped with the final number tallies, Neha Paragi, Gloria Kang, Tanvi Deshmukh, Neha Sridhar, Emma Springer, Rachel Choi, Mark Iskander, Sarah Anthony, Patwa Richa, Shawn Waynick and Jarod Crumpley.

Michigan's Ride on the North American Plate

By Steve Mattox, Department of Geology, Grand Valley State University; Kimberly Jenerou, c/o Department of Geology, Grand Valley State University; Hilary Lenzo, Dansville High School; Chris King, Professor of Earth Science Education, Keele University

Abstract:

The activity examines the evidence for plate tectonic theory from the stratigraphic column, or rock sequence, of Michigan. It uses a series of structured questions asking students to examine the evidence provided to formulate and test their own hypothesis about the movement of the area we now call Michigan over geological time. The activity has been used successfully with students over a number of years.

Background

The basic premise to the theory of plate tectonics is that the position of continents and oceans change over geologic time. As early 1912, Alfred Wegener used the association of rock types and climate zones to support his nascent hypothesis of continental drift. The rock layers preserved on each continent reflect the influence of the latitude/climate zone of the continent at the time they formed, sea level, topography/bathymetry, and concentration of greenhouse gases in the atmosphere. This activity looks at the position of North America over the last 542 Ma (million years) as the continent drifted through different climate zones. The position of the continents is derived from magnetic data stored in basaltic lava flows the day they solidified. Students use paleogeographic maps to estimate latitude and climate zones at several geologic periods. Then, latitudes are matched with the common rock types associated within them. The activity concludes by comparing the stratigraphic column of Michigan to see how the rock record reflects the tectonic path and the climate zones transgressed. This activity is designed to address HSCE Code: E3.r3f Describe how the direction and rate of movement for the North American plate has affected the local climate over the last 600 million years aimed at middle and high school students. The activity was modified for North America, with the permission of co-author Chris King, from The British Isles through Geologic Time from Investigating the Science of the Earth, SoE2: Geological Changes – Earth's structure and plate tectonics (Earth Science Teachers Association, 1996).

Activity

In Step 1 students look at six paleogeographic maps (Figure 1) and estimate the approximate latitude of Michigan on North America at a specific time in the past. The outline of North America conveniently shows the indentation of Hudson Bay, which is a coastal feature younger than the maps shown. Michigan is about 10 degrees of latitude from Hudson Bay. We found that students are commonly accurate within 5 to 10 degrees on the latitude. Note that being a few degrees off can "bump" the location into an adjacent climate zone but will not greatly change the results of the lesson. The students also use Table 1 to correlate their latitude estimate to a climate zone (equatorial, arid, etc.). We provide an answer key at the end of this article.

In Step 2 students plot their data on a time vs. latitude graph (Figure 2). In general, the six data points define a pattern like a check-mark (see answer key). Students need to plot each of the data points by estimating the time (in millions of years) and latitude (in degrees, north or south). The step concludes with four questions to see if the students show understanding of their graphs. For the last question, students can read the climate zone off the graph. In broadest terms, Michigan has passed through four climate zones in the past (equatorial, arid, Mediterranean, and temperate). The students should note we passed through each of these zones in each hemisphere. In greatest detail, because the continent drifted south in the Devonian, a student could say North America passed through the zones three times (equatorial to temperate, temperate to equatorial, then equatorial to temperate).

In Step 3 students are asked to look closely at the depositional environments associated with specific climate zones (Table 1) and select two environments and associated rocks that form in that climate zone. Of course, the exact rock type that forms is influenced by many factors—especially sea level (think of depositional environments on land versus environments in the ocean), topography (steeply dipping rivers in mountains versus low gradient rivers on the plains or near the ocean), and water depth (shallow marine ecosystems producing abundant fossils versus deeper ocean)—as well as climate. Note that some rock types are almost unique to a particular climate zone (such as coal to equatorial or evaporites to arid) and some are ubiquitous (such as sandstone). To simplify the lesson, we introduce some geology shorthand for rock names: lss for limestone, dolo for dolostone, sh for shale, ss for sandstone. You might write these on the board for students to use during the activity.

In Step 4 students look closely at the Stratigraphic Succession of Michigan (Michigan Department of Conservation, 1964) and rank the common rock types during each geologic period. The Stratigraphic Succession represents the rocks of the state over time. If you lived in the central part of the Lower Peninsula, it represents the rocks under your feet. Outward toward the edge of the Michigan basin, the younger rocks have been eroded away. Getting the abundance of rocks in the exact order is not critical. However, a complete list and some key rock types, such as salt in the Silurian and coal in the Carboniferous (commonly called Mississippian and Pennsylvanian in North America), are important.

In Step 5 the students complete two columns so that they can compare the rocks associated with climate zones with the rocks in Michigan. Again, results will vary depending on which climate zones a student selects. However, some clear patterns emerge and should be stressed (see the answer key). For example, Cambrian sandstones could result from both equatorial and arid climates. Reefs flourished as the continent entered a Mediterranean climate in the Silurian. The presence of evaporites also hints that the continent was near an arid climate. In the Carboniferous, the state's coal layers provide evidence of an equatorial climate. The youngest bedrock in the state, the "red beds" near Ionia, likely formed in a tropical climate.

In Step 6 students interpret their correlations and synthesize their observations. The high level of detailed agreement between the expected rocks in a climate zone and the observed rocks in Michigan provides a "local" connection for drifting continents and changing environments over hundreds of millions of years.

Through carrying out this activity, students are 'doing science' as opposed to just learning about science (although they do this at the same time). They carry out the scientific investigational activities of examining evidence, seeking patterns in the evidence, using the evidence to formulate hypotheses, and then checking the hypotheses against the evidence.

Additions and Extensions

Many of the rock types in Table 1 can be collected in the state or in adjacent states, as well as purchased at low prices at the annual MSTA conference or at local shows of gem and mineral clubs. As you move through the lesson, they can serve as a refresher on rock types and a connection to the real world.

The Stratigraphic Succession in Michigan can become difficult to read when copied, especially with regard to small detail such as the salt deposits. To enhance understanding and use of the column, such features may need to be discussed with students or a larger version made available. The lead author may be contacted for a higher resolution version of the stratigraphic sequence or other figures.

Different geologists have posted their paleogeographic maps online. These maps are more detailed than Figure 1 and provide additional information. We chose to use Figure 1 for its simplicity and as an introduction to the topic. The Paleomap Project of Christopher Scotese (http://scotese.com/paleocli.htm) has maps of the continents at different times and several animations that show drifting continents with changing climates. Ron Blakley's Paleogeography (http://jan.ucc.nau.edu/rcb7/) has numerous beautiful illustrations that would complement this lesson. Extending the lesson to include additional maps will help the students connect to ancient Earth. The History of the Earth poster (http://www.chronos.org/pdfs/k-12.pdf) from the Chronos website is an excellent synthesis of paleogeography, changing plate boundaries, and life over time.

References

Earth Science Teachers Association, 1996, The British Isles through Geologic Time from Investigating the Science of the Earth, SoE2: Geological Changes – Earth's structure and plate tectonics,
http://www.nationalstemcentre.org.uk/elibrary/file/4041/Geological%20changes%20-%20earth's%20structure%20and%20plate%20tectonics.pdf .

Michigan Department of Conservation, 1964, Stratigraphic Succession in Michigan.

Michigan Climate Over Time Lab

Step 1. Determining Michigan's Latitude

Use <u>The Movement of Continents over Geological Time</u> (Figure 1), to estimate the latitude of Michigan for each of the geologic periods shown. Record ages in millions of years (Ma). Climate zones are listed in Table 1. Record your observations:

Geologic Period	Latitude of Michigan	Age in Ma	Climate Zone
Cambrian	______	______	________________
Devonian	______	______	________________
Carboniferous	______	______	________________
Permian/Triassic	______	______	________________
Jurassic	______	______	________________
Cretaceous/Tertiary	______	______	________________

Step 2. Plotting the Latitude Data

Plot your latitude data for each geologic period in the space provided on the <u>Michigan's Changing Latitude</u> (Figure 2).

a. About when did Michigan reach its maximum southern latitude?

b. About when did Michigan cross the equator?

c. About when did Michigan reach its maximum northern latitude?

d. How many climate zones has Michigan experienced in the last 520 Ma?

Step 3. Relating Climate Zones to Rocks and Their Environment

Most of the sedimentary rocks that formed in Michigan since the onset of the Cambrian formed in an ocean (sea) environment. Table 1 summarizes the influence of climate on the environments where rocks form as well as the types of rocks that form. **For each climate zone, list two environments that exemplify that climate and a rock type that could form in each environment:**

Climate	Environment 1	Rock 1	Environment 2	Rock 2
Polar				
Temperate				
Mediterranean				
Arid/Semi-arid				
Equatorial				

Step 4. Michigan's Rocks over Time

The **Stratigraphic Succession in Michigan** (Figure 3) shows the sedimentary rocks that formed in the state since the onset of the Cambrian.

For each geologic period below, list the dominant rock types in decreasing order of abundance. Under "Other," list the presence of any coal beds, reefs, or evaporites (halite, anhydrite, and gypsum).

Geologic Period	Rock Abundance	Other
Cambrian	___________ > ___________ > __________	__________________
Ordovician	___________ > ___________ > __________	__________________
Silurian	___________ > ___________ > __________	__________________
Devonian	___________ > ___________ > __________	__________________
Carboniferous	___________ > ___________ > __________	__________________
Jurassic	___________ > ___________ > __________	__________________

Step 5. Compare Rocks/Climate Zones to Michigan's Rock Record

If the evidence we have used about plate tectonics and climate are correct, the environments and rock types from Table 1 should match the rocks in Michigan during the appropriate geologic periods. **Check your observations in Step 3 against what you recorded in Step 4.** If your rock types do not match, you might need to think carefully about what this shows or check the Geological Characteristics of Different Climatic Zones to see if those rock types are included. You will need to refer to your plot from Step 2 to determine the climate zone of Michigan during the Silurian. Record your observations for each period:

Geologic Period	Rocks Based on the Climate Zones	Rocks in Michigan
Cambrian		
Silurian		
Devonian		
Carboniferous		
Jurassic		

Step 6. Making Connections

During which geologic periods do the rocks of the climate zone match well with those actually seen in Michigan?

During which geologic periods do the rocks of the climate zone not match with those actually seen in Michigan? Explain why you think these two different types of data do not match.

As Michigan crossed the equator which rocks were deposited?

Are these rocks what are expected based on the climate zone chart?

Write a brief paragraph that summarizes your observations and supports or refutes the connections between climate zones, rock types, and the movement of North America. This is your hypothesis based on the evidence you have been using.

