

INCITE

JOURNAL OF UNDERGRADUATE
SCHOLARSHIP



Cook-Cole College of Arts and Sciences

LONGWOOD
UNIVERSITY



VOLUME 3
FALL 2010



INCITE
Journal of Undergraduate
Scholarship

Cook-Cole College of Arts and Sciences
Longwood University
Farmville, Virginia

Fall 2010

Executive Editors

Mary Carroll-Hackett, MFA
English – Creative Writing

John R. Graham, Ph.D.
Mathematics and Computer Science

Student Editorial Staff

Alex Odom
Edd Howarth
Melissa Clampitt
Amy Ellis
Erikk Shupp
Amanda Inman
Ashley Maser
Jessica Dixon
Jessy Koelzer
Amy Donaldson
Steven Wood

Cover Design by: Alex Odom
Cover Art Featuring Justin Heffner

INCITE
Journal of Undergraduate Scholarship
Volume 3, Fall 2010

Contents

1 Feature Article	1
Little Shop of Horrors	3
<i>Longwood Theater Department</i>	
2 The Natural Sciences	17
Who Has the Hottest Hotsauce in Farmville: A Quantitative Comparison of Sauces from Local Restaurants	19
<i>Cheryl Peck and Charles Hoever</i>	
Precipitation Effects on the Growth of White Oaks and Virginia Pines on the Mt. Vernon Plantation	28
<i>Brittany Anderson</i>	
Design and Synthesis of Novel Ion Binding Molecules for Self-Assembly and Sensing Applications	41
<i>J. Ervin Sheldon</i>	
3 Mathematics and Computer Science	51
A Statistical Analysis of Algorithms for Playing SameGame	53
<i>Richard Hayden</i>	
Intersecting Cylinders at Arbitrary Angles	65
<i>Yuri Calustro</i>	

4	The Social Sciences	76
	Putting a Foot in the Revolving Door: Strategies for Reducing Teacher Attrition	77
	<i>Candice Fleming and Rebecca Franklin</i>	
	The Effect of Presentation on Spanish Vocabulary Recall	91
	<i>Ashley Yocum</i>	
	How Attractive Are You? Individuals Sensitivity to Number of Sexual Partners	103
	<i>Danielle M. Jagoda and Cristina M. Valdivieso</i>	
5	English and Modern Languages	112
	Culturally Relevant Practices for Teaching Code-Switching to African-American Students in Kindergarten Classrooms	113
	<i>Jameka Jones</i>	
	Two Poems - Dust and Check out girls	124
	<i>Amy Ellis</i>	
	Three Poems - Rosewood Massacre, 1923, and Jarring and Reverence	129
	<i>Ashley Maser</i>	
	Three Poems Dirty Thunderstorm, and Summer Hide 'n Seek Car Tag and Bliss	135
	<i>Erikk Shupp</i>	
6	Visual Art	140
	Analysis of the Wilton Diptych	141
	<i>Jamie Yurasits</i>	

A Collection of Art	147
<i>Various Artists</i>	
7 Music	178
Selections from a Senior Recital	179
<i>Joshua Davis</i>	

From the Dean

It is my pleasure to welcome you to the third edition of *Incite*. In this journal you will find wonderful examples of the undergraduate research and creative activity in the Cook-Cole College of Arts and Sciences at Longwood University. The faculty of the college and I are extremely pleased to be able share the work of our students with you.

Longwood University has a tradition of cultivating a stimulating and effective learning environment through the dedication of our faculty and the close personal attention they give each student. This tradition is amplified and enhanced by the scholarly and creative work of our faculty as they explore new ideas and techniques in their disciplines.

In *Incite* you will find some of the results of our efforts to give our students the opportunity to become scholars in their disciplines. In our college, we are making an effort to give as many students as possible the chance to experience the excitement of generating ideas and creative works that are not only new to the student involved but to the discipline as well. We feel that when a student has the chance to stretch his or her abilities by working closely with a faculty member on a rigorous project, it is the perfect complement to the colleges excellent classroom instruction.

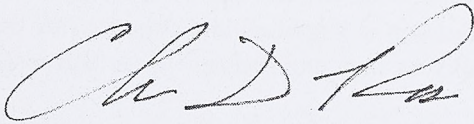
One of the joys of my role as dean is having the chance to learn more about the many fields of study that comprise the Cook-Cole College of Arts and Sciences. As you read through *Incite*, I believe you will get that same sense of enjoyment from the wide variety of student work contained in the journal. Here you will find everything from work on intersecting cylinders at arbitrary angles to poetry and photographs. The DVD included with the journal showcases the work of our student musicians.

Our mission is to provide our students with both a solid liberal arts foundation and a deep understanding of their chosen discipline. I believe that *Incite* provides solid evidence that we are achieving our mission. We also hope that our students and faculty find a love of learning that lasts a lifetime and that the collaborations highlighted in these pages are just first of many such explorations to come for all involved.

Thank you for your interest in our students and for taking the time to inves-

tigate what they have created. In addition to thanking the student authors and artists and their faculty mentors, I must express extreme gratitude to Dr. Mary Carroll-Hackett and graduate student Alex Odom from the Department of English and Modern Languages and Dr. John Graham of the Department of Mathematics and Computer Science. Without