Figure 1. Movement of Continents Over Time

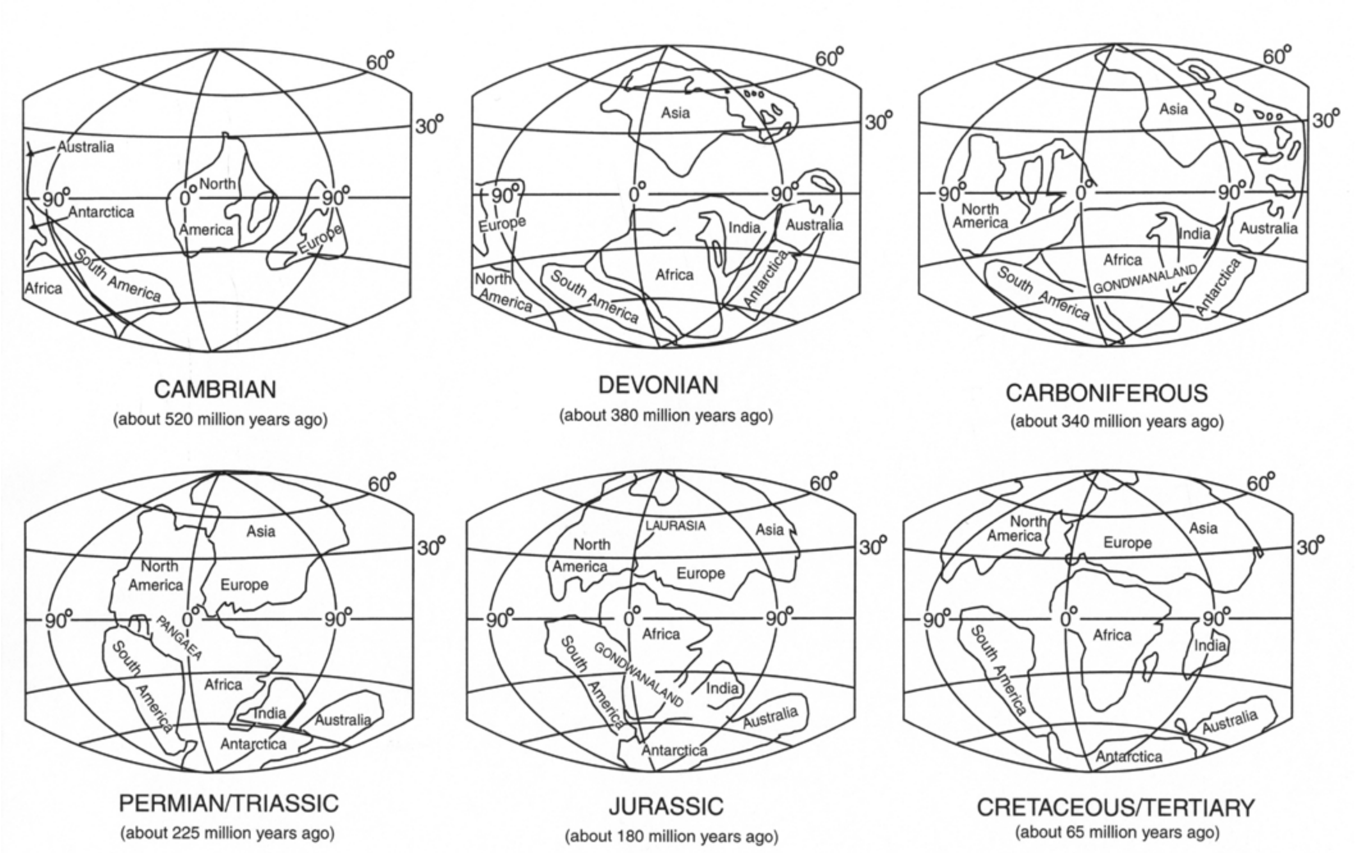


Figure 2. Michigan's Changing Latitude and Climate Over Geologic Time

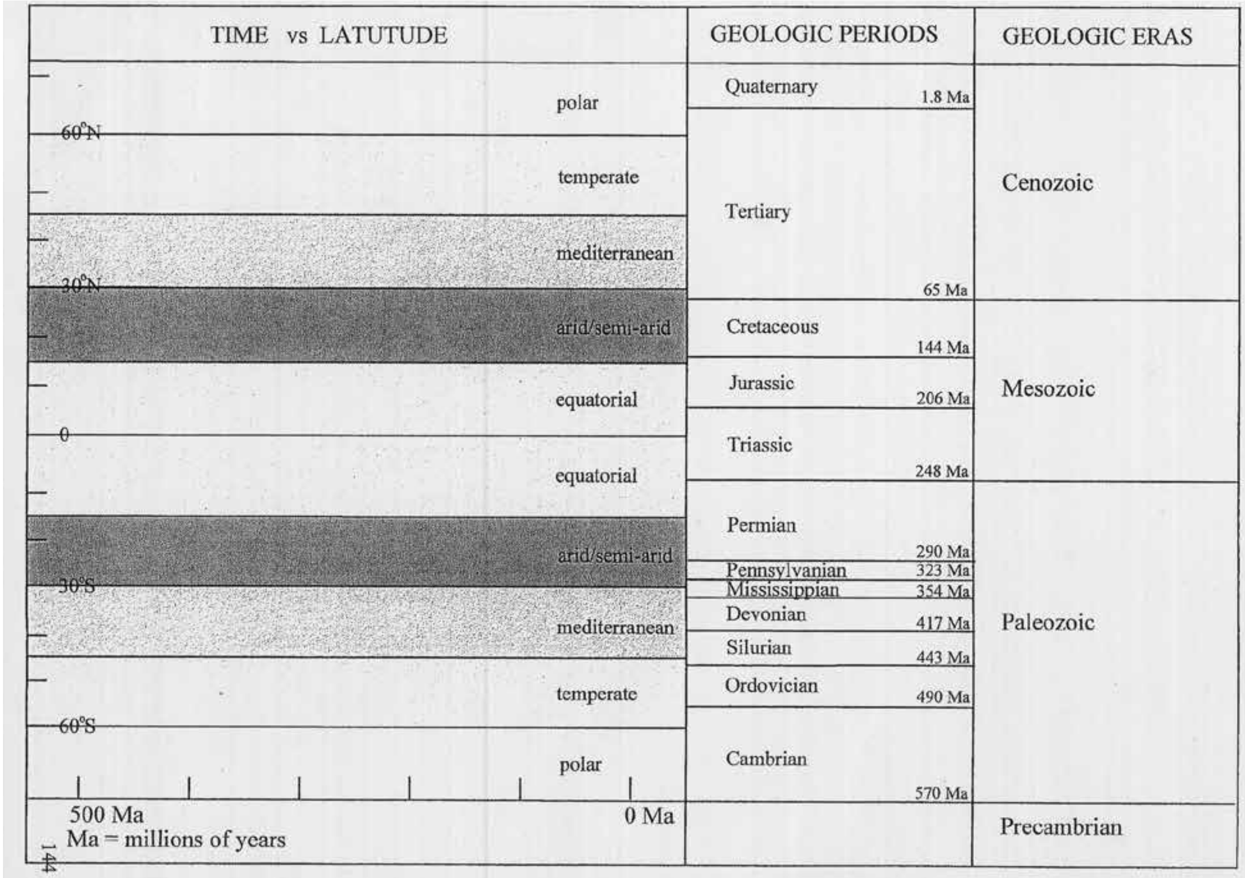
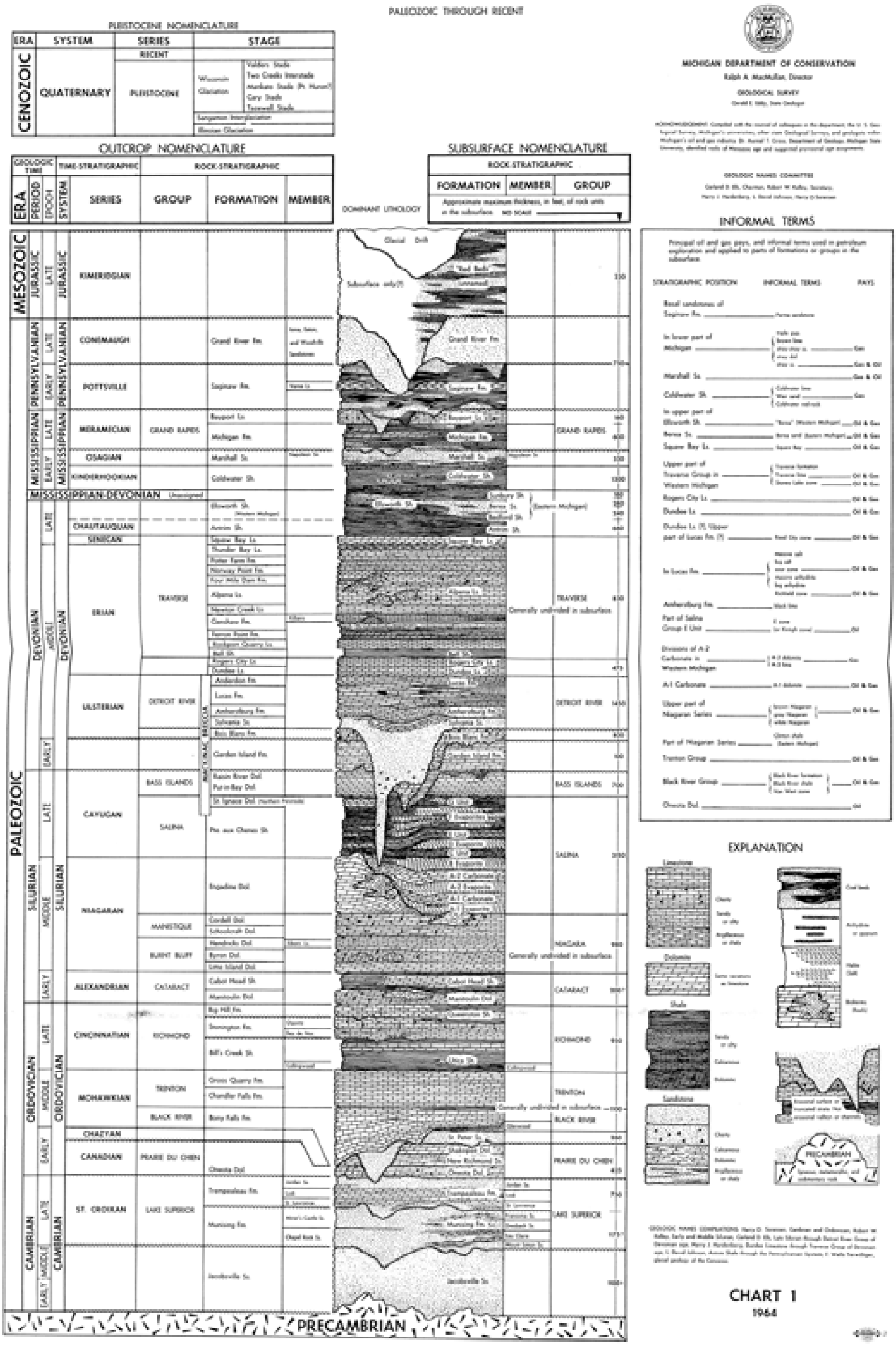


TABLE 1. GEOLOGICAL CHARACTERISTICS OF DIFFERENT CLIMATE ZONES

Climate	Latitude	Environment Exemplified	Rocks that could form	Other Notes
Polar	60°N - 90°N and 60°S - 90°S	On land: ice-covered or affected by cold ………….. In the sea: shallow tidal seas	Tillite; varved silts …………… Sandstones; mudstones; shales	
Temperate	40°N - 60°N and 40°S - 60°S	On land: rivers …………… In the sea: shallow tidal seas	Conglomerates; sandstones; siltstones ………….. Sandstones; mudstones; shales	………… Ancient shallow sea rocks may contain fossils such as trilobites, graptolites, brachiopods or ammonites
Mediterranean	30°N – 40°N and 30°S – 40°S	On land: rivers ………….. In the sea: coral reefs and lagoons in shallow seas	Conglomerates; sandstones; siltstones; palaeosols; ………….. Oolitic limestones; shelly limestones	……….. Ancient rocks may contain fossils such as corals, trilobites, brachiopods
Arid/Semi-Arid	15°N - 30°N and 15°S - 30°S	On land: deserts …………….. In the sea: coral reefs, lagoons, hot coastal basins	Red sandstones ("red beds"); conglomerates; evaporites, e.g. rocksalt …………… Oolitic limestones; shelly limestones; evaporites e.g. rocksalt	
Equatorial	15°N - 15°S	On land: equatorial swamps ………………. In the sea: coral reefs, and lagoons in shallow areas	Sandstones; shales, with coal …………… Limestones with a wide variety of fossils	Coal may contain plant fossils


PALEOZOIC THROUGH RECENT
PLEISTOCENE NOMENCLATURE
ERA
SYSTEM
SERIES
STAGE
CENOZOIC
QUATERNARY
RECENT
PLEISTOCENE
OUTCROP NOMENCLATURE
SUBSURFACE NOMENCLATURE
ROCK STRATIGRAPHIC
FORMATION
MEMBER
GROUP
SERIES
GROUP
FORMATION
MEMBER
DOMINANT LITHOLOGY
MICHIGAN DEPARTMENT OF CONSERVATION
INFORMAL TERMS
MESOZOIC
JURASSIC
PALEOZOIC
PENNSYLVANIAN
MISSISSIPPIAN
MISSISSIPPIAN-DEVONIAN
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
PRECAMBRIAN
EXPLANATION
CHART 1
1964

Michigan's Ride on the North American Plate Answer Key

Step 1. Determining Michigan's Latitude

Use The Movement of Continents over Geological Time (Figure 1), to estimate the latitude of Michigan for each of the geologic periods shown. Record ages in millions of years (Ma). Climate zones are listed in Table 1. Record your observations:

Geologic Period	Latitude of Michigan	Age in Ma	Climate Zone
Cambrian	10-20° S	520	Equatorial à Arid/Semi-Arid
Devonian	40-50° S	380	Mediterranean à Temperate
Carboniferous	10-20° S	340	Equatorial à Arid/Semi-Arid
Permian/Triassic	20-25° N	225	Arid/Semi-Arid
Jurassic	30-35° N	180	Arid/Semi-Arid à Mediterranean
Cretaceous/Tertiary	40-45° N	65_	Temperate

Step 2. Plotting the Latitude Data

Plot your latitude data for each geologic period in the space provided on the Michigan's Changing Latitude (Figure 2).

a. About when did Michigan reach its maximum southern latitude?
During the Devonian, about 380 Ma

b. About when did Michigan cross the equator?
Around the Permian, about 300 Ma

c. About when did Michigan reach its maximum northern latitude?
During the Cretaceous/Tertiary, about 65 Ma

d. How many climate zones has Michigan experienced in the last 520 Ma?
Michigan has experienced four climate zones (equatorial, arid/semi-arid, Mediterranean, and temperate) in each hemisphere.

Step 3. Relating Climate Zones to Rocks and Their Environment

Most of the sedimentary rocks that formed in Michigan since the onset of the Cambrian formed in an ocean (sea) environment. Table 1 summarizes the influence of climate on the environments where rocks form as well as the types of rocks that form. **For each climate zone, list two environments that exemplify that climate and a rock type that could form in each environment:**

Climate	Environment 1	Rock 1	Environment 2	Rock 2
Polar	*Ice*	*tillite*	*Sea*	*Mudstone*
Temperate	*Rivers*	*ss*	*Sea*	*ss, sh*
Mediterranean	*Rivers*	*ss*	*Reefs*	*Lss*
Arid/Semi-arid	*Deserts*	*ss (red)*	*Sea*	*lss, evaporates*
Equatorial	*Swamps*	*coal*	*Reefs*	*lss, fossils*

Step 4. Michigan's Rocks over Time

The **Stratigraphic Succession in Michigan** (Figure 3) shows the sedimentary rocks that formed in the state since the onset of the Cambrian.

For each geologic period below, list the dominant rock types in decreasing order of abundance. Under "Other," list the presence of any coal beds, reefs, or evaporites (halite, anhydrite, and gypsum).

Geologic Period	Rock Abundance	Other
Cambrian	___ss_____ > __dolo ss____ > _________	________________
Silurian	__dolo lss__ > _____sh___ > _________	__reefs, halite (salt)_
Devonian	__dolo lss__ > _____sh___ > __ss__	_________reefs______
Carboniferous	____h_____ > ____ss_____ > ______	coal, gypsum/anhydrite
Jurassic	____sh____ > ____ss____ > ______	______red beds______

Step 5. Compare Rocks/Climate Zones to Michigan's Rock Record

If the evidence we have used about plate tectonics and climate are correct, the environments and rock types from Table 1 should match the rocks in Michigan during the appropriate geologic periods. **Check your observations in Step 3 against what you recorded in Step 4.** If your rock types do not match, you might need to think carefully about what this shows or check the Geological Characteristics of Different Climatic Zones to see if those rock types are included. You will need to refer to your plot from Step 2 to determine the climate zone of Michigan during the Silurian. Record your observations for each period:

Geologic Period	**Rocks Based on the Climate Zones**	**Rocks in Michigan**
Cambrian	*Equatorial: ss, sh, coal, lss, fossils* *Arid/Semi-Arid: ss, lss, evaporites*	*ss* *dolo ss*
Silurian	*Mediterranean: ss, lss*	*dolo lss* *sh* *halite (salt)*
Devonian	*Mediterranean: ss, lss, reefs* *Temperate: ss, sh*	*dolo lss* *sh* *ss* *reefs*
Carboniferous	*Equatorial: ss, sh, coal, lss, fossils* *Arid/Semi-Arid: ss, lss, evaporites*	*sh* *ss* *coal* *evaporites (gypsum/anhydrite)*
Jurassic	*Arid/Semi-Arid: red ss, lss, evaporites* *Mediterranean: ss, lss, reefs*	*sh* *ss* *red beds*

Step 6: Making Connections

a. During which geologic periods do the rocks of the climate zone match well with those actually seen in Michigan?

Devonian, Carboniferous, Jurassic

b. During which geologic periods do the rocks of the climate zone not match with those actually seen in Michigan? Explain why you think these two different types of data do not match.

Cambrian, Silurian
These periods are ambiguous because sandstone is able to be formed under multiple different environmental conditions.

c. As Michigan crossed the equator, which rocks were deposited?

Coal, shale, sandstone

d. Are these rocks expected based on the climate zone chart?

Yes, land environments in equatorial climate zones should show sandstone, shale, and coal.

e. Write a brief paragraph that summarizes your observations and supports or refutes the connections between climate zones, rock types, and the movement of North America. This is your hypothesis based on the evidence you have been using.

Answers here will vary, but students should note correlations between expected rock types based on climate and rock types found during specific geologic periods in Michigan's stratigraphic column. These findings are aligned with climate zones experienced by North America as it traveled to its present day location. It can also be noted that some periods, such as the Cambrian and Silurian, do not give clear correlations between rock type and climate zone, as the rock types found can be formed under various conditions.

The New Reality of Higher Education: Technology and Learning

By Aekam Barot, Bal Barot, Lake Michigan College

Introduction:

To highlight the new reality of higher education, we must take a tour of the new landscape where technology, specifically educational technology in the classroom, is providing powerful tools for teaching and learning. If students are excited about the impact of science and technology on the future, society will be able to reap the benefits. Technology's progress is remarkable, as it has evolved from the past to present, from stone tools to the Rover on Mars**. (1)** The world recently witnessed NASA's rover landing on the red planet. It was an exciting moment, a landmark step towards the future goal of sending humans to the planet.

The Curiosity rover mission has remarkable software and hardware technology. The mobile lab is equipped with the ability to vaporize rocks, ingest soil, and aid in determining if Mars has been inhabited by smaller forms of life. It has some tools that are the first of their. There is a laser-firing instrument equipped with an elemental analyzer for checking elemental composition of rocks from a distance. The rover is equipped with a drill and scoop at the end of its robotic arm to gather soil and powdered samples of rock interiors, then sieve and parcel out these samples into analytical laboratory instruments. It is equipped with a science toolkit to identify clay and minerals in the lower layers, giving us clues about the history of the planet. The rover carries a radioisotope powered system that generates electricity from the heat of plutonium's radioactive decay. This power source gives the mission an operating lifespan on Mars' surface of a full Martian year (687 Earth days) or more, while also providing significantly greater mobility and operational flexibility. The Mast Camera is a two-instrument suite of imaging systems mounted on the MSL rover's Remote Sensing Mast (RSM).

The science making this mission possible includes applications from all of the STEM disciplines. This mission is driven by the desire to explain the creation of the universe and by the drive find fundamental particles. The same desire drives us to probe the cosmos or seek out the Higgs boson particle. Each new scientific discovery whether it is Darwin's theory of evolution, Einstein's theory of relativity, or Crick and Watson's discovery of DNA –leads us to deeper truths and excites human curiosity for further exploration. We must make this excitement and drive in science inclusive for all those with the potential to contribute.

The New Reality of Higher Education:

Despite the exciting material, we face challenges. (2) A common misconception among many students is that science is dull, difficult and irrelevant to everyday life, requiring too much time, effort and talent. To attract more young men and women to consider science, technology, engineering and math related careers is not easy. This is due to multifold reasons, including some problems learners face when they take science classes. Some students have an insufficient background and cannot comprehend faster paced higher education classes due to either lack of time to prepare or to review. Others suffer from lack of focus and attention needed to understand scientific terminology. They do not question new concepts to help gain clear understanding.

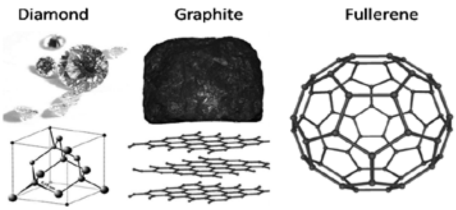
Mastery of many scientific concepts requires imaging, interaction, and critical thinking including hands-on experience.

The new paradigm of technology application demands a learning aptitude for instructors to meet expectations of new generations. The variety of technologies available to individual instructors seems to grow each day. It is easy to get overwhelmed due to the dynamic nature. Teaching with technology is not just about staying current with the latest gadgets. Many novel tools can be cost prohibitive and/or too time consuming to learn and implement across an institution. So the question is how to meet these challenges and make the best use of the teaching tools to enhance effectiveness in the classroom.

It has been observed by many of us that some technologies do not help achieve learning outcomes; while others do. Some technologies become obsolete and further support disappears. A few years ago, the Lake Michigan College chemistry department adopted "Lab-Works", a technology which used chemical sensors. **(3)** It included an affordable lab kit that enabled students to make almost every instrumental measurement required in general chemistry. The kit included instrument with high-grade resolution coupled with powerful software. It was easy to engage students in the process of learning science. Integrated sensors and sensor amplifiers prevented cluttered from the bench tops, reduced cost, and allowed for low-noise, high-resolution measurements. We used it in general and other chemistry laboratory courses. The interfaces' dual AC / DC power supply permitted use in the field as well as inside the laboratory. But the manufacturer went out of business, as soon as the instructors mastered the skills to best use the software and hardware.

There are revolutionary developments in the world of communication using computer technology. Discussion boards and blogs help to continue lessons outside of the classroom, into a different range of settings, For example, one can create virtual learning environment at home, cafes, hotels, airports, on trains, at workplace during lunch breaks and so on. Personally, I was able to share my learning and travel experience in during 2011, on Fulbright Scholarship assignment in India, as they were occurring. My college community and other friends in Michigan were witnessing, my experiences on the other side of the world as they happened through my regular blogs**. (4)**

There are pros and cons of virtual labs in sciences, like chemistry, as well as other popular teaching tools in the classroom including the well known Clickers and explore applications and limitations, as well as alternatives. We need to examine the impact of 3-D Projector, Videos, YouTube, Blackboard, Whiteboard and also discuss how to unleash the power of PowerPoint. An engaging way to learn science and bring the excitement of exploration and knowledge is through the use of technology.



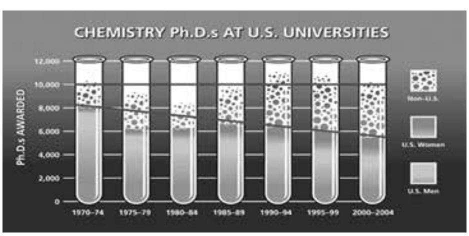
Teaching and Learning Strategies:

To better facilitate learning, the instructors should use the power of hands-on experiences for each learner. For examples, to teach how similar is graphite to diamond or how big or small an atom is or how are molecules made, we can use not only words, but pictures, animations and videos. Many are available for free download and students can see the gold, carbon, and water molecules to understand the difference.

Words are poor visuals for helping learners to "see." For example, what happens if the screen says, “And now for a Thermite Reaction...” then shows Fe2O3+2Alà2Fe+Al2O3+heat. Instead, if the instructor shows a video first, and then teaches how to balance a Thermite Reaction, it leaves lasting effect on a learner. (5)

Modern technology delivers virtual reality at low cost. It is safe and effective and as each day passes, many more software and hardware solutions are becoming readily available. These are teaching tools which engage students to learn concepts with a level of clarity never before possible. Computer-assisted presentations show real life application and they reinforce learning of scientific principles. In the old days, it was not possible to use millions of colors, pictures, or animations, as lecture materials were primarily text-based. Now, computers and iPads have entered the classroom, along with eBooks. Students engage with content in interactive ways, find information in an instant, and access an entire library wherever they go, with iBook’s or eBooks; iPads take learning to a whole new level.

An image can cover a range of 16 million colors, 14 million more than the human eye can even see. If you type “Canada” in the Google images field, it will show about 8,270,000,000 results in 0.29 seconds! This shows the power of modern technology at each person’s fingertip; just one click away. We can outline the changing landscape of new Ph.D. graduates in the last few decades in field of chemistry in USA using a graphic color representation.



Let us revisit Clickers, which many of you have used. Clickers, or student response systems, are a technology used to promote active learning in the classroom so that students become engaged and enjoy answering questions in class. Two key features distinguish clicker use, first Clickers provide a mechanism for students to participate anonymously and integrate a “game approach” that may engage students more than traditional class discussion. But there is another side of the coin with regard to use of clickers. They are still expensive, and do only one thing. Students often lose or misplace them, and cannot enter text. They are not easy to share as a group. Now, many Software Solutions use multiple devices and rotate for a group by log-in. Such solutions allow recording a presentation and sharing with rerecording voice over. **(6)**

Student engagement in science courses through technology applications is essential. It fosters the active learning process in large classrooms. All of us have engaged students by class discussion. In the place of clickers, now software-based student-response systems are becoming available. They can be used in conjunction with group work. Groups are formed such that some members have a device that could be used with the system. The group would have one member log in during a lecture – and act as the group ‘spokesperson’ for the day. They rotate who logs in and is the spokesperson for each lecture. The result is that the instructor would get immediate feedback on how well students understood the in-class activities – and reinforce the dynamics of students working in groups. The game changer is iPad, which can be used to wirelessly run lectures – control anything on the host computer – and smoothly annotate over anything on the projector – allowing the instructor to teach from the front or the back of the room and allowing for more interaction with students. iPads as educational tools can be seen in this last promotional video, in the link: http://www.apple.com/education/ibooks-textbooks/. Introducing even simple sound effects in teaching a scientific concept is effective as well. For example, how a pager works can be explained by a picture, words or video. But if nothing else, an introduction of a beeping sound helps those who have never used the device. Watch a movie with sound muted and the same movie with the sound on to appreciate the difference on the impact. So, whether it is for entertainment or for learning, sound effect plays a vital role.

Case Study using Blackboard:

One project 'Application and Advantages of Customized Internet Assessment' in a chemistry course illustrates the power of technology to empower science teachers. (7) Teaching and learning in Higher Education is very different now than it was just few years ago. Students have different expectations, consumption patterns, and needs. Their expectations are higher, their retention power is lower and their technical capability is better, especially regarding technology. Creating a better educational experience today requires different tools, technology, and thinking by academic leaders than the last decade. Blackboard improved access to education, and engaged students in effective manner. Teaching and learning solutions by Blackboard supports the needs of students, faculty and administrators, providing technology required to offer a mix of learning environments with digital content delivery to connect with students through the mobile devices. The Blackboard platform provides tools to measure program quality and the value of a programmatic or pedagogical alteration. To improve learning outcomes for chemistry course, we developed customized internet assessment using Blackboard and then analyzed our findings. The assessment, feedback, grading and record keeping was done using Blackboard. We deployed this strategy without any computer programming skills. Even students did not have any computer programming skills before using it.

In this project, students were given a choice to take the quiz or test from any place, other than the college assessment center. Each student was emailed a password and warned about time limitation for each weekly quiz. We had to address a number of technical issues like browser selection, the speed of internet connection, the minimum modem requirements and plug-in requirement. We found out that clicking back, forward, home or refresh caused interruption and had negative consequences. The class averages of traditional testing in the classroom from 1995-2000 against computer-based electronic assessment from 2001-2005 showed mixed results, with the promising improvement in results in the last two years of this project. We were able to study student participation analysis due to this flexible mode of assessment. Most of the students took the weekly quiz during the middle of the week, with few catching up on Fridays! The main advantage of the project was it allowed more class time for each instructor to include more class discussion and other hands-on activities. The last term for using Blackboard at Lake Michigan College will be spring semester of 2013. **(8)**

Future and Transition to Canvas:

Each faculty planning to transition to the new platform, Canvas, must attend at least 3 training sessions sometime during the fall semester. This will help them to use Canvas to yield a broader understanding of the pedagogy of online teaching and learning, introduce design principles for developing instructional units for online use. It will provide them with specific skills necessary to effectively maximize the use of Canvas for unique content. Why Transition to Canvas? It allows the school to offer online degree and certificate programs and to verify minimum training levels for all online instructors, which is a required aspect by the Higher Learning Commission. The other reasons include sharing of existing expertise among faculty. Canvas is designed specifically for mobile touch devices — allowing the drawing area scales beautifully, on a small screen iPhone or on a larger device such as an iPad. It provides ability to save drawings, works offline and free automatic software updates. **(9)**

We equipped our classrooms by 3-D projectors. Student engagement and test scores data as compared to using 2D tools alone suggest 3D projectors are proven to make an impact in the classroom. Research shows a 46% increase in student engagement and a 34% increase in test scores. **(10)** Such technology provides students with an immersive environment that will capture their attention and stay with them. Lake Michigan College installed 3D projectors, software and special glasses for students in two biology classes, a chemistry class and a physical science class in fall term 2012. Students can see the type of software that sparks their imagination. To know more about scientific principles and the role of science in our everyday life can be facilitated by technology to enhance learning. Texas Instruments was the projector vendor, while the software came from multiple vendors. The basic principle of 3D technology involves boosting the illusion of depth perception, or making objects appear closer than they seem. A different image is shown to each eye, and filtered through special glasses to create the illusion of a 3-D display.

Other Resources in Technology:

Virtlab is a series of hands-on experiments and demonstrations using a simulated science laboratory. Students can also build their own simulations using electronic spread sheets. This approach allows each participant to integrate personal computers and science education. The best use of Virtlab is to supplement the core material, due to the fact most accrediting and professional organizations require an in lab experience for approval or transfer of such science courses in US. (11) SMART's whiteboard in the classroom is easy to use; one can quickly incorporate them into teaching with the use of a special pen. Combining the simplicity of a whiteboard with the power of a computer, the SMART Board interactive whiteboard lets an instructor deliver dynamic lessons, write notes in digital ink and save work. It allows effective use of PowerPoint Presentation, due to writing on it by the special pen as well as saving it for later use. It consists of three types of hardware a projector, screen and remote control. (12)

Various other technology solutions for teaching labs online, for homeschool students, are available; for example, QuickStudy. It is a fast, affordable way to create quality teaching applications. (13) iReflect is another unique web based technology that provides for individualized practice, self-assessment and management coaching for skill development, with virtual solution for distance or classroom learning. This is a website for those who are interested in the use of digital approaches and new technologies to support reflective learning in Higher Education and includes links to practical resources for students, tutors, teachers, or academic practicing researchers and it is inclusive on-line community forum. (14) Customized Educational Technology Pearson Custom Media is another choice for science educators. (15)

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References:

http://content.usatoday.com/communities/sciencefair/post/2012/08/video-curiosity-rover-lands-on-mars/1

Bal Barot, Aekam Barot, “Critical Thinking Inspired Guided Inquiry (CRITIGI) in Science Teaching and Learning”, MSTA Journal • Spring 2009 • p 15-20

The same technology is available through another vendor now. Please check the website: www.microlabinfo.com

http://lmc-balbarot.blogspot.com/2011/01/from-benton-harbor-to-india-fulbright.html

Please see YouTube video for a Thermite Reaction using the link: http://www.youtube.com/watch?v=IIeZIbX5Wi8

Andrew Grall, paper presented at 22 BECC Penn State University, July 29-Aug 2, 2012 (University of Arizona, USA)

Aekam B. Barot and Bal Barot, “Customized Internet Assessment for Students and Educators”, *The Community College Enterprise* (a journal of research practice), 12 (1): 57-68, 2006.

Departmental internal communication of Lake Michigan College, 2012

For Canvas, see http://www.instructure.com/

For further information, see http://dlp.com/

‘Virtlab’ is a series of hands-on experiments and demonstrations using a simulated chemistry laboratory, see http://www.virtlab.com/

For further information, please see: http://smarttech.com/

Please see: http://www.quickstudylabs.com/

For further information, see http://www.ireflect.leeds.ac.uk/

The promotional and informative video is available at this link: http://www.pearsonlearningsolutions.com/custom-media/

Print is Dead - A Year Without Textbooks in General and Organic Chemistry: Alternatives to Using Traditional Textbooks

By David M. Bartley, Mark A. Benvenuto, Matthew J. Mio, and Jonathan E. Stevens
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"Print is dead," pronounced the Egon Spengler character in the movie *Ghostbusters* (1984). Yet stubbornly, textbook printing hangs on. When will Egon be right? Here we present alternative sources of course information being used at the University of Detroit Mercy for general and organic chemistry classes. Our observations and conclusions from a year long trial of teaching freshman general and sophomore organic chemistry courses without a textbook have led us to think that Egon will be right, and it's just a matter of time.

I. Introduction

"Print is dead," claims Egon Spengler in the 1984 movie *Ghostbusters* **[1]**. Yet, more than a quarter of a century later, traditional print seems to be alive and well, in particular in the choice of required textbooks for college chemistry courses. New traditional textbooks appear on the market annually**[2]** However, the way textbooks may be created and accessed has changed dramatically with the advent of digital information technology. Books may now be stored in a number of electronic formats to be accessed by desktop or laptop computers or electronic reading devices, some of which are now found on personal cell phones, and the wide distribution of word processing and graphical programs makes it possible for relative amateurs to engage in "desktop publishing" of slick-looking and mass producible text documents. There are a number of reasons to abandon using a traditional, commercially published general chemistry or organic chemistry textbook: the rising cost of textbooks poses a problem for numerous students; customized or custom print textbooks may more directly and effectively serve the needs of students. Faculty may be convinced students don't read traditional textbooks anyway, and hope to engage the students with an electronic or online text which may have interactive features. Yet traditional textbooks appear to be as present in our classrooms now as they have ever been, although traditional texts now generally offer a slightly lower priced e-book version and/or some form of included online content in addition to the traditional, physical book. **[2]** Indeed, there are at least ten general chemistry textbooks on the market, targeted either at high school students, or at college freshmen**. [2]**

The Chemistry & Biochemistry Department of the University of Detroit Mercy has recently begun using non-traditional alternatives to textbooks in some undergraduate chemistry courses. **[3]** In the past four years, we have given up the use of a traditional textbook for a course entitled Introductory Chemistry (CHM 1050), a remedial chemistry course to be taken by underprepared students before taking the typical first year college inorganic chemistry course, titled General Chemistry I (CHM 1070) at the University of Detroit Mercy. Here, a nominally-priced volume produced by the authors from their class notes replaces commercially published college chemistry textbooks.

Additionally, in an even more dramatic departure from tradition, we have gone to an entirely *free* and on-line approach to text material for our Organic Chemistry course sequence (CHM 2270 and CHM 2290). This has been in place for the last three years. In the process of creating these resources, information material for each class had to be brought together and additionally, a significant number of practice problems and exercises had to be created and incorporated into the new materials.

This article aims to introduce you to our "crazy idea" to replace traditional textbooks with low-cost alternatives, present a discussion of the motivations and methodology in the design of the material that has been created, and provide some information on our students' response to the changes.

II. Design of Materials: Motivations and Methodology

A. Introductory/General Chemistry: Text Booklet Design Process

At the University of Detroit Mercy, CHM 1050 is intended to be a remedial course taken prior to the traditional freshman General Chemistry I and II lecture courses, CHM 1070 and CHM 1080, respectively. Incoming freshmen are placed into CHM 1050 or CHM 1070 based on their performance on a chemistry proficiency test taken during freshman orientation. By intent, the typical CHM 1050 student is one who did not have chemistry in high school or is otherwise unprepared to immediately enter a college chemistry course. The course focuses on formulas and nomenclature of compounds, training in stoichiometric arithmetic, and orbital diagrams and arrangements of electrons in atoms. There is a heavy emphasis on developing Lewis structures and learning the properties that may be inferred from them, such as hybrid orbitals and molecular shapes. Topics such as dissociation of ions in solution, acid-base chemistry, and oxidation/reduction reactions, a significant topic in most college General Chemistry I courses and in many high school courses, are neglected or only briefly touched upon in CHM 1050.

Clearly a typical college chemistry textbook designed for General Chemistry I and II courses contains much material that would not be presented in a CHM 1050 course. However, CHM 1050 instructors felt that it was not desirable to attempt to use the same text for CHM 1050 and CHM 1070; although clearly the intent of having a freshman take 1050 and 1070 in sequence is that students will be presented with topics such as stoichiometry and Lewis structures twice, it was believed that the student would learn more if the second presentation was not identical to the first. Prior to the Winter 2007 semester, the UDM department of chemistry used two separate commercially published college chemistry texts for freshmen classes, one textbook for CHM 1050 and another for the CHM 1070/1080 sequence. As noted previously, the textbook used for CHM 1050 generally contained a great deal of material unused in CHM 1050 and freshmen students in the 1050/1070/1080 were thus required to purchase two freshmen chemistry textbooks. Thus, they were required to deal with this economic strain and, due to the publication of new additions, often faced issues of being unable to sell the textbooks back to the bookstore or to other students at the end of year. This was a situation very similar to that to be described below for students in the UDM organic chemistry sequence. Feedback from CHM 1050 evaluations and many conversations between CHM 1050 professors and students indicated that many students relied almost entirely on course notes and handouts as opposed to the assigned text.

In the winter of 2007, the decision was made to take the existing collection of lecture notes, example problems, and handouts developed for the course, and develop this into a textbook for the course. The existing materials were supplemented by some written discussions of the elementary topics of the course (essentially repeating and in some instances elaborating on material presented orally in lectures) and by many example problems generated through the history of teaching the course. In the winter of 2007 this text was presented to the students as a series of "units" provided as handouts; in the fall of 2008 these units were organized into a text booklet and during that semester and all following fall semesters hard copies were sold to students from the department office. It was deemed that this would collect and organize all the information contained in the lecture materials, for a very nominal price (currently hard copies are sold for $10 from the department office.)

B. Organic Chemistry: Virtual Organic Resource Design Process

The decision to become "textbook free" in the organic chemistry curriculum was based on three main factors. First, the rising cost of textbooks coupled with the minor changes provided in new editions are economic strains on many students. Not only are the textbooks expensive but also if a new edition is released, the students are unable to sell the textbooks back to the bookstore or to other students at the end of year. Second, while customization of textbooks by the publisher is now available to decrease the cost of textbooks by only purchasing the chapters that are used in a course, the extent of customization is limited and the cost is often not that much lower than the traditional textbook. Finally, data collected through mid-term and end-of-term course evaluations, as well as by the use of in class "clicker" questions, suggested that our students were not reading the textbooks but were relying on course notes for the majority of their education with the occasional Internet search to supplement their lecture notes. In the summer of 2009, we made the decision to stop using a traditional textbook and utilize what the students were actually using to learn, our lecture notes and the Internet.

The criteria utilized for the design of the new course information resource, the Virtual Organic Chemistry Resource (VOCR), were that the material had to be well organized, easily modified, free to the students, utilize online resources, and provide a replacement for traditional end-of-chapter practice problems. The two organic chemistry professors spent the summer of 2009 organizing and converting their lecture notes into the VOCR in a systematic fashion. First, they each prepared detailed outlines of their lecture notes. Next, they went through all of the lecture notes and each prepared a keyword list of all the terms they deemed important. The two outlines were merged together to provide the basis of the VOCR. The outlines were then hyperlinked to online resources by content area. The keywords lists prepared by the individual faculty were combined into one list and the majority of the terms were linked to their Wikipedia entries. The course was divided into seven parts based on content areas with each part having one page of hyperlinked course outline and one page of "Terms to Master" linked to Wikipedia. The seven parts of the VOCR were combined into a single PDF document that also contains a cover pages and a page of useful links to General Organic Chemistry Resources **(Figure 1)**. The entire package is less that 2 MB and is easily downloaded by the students from the course website.

FIGURE 1. GENERAL LINKS PAGES FROM THE VOCR.

General Organic Chemistry Resources

Organic Learning Resources
1. Michigan State Virtual Textbook
2. Wikibooks "Organic Chemistry"
3. Mol4D
4. MIT Open Courseware
5. St. Olaf Organic Chemistry Toolkit
6. ChemgaPedia
7. Carey's Organic Chemistry
8. Organic Chemistry Flashcards
9. Ace Organic Chem

Online Practice Problems
1. Sapling Learning
2. Muzyka's Site
3. Synthesis Explorer
4. MSU Virtual Text Practice Problems

Organic Chemistry Data
1. IUPAC Nomenclature
2. Organic-Chemistry.org
3. Nobel Prizes in Organic Chemistry
4. The PubChem Project
5. eMolecules
6. ChemIDplus Advanced
7. Spectral Database of Organic Compounds

Line-Angle Drawing Tools
1. MarvinSketch
2. JME Editor
3. ACD/Labs ChemSketch
4. ChemPad
5. ISIS/Draw

3D Visualization, Animation, Video
1. Darling Model Tutorial
2. Jmol
3. Rasmol
4. Chime
5. Colby Computer Demos
6. Organic Demo Experiments
7. ChemTube

Specialized Tools
1. Periodic Table Data
2. Dynamic Periodic Table
3. Atomic Explorer
4. Orbitron
5. Linus Pauling Archives
6. SHMO
7. NIST Group Additivity Estimator

General Organic Chemistry Resources

American Chemical Society
1. ACS.org
2. ACS Publications
3. Journal of Chemical Education

Detroit Chemistry
1. ACS Detroit Local Section
2. SEMCTO
3. MSTA
4. Brewing Chemistry

Organic and Synthetic Blogs
1. Carbon-based Curiosities
2. The Haystack
3. Totally Synthetic
4. Just Like Cooking
5. In the Pipeline

Course reading material that would normally be in a traditional textbook was replaced by linking the main topics in the course outline to the Virtual Textbook of Organic Chemistry maintained by William Reusch. **[4]** A more traditional online organic textbook is also available in PDF from Daley and Daley. **[5]** These two resources were use to prepare a suggested reading list, organized by topic, for the students. Links to additional reading sources such as Wikibooks are also provided on the General Organic Chemistry Resources page. Content that would normally be provided by a stagnant picture or diagram in a traditional textbook were linked to online videos or interactive websites that utilized hands-on learning of the topic through an interactive environment. The traditional end-of-chapter problems found in a traditional textbook were replaced with the Sapling Learning online homework systems. **[6]**

To maintain the validity of the online resources the professors check every link in the VOCR prior to the start of each new semester. The links are not only checked to make sure they are active but also the instructor validates the content of each link. During the semester the students are encouraged to also check the links for any errors and report any problems to the professors. The students are also encouraged to find new links that can be incorporated in to future editions of the VOCR.

III. Student Response

A. Introductory Chemistry

The instructors of CHM 1050 note no observable impact on student grades since the adoption of the current text booklet**.** CHM 1050 instructors suspect, as noted earlier, that many students have been relying all most exclusively on the lecture notes the new "text" was drawn from, and disdaining their traditional text, for some time before introduction of the current text booklet.

Student evaluations suggest that many students find this text very approachable and helpful to the course, and historically some General Chemistry I students have also purchased this text as a study tool for their CHM 1070 course. In spite of the very nominal price of the text booklet, there appears to be a moderately brisk trade on-campus in used half-price ($5) copies, even if a "new edition" with minor changes and corrections is in use during the current semester.

B. Organic Chemistry

Using the VOCR in place of a traditional textbook has been well received by the students and in the process of compiling and using the VOCR we have learned a lot about how our students think. One of the first things that we encountered was that while the student may be "digital natives" that have no problems utilizing technology for social networking and texting, they needed to be taught how to use other forms of digital media. The idea of clicking links on the pages of the VOCR, in order to get to more material, seemed foreign to them. The second semester that we used the VOCR, we held a recitation the first week of class to instruct the students how to use the VOCR. The student satisfaction with the VOCR was much higher after we walked them through the VOCR and the process of clicking links to open new resources and then actually using the newly opened media to investigate the topics being covered. As part of this project by allowing students to submit suggestions for the next edition of the VOCR, we were also able to teach the students how to vet good and bad information from the web and how to formulate strategies to locate, evaluate, and apply on-line information.

The results of surveys taken from the students during the last two years have indicated several positive outcomes of using the VOCR as well as some issues that we are still working on addressing. On the positive side, the students appreciated the monetary savings of not having to purchase a textbook for the course. The students liked being able to have input into future editions of the VOCR both by checking links and by suggesting new links to incorporate. The on-line homework system allowed us to see easily who was not doing their homework and how students who routinely did the assigned work versus those who did not do it affected grades. The students also learned how to vet on-line information, which is certainly a skill that can be applied outside of organic chemistry.

Some of the issues that we have encountered are that students still don't read outside of class and resent having to do work on their own. Some of the students still wanted to have a hardcopy book and did not like reading off a computer screen. Students also reported that they just used their lecture notes to study and did not utilize the VOCR. The need to have internet connectivity to use the VOCR is a problem that the faculty anticipated as being a major issue, but one that was not brought up to a significant degree by the students, suggesting that most of our students have easy access to the internet both at school and at home.

Some of these are problems that not inherent just to the VOCR. The problem of getting students to do work outside of class, particularly reading, is a universal problem encountered at all grade levels and one that has no easy solution. One method we have used as an attempt to persuade the students into doing the assigned reading is to utilize "clicker" quizzes asking questions about the readings prior to lecture. Whether this motivates the students to actually do the reading is hard to determine. The issue of not liking to read off a computer screen is one that we hope will be solved as more and more students begin to utilize e-readers with e-Ink that causes much less eye strain than the much brighter LCD or LED monitors traditionally found on laptops and computers.

IV. Conclusions

Our experience demonstrates that, with effort on the part of instructors, expensive commercial textbooks for college chemistry classes may be replaced with alternatives with extremely low cost, or no cost, to students. The academic results of these endeavors are comparable to courses centered on traditional chemical textbooks. This work has already cited online resources which may replace traditional organic texts with free alternatives; **[4,5]** similar resources exist for introductory/freshman chemistry courses. **[7]** In addition to the advantage of reduced cost for students, replacement of commercial textbooks with free textbooks offers the advantages of allowing instructors to determine completely the resource content. Instructors thus may be sure that necessary material is included and extraneous or unnecessary material is excluded. Online homework systems may provide additional information about student study habits and activities.

Students at the University of Detroit Mercy have voiced both positive and negative comments about the low-cost alternatives presented. Many of the negative comments center on a student preference for printed text to electronic text. This preference is likely to change with time, or to be compelled to change with time; we have already noted that commercial texts are both increasingly offered for purchase as e-books and coupled with online content. **[8]**

References

[1] *Ghostbusters*, Columbia Pictures, 1984.

[2] a) Introductory Chemistry: A Foundation. Zumdahl, S. S.; DeCoste, D. J.; Brooks/Cole Cengage Learning; 7th edition (2010);

b) Introductory Chemistry. Tro, N J. Prentice-Hall, 4th Edition (2011);

c) Introduction to Chemistry. Bauer, R. C.; Birk, J. P.; Marks, P. S. McGraw Hill, Third Edition (2013);

d) Introductory Chemistry. Russo, S.; Silver, M. Prentice-Hall, 4th Edition (2011).

e)Chemistry for Changing Times. Hill, J.W.; McCreary, T.W.; Kolb, D.K.; Pearson; Thirteenth Edition (2013)

f) Chemistry, The Molecular Nature of Matter, Jesperen, N. D., Brady, J. E., Hyslop, Wiley, Sixth Edition (2011)

g) Kotz, J.C.; Treichel, P.M.; Townsend. Chemistry and Chemical Reactivity. 7th Edition, Brooks/Cole Cengage Learning; Seventh Edition (2009)

h) Chemistry: A Guided Inquiry, Moog, R. S.; Farrell, J. J. 5th Edition, Wiley (2012)

i) Chemistry: Structure and Dynamics, Spencer, J. N.; Bodner , g. M; Rickard, L. H.; Wiley,5th Edition (2011)

j) Chemistry: The Molecular Nature of Matter and Change, Silberberg, M. S. McGaw Hill (2012)

[3] See Bartley, D. M.; Benvenuto, M. A.; Mio, M. J.; Stevens, J. E. “Print is Dead: A Year Without Textbooks in General and Organic Chemistry,” *Abstract of Papers*, 240th National Meeting of the American Chemical Society, Boston, MA, August 22-26, 2010; American Chemical Society: Washington, DC, 2010; CHED 422.

[4] Reusch, W. Virtual Textbook of Organic Chemistry. www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm (accessed 8 August 2012).

[5] Daley, R. F.; Daley, S. J. Daley and Daley Organic Chemistry. ochem4free.info (accessed 8 August 2012).

[6] Sapling Learning Interactive Homework and Instruction. SaplingLearning.com (accessed 8 August 2012).

[7] a) Dickerson, R. E.; Gray, H. B.; Haight, G. P (1979) Chemical Principles. Third edition. caltechbook.library.caltech.edu/178; b) General Chemistry: A Free Online Textbook en.wikibooks.org/wiki/General_Chemistry/Print_version; c) Chemistry Virtual Textbook chem1.com/acad/webtext/virtualtextbook.html; d) Concept Development Studies in Chemistry cnx.org/content/col10264/latest e) Bishop, M. An Introduction to Chemistry. preparatorychemistry.com.

[8] Arnaud, C. A. The Future of Textbooks. *Chem. Eng. News* **2010**, 88 (39), 63-64.

Why belong to a Science Teacher Organization?

By Tim Neason MESTA Liaison

Let's take the **Michigan Earth Science Teacher Association (MESTA)**

MESTA has been a Science Teachers Organization since the 1970s started under the leadership of the late Harold "Stoney" Stonehouse. The **National Earth Science Teacher's Association (NESTA)** was formed in the 1980s out of the MESTA Organization.

MESTA is an organization the prides in **"Teachers Helping Teachers".**

The **MESTA / NESTA Summer Conference was held, August 15-19,** in Houghton Michigan hosted by MTU (Michigan Tech University), located on the Keweenaw Peninsula. Nearly 150 educators from schools, universities and USGS Service in attendance from far away locations that included Michigan, Wisconsin, Ohio, Indiana, New Mexico, Arizona, California, Colorado, Oregon, Canada and more.

The Summer Conference Program was set up with three full days of Field Studies. A Friday Night Honors Banquet. And a Saturday filled with Classroom Presentations and time to take part in the MESTA Famous Rock Shop and Raffle.

Let's look at some of the **Field Studies** you could have participated in if you were a MESTA Member:

All sessions were lead by highly qualified leaders sharing their expertise.

The Keweenaw Copper Company (Centennial Mine), Red Metals, Ontonagon and Porcupine Mountain Field Trip. Leader: Richard Whiteman

Focus: Looking at the copper mining sites and the rock formation from Calumet to the Porcupine Mountains.

Paleomagnetism Field / Lab Experience. Leader: Aleksey Smirno and MTU Grad staff.

Focus: Hands –on exploration into paleomagnetism of the local keweenawan basalts for their magnetic signature and magnetic mineralogy.

Keweenaw Gem and Gift Mineral Preparations. Leader: Ken Flood

Focus: Copper pours, Lapidary / Stone Polishing, and Copper Cleaning.

Caledonial Mine. Leader: Richard Whiteman

Focus: Tour of the mining operations and get specimens in certain areas of the mine. Get help with identification and composition of samples collected.

Copper Harbor Field Trip. Leader: Dr. Bill Rose

Focus: Explain the history of geological phenomena found on the Keweenaw Peninsula Lava flows to the Lake Superior's Formation and more.

Lake Superior. Aboard the Agassiz Research Ship. Leader: Dr. Marty Auer

Focus: Explore the physical and biological phenomena know as the Deep Chlorophyll Maximum (DCM) in Lake Superior.

Special Evening Event: Quincy Mine and Shaft House Tour.

Focus: Tour of the enormous and complex Nordberg Hoist Steam Engine and the Quincy Mine.

Imagine what the participants learned and were able to take back to their respective classrooms and more. But, there is time and expense in participating in a science conference.
Yes, there must be a commitment to free up time for conferences, cost of travel and expenses and the rewards you will take away with you will excite you as an educator.

So why join a Science Association? You can see the obvious reason why.

Let's Look at MSTA. The Annual MSTA Conference is coming up in March. Many experts in the field of science are volunteering their time to share their knowledge with you.

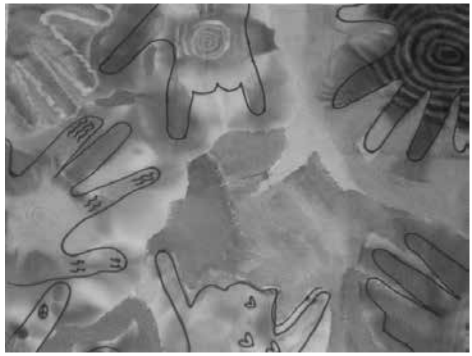
Get fired up. Clear your calendar for March 8 and 9, 2013. Plan on registering for the 60th Annual MSTA Conference at Eastern Michigan University.

You will be glad you did.

The Art of Chemistry

By Mary Jordan McMaster, Chemistry Teacher, Allen Park High School, Jelane Richardson, Visual Arts Teacher, Allen Park High School

Cross-curricular and real-world applications are educational buzzwords that are used quite often to describe an authentic learning experience. Combining the disciplines of art and chemistry is a natural collaboration that serves to engage students in the chemistry content while expanding their knowledge base concerning the materials they are using in art class. The following are just a few examples of how the merging the two disciplines can enhance both the art and chemistry classrooms.



Chromatography Cloth A lesson in Polarity

Michigan HSSCE Chemistry:

C4.4b-Identify if a molecule is polar or nonpolar given a structural formula for the compound.
C4.3f -Identify the elements necessary for hydrogen bonding (N, O, F).
C4.3g-Given the structural formula of a compound, indicate all the intermolecular forces present (dispersion, dipolar, hydrogen bonding).

Michigan Visual Arts Standards:

2.6-Create media productions that demonstrate knowledge, contexts, values, and aesthetics.
5.3-Compare the materials, technologies, techniques, and processes of the visual arts with those of other arts disciplines as they are used in creating and types of analysis.

Chemistry Background Information:

Chromatography is a process used to separate mixtures. The word chromatography is derived from the Greek words “khroma” and “graphein” meaning “color” and “to write” or “to represent”. Although there are several different types of chromatography, in each case a substance is placed onto or into a medium and a solvent is passed through the test substance. In chromatography science, the solvent is called “the mobile phase” or “the carrier fluid” and the medium is called “the stationary phase”.

In this experiment, the medium is cotton cloth, the solvent is isopropyl alcohol (2-propanol) and our test substance is permanent marker ink. Ink is a mixture; it is made of different substances mixed together. Parts of the test substance (the ink) may be attracted to the solvent (Isopropanol) and follow it up the medium (the cotton cloth).

As the solvent and the mixture move through the medium, different types of molecules in the ink mixture spread out (elute) at different speeds, causing the mixture to separate. Molecules with an affinity (attraction) to the medium travel slower than the molecules with less of an affinity to the medium. In paper chromatography, colored bands of the separated substance are created.

Today, chromatography is a major chemistry field and important analysis tool used in industry and in medicine. Chromatography is used to detect, separate or purify different substances. Using this process food, drugs, blood, soil, water, air, fuel and petroleum and radioactive-fission products are analyzed. For example, in medicine, chromatography can determine the presence of drugs in a person's blood. In water and air quality analysis chromatography is used to isolate pollutants.

Chromatography also is used to synthesize new products since it can separate a pure substance from a complex mixture with great precision. Operating conditions generally are not severe and safe for (do not damage) even delicate products. The techniques have been used in the petroleum industry to separate and purify products and make petroleum jelly. Background Information Source: the Society of Women Engineers homepage http://www.swe.org/iac/LP/chrom_03.html

Materials:
- various colors of Sharpie Markers
- paint pens for embellishing finished compositions
- isopropyl alcohol (2-propanol)
- small containers for the alcohol
- plastic pipettes
- plastic cups
- rubber bands
- Cotton material (muslin)

Caution: 2-Propanol-Use in a well-ventilated room. Harmful if inhaled or swallowed. Highly flammable, keep away from open flames and wear safety goggles when working in the chemistry lab.

Pre Activity:
Students should:
- draw the structural formula for isopropyl alcohol (2-propanol)
- identify the intermolecular forces and label them on the structure.
- Compare and contrast the intermolecular forces of Isopropanol and water.
- Predict how the solvent will affect the ink from the markers.
-

Procedure:
- Have students stretch their cloth over their plastic cups and keep it in place with the rubber band.
- Instruct students to make a design on the stretched muslin using the Sharpies and to leave some space between the marks they make.
- Students then use either the plastic pipette to saturate the material with isopropanol.

- Students then observe the components of the ink move with the mobile phase on the medium.
- Once that section dries instruct the students to move the cloth around the cup and continue their designs.
- When the cloth is covered completely and it is dry use paint markers or black Sharpies to embellish certain areas on the composition.
- Assessment:
- Students should:
- Describe their observations, what happens to the Sharpie designs when the isopropyl alcohol is dripped over the marker design?
- Be able to identify the mobile phase, the stationary phase, the medium, and the solvent.
- Describe the process and uses of chromatography.
- Explain why isopropanol was used as the solvent instead of water.
- Explain how this experiment connects to the concept of polarity.

Extension:
Try a more inquiry based approach. Provide the students with both permanent and water soluble markers, a variety of mediums such as paper towel, coffee filters, writing paper, wax paper, etc., and different solvents such as water and isopropanol. Have them pose a question and develop a method to gather data to answer their question.

Polymer Clay Test Tube Sculptures

Michigan HSSCE Chemistry:
C5.8A-Draw structural formulas for up to ten carbon chains of simple hydrocarbons.

C5.8B-Draw isomers for simple hydrocarbons.

C5.8C-Recognize that proteins, starches, and other large biological molecules are polymers

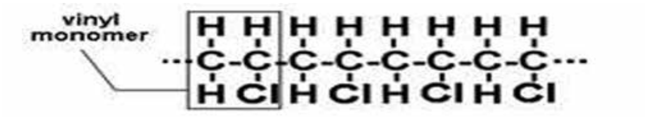
Michigan Visual Arts Standards:
2.6-Create media productions that demonstrate knowledge, contexts, values, and aesthetics.

5.3-Compare the materials, technologies, techniques, and processes of the visual arts with those of other arts disciplines as they are used in creating and types of analysis.

Chemistry Background Information:

Polymer Clay is not something found in the earth, but in fact is PVC (polyvinyl chloride) plastic. Similar plastics are frequently used in today's plumbing and water piping. Tiny grains of PVC are mixed with plasticizers and pigments. When the clay is baked at the proper temperature (varying from 212°F to 275°F depending upon the make and color), chemical changes occur and the particles fuse into a solid mass without shrinking.

The polyvinyl chloride polymer is made up of many monomers as seen in the diagram below.



Materials:

- 3-4 oz. of polymer clay (Sculpty III) per student
- 1 test tube per student
- PVC pipe (12" per every 2 students) to be used as a rolling pin
- white drawing paper and pencils with erasers
- straight edge knife for cutting polymer clay if necessary for some designs
- conventional oven or toaster oven set at 275 degrees Fahrenheit
- metal baking sheet

Caution: Baking sheet and oven do become hot, use caution.

Procedure:

- Students draw a sketch of a test tube on their white drawing paper. The test tube should change into a sculpture by adding features such as eyes, nose, mouth, feet, and any other design elements that transform it into a three dimensional object with interesting design features.
- Pass out the polymer clay and instruct students to make trades with other students if they desire more of one color to create their sculpture.
- Students will warm and make pliable, polymer clay in their hands so that they may roll it out flat so that it can be used to cover the glass test tube. Press the flattened polymer clay gently to make it stick to the glass. Once the test tube is covered continue warming the polymer clay and forming it into the shapes based on the designs from the drawing paper. Any features made, need to be pressed firmly to the test tube so that they stick.
- When the sculpture is completed and it stands up on its own place it on baking sheet and bake it at 275 degrees Fahrenheit for 25 minutes.

Assessment:

Students should:

- Describe how the polymer clay reacts to their body heat.
- Describe how the polymer changed when cured in the oven.
- Compare and contrast the Sculpty clay and the PVC rolling pin.
- Draw a PVC polymer and explain chemical makeup that makes polymer clay what it is.
- List other polymers and what they are used for.

Distinguishing Fruits and Vegetables

By Maya Strauss, Kindergarten/First Grade Teacher at Trillium Academy; Blair Chamberlin, Bradford Academy; Brooke Holman, Student Teaching at Amerman Elementary School; Charlotte A. Otto, Professor of Chemistry and Science Education, University of Michigan - Dearborn

Abstract

Conversations among second grade students during an inquiry lesson on plants about whether carrots were a fruit or a vegetable led to development of a short assessment on fruits and vegetables. We found that our students could not label some common fruits and vegetables according to the scientific distinction nor could they explain what the difference was. An inquiry lesson asking students to classify an assortment of fruits and vegetables led to a class discussion focusing on the presence or absence of seeds. Post-assessment of the students demonstrates that the lesson was effective in increasing second grade student understanding of the difference as 79% of the students could answer correctly compared to 13% on the pre-assessment.

Michigan's Grade Level Content Expectations (Michigan Dept. of Education, 2007) for second grade include "L.OL.02.22 Describe the life cycle of familiar flowering plants including the following stages: seed, plant, flower and fruit" (p. 24). In addition to life cycles, Michigan elementary teachers also introduce K-8 students to the parts of a plant and a plant's needs for survival and growth including sun, air, water and nutrients.

Much research has been conducted about student understandings of plants. For example, Barman, Stein, McNair and Barman (2006) reported "that students' understandings of plants and what plants need to grow are often limited" which causes many of the misconceptions the students have (p. 73). In terms of requirements needed for a plant to survive, Barman and colleagues state that many of the students' ideas were determined by "how they themselves take in food and water to grow or stand in the sun to be warmer" (p. 75). They reported that the majority of students (95%) who said the sun is needed for plant growth reasoned that the sun "helps the plant grow by warming the plant" (p. 75). The researchers also found that students think of plants as possessing leaves and stems, having a green color, and growing in the ground (Barman, Stein, McNair & Barman, 2006). When elementary children were asked to draw a picture of a plant, the majority added flowers thus the researchers concluded that many children believe that plants must have flowers. Barman et al. wrote "During the elementary grades, children build understanding of biological concepts through direct, concrete experiences with living things, their life cycles, and their habits" (p. 73).

In this journal in 1999, Berthelsen reported a number of student misconceptions about plants and photosynthesis. The author concluded that the difficulties students had could be attributed in part to the students' lack of understanding about what a plant was and where it obtained the necessary nutrients and energy for growth. Berthelsen believed that this issue could be addressed early in a student's academic career.

A Google search using "children's misconceptions about plants" as keywords reveals a large number of websites that discuss common misconceptions and include suggestions for avoiding these misconceptions. An example of such a site is Beyond Penguins maintained by Ohio State University. This site is particularly useful as it describes common student misconceptions about plant growth needs, food, parts and classification as well as providing the correct science concepts.

In a science capstone course required of all future elementary education teachers at the University of Michigan-Dearborn, we conduct an action research project in a local K-8 classroom. In our case, we worked in a second grade classroom with 24 students. Our projects include a classroom observation, analysis of a pre-assessment that we created ourselves, teaching two inquiry lessons to address the misconceptions or lack of information discovered in the pre-assessment and finally, analysis of a post-assessment to determine the impact of our teaching on student understanding. Initially, we intended to teach the second grade students about plants and their parts. To develop lessons that built upon prior student knowledge, we administered an assessment which asked students, among other questions, to identify the most important job of a flower or fruit. We expected that students would answer that flowers and fruit make, protect and help disperse the seeds. Sixty-two percent (15 out of 24) of the students answered correctly while 16% had answers that pertained to either a flower or a fruit, but not both, and 23% of students had no idea at all. We also found some of the common misconceptions described above. For example, our second grade students were able to correctly identify most of the parts of a plant but some were unable to identify the role of the roots and leaves. Less than half of the students in the class were able to convey accurately the role of a flower or fruit.

During group work in our first inquiry lesson comparing pansies and carrots, we overheard conversations about whether a carrot was a fruit or a vegetable. This intrigued us and we decided to modify our action research project to find out what our second grade students knew about fruits and vegetables and their differences. We were aware that some people have the non-scientific idea that where the food item grows determines if it is a fruit or a vegetable. They believe that fruit, such as apples, pears and cherries, grows on trees while vegetables grow underground (potatoes, onions) or in plants near to the ground (peas, beans, squash). Other people believe that fruits are sweet and vegetables are not and thus grapes, raspberries and strawberries are fruits although they grow on plants near the ground. These common ways of separating fruits from vegetables are 'grocery store' definitions, not scientific definitions. Scientists classify fruits as a seed containing part of an angiosperm developed from the ovary after flowering. A vegetable is any other edible part of the plant which can include roots, stems and leaves.

An examination of the literature found only one study reporting what young children thought of fruits and vegetables. Fleischhacker, Cason and Achterberg (2006) studied preschoolers in an urban Head Start program by showing pictures of various fruits and vegetables and asking the children to identify the food item. Preschoolers were not able to correctly identify each food item. Some indicated the carrots, greens, peas and baked beans were fruits and others said that apples, oranges, peaches and grapes were vegetables. The focus of this study was to develop a baseline understanding of children's knowledge of fruits and vegetables in an effort to improve good eating habits. The researchers did not pursue any instructional strategies to teach the differences between fruits and vegetables.

We decided to develop an assessment to determine if our second grade students were aware of the scientific distinction between fruits and vegetables. Our assessment included, like that of Fleischhacker et al. (2006), pictures of food items including a carrot, apple, cucumber, potato, tomato, and celery. Instead of interviewing students, we asked our second graders to classify each picture by circling the word "fruit" or "vegetable" underneath each picture. In addition, we asked the students to explain how they could determine if an item is a fruit or a vegetable.

Although 62% of the students had previously stated that fruits make, hold, and/or protect seeds, they did not transfer this understanding to their everyday lives. We found that ninety-six percent (22 out of 23) of the students incorrectly answered that cucumbers were a vegetable. Other incorrect responses were that potatoes were a fruit (22%, 5 of 23), and that tomatoes were a vegetable (22%). A complete summary of the student responses is listed in Table 1. These results indicate that these students were unable to apply their knowledge of what a fruit does in identifying food items as fruits.

Table 1. Second grade students' identification of common fruits and vegetables on the pre- and post-assessment[a].

Item	Correct Response	Pre-assessment		Post-assessment	
		Fruit	Vegetable	Fruit	Vegetable
Carrot	Vegetable	0	23	0	24
Apple	Fruit	23	0	24	0
Cucumber	Fruit	1	22	19	5
Potato	Vegetable	5	18	2	22
Tomato	Fruit	18	5	24	0
Celery	Vegetable	1	22	1	23

[a]One student was absent for the pre-assessment.

Only 13% (3 out of 23) of students answered that they could tell the difference between a fruit and a vegetable because fruits have seeds. Thirty-nine percent (9 out of 23) of students responded with "I don't know," and the other 48% of students responded with answers concerning physical appearance or taste. These results are not surprising given the common, non-scientific understanding of the difference between fruits and vegetables. Table 2 summarizes student responses.

Table 2. Student responses to the difference between fruits and vegetables.

Student Answers	Number of students
I don't know	9
Fruits have seeds	3
Color	2
Where they grow (tree vs. ground)	2
Juiciness	2
Fruits grow from a flower	1
Taste	1
Length	1
Vines	1
"They look like a fruit"	1

After analyzing the above data, we concluded that a lesson on the scientific distinction between fruits and vegetables was needed. We created a hands-on, inquiry lesson in which student groups examined carrots, radishes, potatoes, strawberries, apples, tomatoes, cucumbers and celery with magnifying lenses. Students were asked to look at both the inside and outside of each item. For safety reasons, we sliced open each item for them. We asked the students to put the items into groups and we found that students grouped the items by color or by size or by sweetness. After the exploration, students were asked to share their groupings with the class but none of the groups sorted by presence or absence of seeds. During class discussion of their groupings, we asked questions of the students and guided them to a sorting based on the presence or absence of seeds. We also made sure to explain that although tomatoes and cucumbers are scientifically fruits, many people consider them vegetables based on culinary usage. We also addressed the concept that fruits are 'sweet' and vegetables are not and we made it clear that this distinction is not scientific. To extend the lesson, we showed pictures of other fruits and vegetables that the children had not explored and asked the students to sort them using a scientific definition of a fruit or vegetable.

Student knowledge of the distinction between fruits and vegetables improved considerably as shown by the results of the post-assessment (see data in Table 1) which was identical to the pre-assessment. Before the lesson, students incorrectly said that cucumbers were a vegetable (96%); potatoes were a fruit (22%); tomatoes are a vegetable (22%); and 87% of students could not distinguish between a fruit and a vegetable. After the inquiry lesson, students correctly labeled cucumbers as fruits (79%), an increase of 75%; correctly labeled potatoes as a vegetable (92%), an increase of 14%; and correctly labeled tomatoes as a fruit (100%), a 22% increase. Seventy-nine percent of students answered that fruits have seeds and vegetables do not, a 66% increase from the pre-assessment.

In conclusion, we found that second grade students possessed a non-scientific understanding of the difference between fruits and vegetables but that an inquiry lesson centered on grouping a variety of different common fruits and vegetables and a class discussion based on student groupings resulted in a large increase in the number of students who possessed a correct understanding of the scientific difference. Our results also provide yet another demonstration that a single lesson is rarely sufficient to correct all previously held conceptions.

References

Barman, C., Stein, M., McNair, S., & Barman, N. (2006). Students' Ideas about Plants and Plant Growth. *The American Biology Teacher, 68*(2), 73-79.

Berthelsen, B. (1999). Students' Naïve Conceptions in Life Science. *MSTA Journal*, *44*(1), 13-19.

Fleischhacker, S., Cason, K., & Achterberg, C. (2006). "You Had Peas Today?": A Pilot Study Comparing a Head Start Child-Care Center's Menu with the Actual Food Served. *Journal of the American Dietetic Association*, 106(2), 277-280.

Michigan Department of Education. (2007). (Science) Grade Level Content Expectations. Retrieved from www.michigan.gov/mde

The Ohio State University. (nd). Common Misconceptions about Plants. Retrieved April 24, 2012 from http://beyondpenguins.ehe.osu.edu/issue/polar-plants/common-misconceptions-about-plants

Addressing Children’s Misconceptions About Spiders: Teaching a Difficult Concept to Preschool and Elementary Children

By James T. McDonald. Professor of Science Education, Department of Teacher Education and Professional Development and Lynn A. Dominguez, Associate Professor of Recreation, Parks, and Leisure Service Administration, Central Michigan University,

Introduction

As children develop misconceptions about animals they believe are dangerous, they also create attitudes that are difficult to change. Changing these attitudes after they have already developed then becomes difficult for teachers. Cardak (2009) found that students considered the features that make animals dangerous to include: being venomous, having a large size, being vicious and wild, and also being sneaky. Children also believe vertebrate animals are more dangerous than invertebrates. Students were found to have significantly insufficient knowledge and alternative concepts for animals such as snakes, scorpions, spiders, and centipedes. One of these animals that are easy to find but difficult for children to understand is spiders. As with most wild animals, they are difficult to teach about because of children’s lack of first-hand experience with them, misunderstandings about the behavior they exhibit, and negative attitudes regarding them. Although we have selected spiders to concentrate on, the activities and methods we describe can be applied to a variety of animals that students have misconceptions about or consider dangerous. Many studies have been conducted with children about the alternative conceptions they have about dangerous animals such as spiders.

Biddulph (1982) discovered that the majority of questions raised by children about spiders were grouped into the categories of spider features such as: spinning silk or creating webs; foods and their prey; reproduction habits; different types of spider species; if they have poison; and the habitats in which they life. Strategies used by children to gain insight to help with their ideas about spiders included guessing, generalizing from limited experience, recognizing when they have insufficient knowledge to form or offer an idea, recalling relevant past experiences, reasoning by analogy, and gaining ideas from such sources as books or television.

Prokop and Tunnicliffe (2008) found that most children know that spiders feed on smaller animals and are not vegetarians. Surprisingly, many actually do reject the idea that spiders are insects. However, children also incorrectly believe that spiders are dangerous to humans when they are asleep. What are the most prevalent alternative conceptions about spiders that children and adults share? According to the Burke Museum of History and Culture in Seattle (www.burkemuseum.org) the ten most common misconceptions about spiders are (correct answers are in parentheses):

1. Spiders are insects. (Spiders are arachnids.)
2. All spiders make webs. (Only half of spiders make webs.)
3. You swallow an average of 4 spiders in your sleep every year. (There is no factual basis for this.)

4. Instead of killing them, house spiders should be put outside. (House spiders will not survive and will die if placed outside.)
5. A spider found in the bathtub probably came through the drain. (It would be difficult for them to come up through a drain. Most spiders found in the bathtub are looking for water and cannot get out.)
6. Daddy Long-Legs have incredibly potent venom but cannot bite humans. (Daddy Long-egs have almost no venom and their venom does no harm to most insects.)
7. A Daddy Long-Legs is a kind of spider. (They are actually a crane fly [insect], harvestman [arachnid], or a cellar spider [actually a spider].)
8. Most spiders cannot bite humans because their fangs are too small. (Most spider bites are harmless to humans.)
9. Spiders come into houses to escape the cold. (House spiders live inside all year-round.)
10. Tarantulas are highly poisonous and can be deadly to humans. (Most tarantulas are harmless.)

Since breaking down misconceptions and negative attitudes about spiders is difficult, it is important for teachers to use a variety of ways to direct their instruction. Shaffer, Hall, and Lynch (2009) believe that children are curious and competent individuals capable of co-constructing knowledge. It is important for teachers to support students in developing a new process of scientific journey to limit misconceptions, including: observing, asking questions, forming hypotheses, investigating, gathering data, drawing conclusions, and building ideas that lead to new questions into the lives of insects, spiders, and related creatures. Copple and Bredekemp (2009) note that, "children are active constructors of their own understanding of the world around them," and "developmentally appropriate teaching practices provide an optimal balance of adult-guided and child-guided experiences" (p. 17).

Prokop and Tunnicliffe (2008) concluded that designing first hand experiences for children over the course of several days improved the attitudes and knowledge of children about spiders. After such experiences positive attitudes were increased and alternative misconceptions decreased after lengthy interaction with spiders. One way to increase exposure to spiders is to supplement activities used in the classroom and extend those activities into the readily available resource of the schoolyard.

Taking children outdoors has many learning benefits. According to Broda (2007), using the schoolyard to enhance learning provides children with concrete experiences and assists in clarifying abstract concepts. Hands-on, sensory rich activities help to motivate reluctant learners and add variety to teaching and learning. Unfortunately, as Gladwin (2005) has observed, children are learning to fear the outdoors, "finding nature unpredictable, dirty and polluted" (p.13). Children who avoid going outdoors because of the pull of indoor technology are missing out on the discoveries and skills they learn through direct observation and the use of their senses (Basile, 1999). As Louv (2005) has found, getting children outside improves their problem-solving, critical thinking, and decision-making skills while stimulating their creativity.

Using the outdoors for learning about spiders allows for real-world observations of their habitats and increases understanding of the complex interrelationships that exist in nature. Children work to co-construct knowledge through first-hand experiences and increase their processing skills. Supplementing the activities used in the classroom to study spiders provides children with the opportunity to make their own real-world observations, ask questions about those observations, and apply what they learn in new situations. Lieberman and Hoody (1998) found that "when students learn about science within the context of their community and natural surroundings, they demonstrate great proficiency in applying scientific skills to real-world situations" (p. 51).

Imagine how easy it is to take a field-trip just outside the classroom door, students armed with clipboards and pencils at the ready to draw and take notes about their observations of spiders and webs. When faced with a real spider or its web students quickly gain real observations and experiences to ask questions about rather than continuing to develop misconceptions.

Activities to Address Misconceptions and Provide First-hand Experience

From the descriptions of studies done with children ages 3-16, the most beneficial activities with students concerning spiders are those that let children co-construct knowledge through using process skills such as observing, asking questions, forming hypotheses, investigating, gathering data, drawing conclusions, and building ideas that lead to new questions. The activities must also provide first-hand experiences that let students encounter spiders both inside and outside of the classroom where natural behavior can be observed and conclusions can be made.

Here we introduce two examples of activity guides, from the many possible activities that have been developed, that provide both first-hand experiences and the opportunity for students to co-construct their own knowledge about spiders. The first of these activities are presented from the Growing Up Wild activity *Spider Web Wonders* designed specifically for children ages 3 to 7 and the Great Explorations in Math and Science (GEMS) Schoolyard Ecology guide for Grades 3-6, specifically the activity *Finding and Observing Spiders*. Activities from each of the guides are presented in the 5E format with which many science teachers are already familiar.

Growing Up WILD: Spider Web Wonders (Ages 3-7)

(Note: The following activities represent a small sample of the spider activities available in the Growing Up WILD guide)

Engage

Lead a discussion about spiders. Ask the children if they have ever seen a spider; what did it look like? How many legs does it have? What was it doing? If the students mention seeing webs ask them to describe the web. Have students draw a picture of a spider.

Explore

Take students outside on a Spider Walk! First remind them to look not touch. Demonstrate for younger children how to use their first finger to carefully point, without touching, the spider or web they see. Remind the students to walk and talk quietly to have a better chance to see spiders. Look carefully in protected areas around the building and in bushes. If you go out early when the dew has settled on the grass you may find spider webs that have caught the moisture and are easier to see. When students find a spider have them carefully observe it. Count how many legs it has, describe the shape of the body, describe what the spider is doing. Look for webs. Make some sketches of the spiders and webs the students find.

Explain
After returning to the classroom, read a book about spiders and allow time to freely explore toy replicas of spiders. Sing the song: *Little Spider Weaves a Web* (to the tune of "Twinkle, Twinkle Little Star)

Little spider weaves a web
With some dry and sticky threads.
Her bristled feet keep her free
From getting stuck, can't you see?

Here comes a fly buzzing by
Into her web, watch it fly.
Wiggle, wriggle. It's stuck tight.
Spider has her meal tonight.

Do the activity: *Picking up Vibrations* – tie a piece of string or yarn between two chairs and stretch it tight. One child is the 'spider', have them close their eyes and lightly touch the string. Another child is the 'prey' and plucks the string gently, then with more force. The spider raises their hand when they can feel the 'prey'. Take turns being the 'spider' and the 'prey'. Let the children examine pictures of spiders and webs; matching types of webs to the appropriate spider.

Elaborate
Use math for a 'counting legs' activity. Collect pictures of different types of animals. Have the children count how many legs they have. Ask if other animals have the same number of legs. How many legs does a dog have? An ant? A spider? Look at the pictures of different animals and count the legs. Have the children identify the animal with the most legs, with the least, and place the pictures in order from least to most legs. Explain the difference between insects and spiders, emphasizing the number of legs each has.

Evaluate
Take the children back out into the schoolyard. Encourage them to look for spiders and webs. When they find a spider post a sign titled "Spider Refuge". Have them quietly observe the spider/web and draw what they are observing. Draw the area the spider is in, draw a picture of the spider, and use the information later to create a book about spiders. Use the book to teach their family about spiders. Have the students compare their first spider drawing with the actual one in their books.

GEMS Schoolyard Ecology: Finding and Observing Spiders (Grades 3-6)

(Spiders and ants are the focus of this GEMS guide. The activities described are representative of the many activities contained in the guide.)

Engage
Let students know that for this activity they will visit the schoolyard to locate and observe spiders. A good way to engage students is with stories about spiders, pictures of spiders, or some fun spider facts. Brainstorm some of the positive and helpful things about spiders. Ask students where they have seen spiders in the schoolyard.

Explore
It needs to be pointed out that spiders are secretive. In order to focus their observations, ask students to list some clues that they can look for that may show that spiders are near-

by. Such clues would include webs, egg cases, wrapped insect bodies, and spider skins.

All students will receive a map of the schoolyard and a set of animal ID cards to add to their clipboards. Depending on the grade level and the time available, each student should fill out two cards. On each ID card, students will draw and write about a kind of spider that they find. Students should use descriptive words and draw what they really see. A new ID card should be used for each different kind of spider. On the card they'll write their name, the date, and how many of that kind of spider they saw. If possible, students should draw the shapes of the different kinds of webs observed.

While the students are observing spiders, the teacher should circulate encouraging their discoveries. Offer to mist the webs with water for easier viewing. Remind the class to mark the locations of the webs and the spiders on the map.

Explain
Back in the classroom, take a few minutes for a discussion of students' discoveries. You may want to introduce some information to the students such as each different type of spider makes a different sort of web. Draw a new kind of spider symbol in a new color marker (or use a colored dot) on the key of your class map and write spiders next to it. Each pair of students will get to draw a spider symbol to record one spider location on the class map. After all pairs have recorded their spider locations, hold a brief discussion about the conclusions that can be drawn by looking at the distribution of the spiders.

Elaborate
Ask the students to look at the data on the class map for sunlight, moisture, and cover. Ask about where most of the spiders are located. Ask about what environmental factors seem to influence spiders.

Evaluate
Have students write in their journals about the conclusions that they have made about where spiders are located in schoolyard and the different types of spiders that they observed. What are some of the new things that they have learned about spiders?

Conclusion
Misconceptions about science concepts, natural processes, or species are difficult to correct, particularly if they have been reinforced by family, friends, or popular media. Allowing children plenty of time to explore nature, make observations, and co-construct their own knowledge through experience greatly diminishes or prevents misconceptions. Allowing time for discussion of misconceptions followed by the appropriate information, activities, and experiences will assist children develop confidence in their own ability to make observations, design experiments, and draw inferences from the results they discover.

References

Basile, C. G. (1999). Collecting data outdoors: Making connections to the real world. *Teaching Children Mathematics, 6*(1), 8-12.

Biddulph, F. (1982). *Primary School Children's Ideas about Spiders, Learning in Science Project (Primary)*. Working Paper No. 108, Waikato University, Hamilton, New Zealand.

Broda, H. W. (2007). *Schoolyard-enhanced learning: Using the outdoors as an instructional tool, K-8.* Portland, ME: Stenhouse Publishers.

Spider Myths. Burke Museum of History and Culture. Available at: http://www.burkemuseum.org/spidermyth

Cardak, O. (2009). Students' Ideas about Dangerous Animals, Asia-Pacific Forum on *Science Learning and Teaching*, 10(2) 1-15.

Copple, C., & S. Bredekamp, eds. (2009). *Developmentally Appropriate Practice in Early childhood Programs Serving Children from Birth Through Age 8* (3rd ed). Washington, DC: NAEYC.

GEMS. (2003). *Schoolyard ecology: Finding and observing spiders*. Berkeley, CA: Lawrence Hall of Science, University of California.

Gladwin, S. G. (2005). Green space, blue sky: The importance of the outdoors for health and learning. *Delta Kappa Gamma Bulletin, 72*(1), 11-14.

Lieberman, G. A. & Hoody, L. L. (1998). *Closing the achievement gap: Using the environment as an integrating context for learning.* Poway, CA: Science Wizards.

Louv, R. (2005). *Last child in the woods: Saving our children from nature-deficit disorder.* Chapel Hill, NC: Algonquin Books.

Patrick, P. & Getz, A. (2008). Becoming a Spider Scientist. *Science and Children*, *46*(3), 32-35.

Prokop, P. & Tunnicliffe, S. (2008). "Disgusting" Animals: Primary School Children's Attitudes and Myths of Bats and Spiders. *Eurasia Journal of Mathematics, Science, and Technology Education, 4*(2), 87-97.

Project WILD. (2010). *Growing up WILD: Spider Web Wonders*. Houston, TX: Council for Environmental Education.

Shaffer, L.F., Hall, E., & Lynch, M. (2009). Toddlers' Scientific Explorations: Encounters with Insects. *Young Children* 64 (6): 18–23.

Table 1: Standards that support the teaching of spiders preschool through sixth grade

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Resources

Non-Fiction

About Arachnids: A Guide for Children by Cathryn Sill
Are You a Spider? by Judy Allen and Tudor Humphries
Do All Spiders Spin Webs? by Melvin and Gilda Berger
Spiders by Gail Gibbons
Spider's Lunch: All About Garden Spiders by Joanna Cole
Spiders Spin Webs by Yvonne Winer
Web Weavers and Other Spiders by Bobbie Kalman

Fiction

Anansi the Spider by Gerald McDermott
Cobweb Christmas: The Tradition of Tinsel by Shirley Climo
Diary of a Spider by Doreen Cronin
Dream Weaver by Jonathan London
A House Spider's Life by John Himmelman
Itsy Bitsy Spider by Iza Trapani
Miss Spider's Tea Party by David Kirk
The Very Busy Spider by Eric Carle

Appendix

Standards and Correlations

Head Start Domains

Science

Scientific Skills and Methods

1. Begins to participate in simple investigations.
2. Develops growing abilities to collect, describe, and record information.
3. Begins to describe predictions, explanations, and generalizations based on past experiences.

NAEYC Accreditation Criteria

Curriculum Content Area for Cognitive Development: Early Science

Children are provided varied opportunities and materials

a. to learn key content and principles of science.
b. that encourage them to use the five senses.
c. to use simple tools.
d. to collect data.
e. that encourage them to think, question, and reason.
f. that encourage them to discuss scientific concepts in everyday conversation.
g. that help them learn and use scientific technology.

National Science Education Standards

Science Teaching Standards

Teachers of science

- select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students
- orchestrate discourse among students about scientific ideas
- use multiple methods and gather data about student understanding and ability
- guide students in self-assessment
- display and demand respect for the diverse ideas, skills, and experiences of all students.

Appendix

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Miss Spider's Tea Party by David Kirk

The Very Busy Spider by Eric Carle

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At Eastern Michigan University's
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Notes

Author Guidelines

Deadlines: August 15th for the Fall Journal & March 15th for the Spring Journal!!

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(2) <u>classroom ideas</u> that give classroom activities, usually in much the same format as the teachers uses in their own classroom.

Write clearly and concisely, organize your material logically, and use an active voice and conversational tone. Write about your firsthand experiences or your unique area of expertise and stress classroom applicability.

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Email your article to Lisa at (lweise@hpsk12.net) in Word format. If your article has specific formatting, please mail a printed hardcopy proof of your article to the editor for formatting reference. *Note: If you do not supply a printed hardcopy proof for formatting reference, we can't be held responsible for formatting errors or inconsistencies.*

Photographs should be submitted electronically in high-resolution format (4" x 3", 300 dpi). Students in lab must be shown following appropriate safely guidelines and wearing proper safety attire, including splash-proof goggles. Their faces should be visible, but they should not look directly at the camera. If the photo is used, a signed model release will be required of each student pictured.

Checklist

- ❒ Author's name, current position, mailing address, phone numbers are included with article.
- ❒ Written clearly and concisely with an introduction and conclusion.
- ❒ Stresses classroom applicability.
- ❒ References are complete.
- ❒ Photos show students following appropriate rules of safety.
- ❒ Two printed copies and a disk are mailed to the editor.

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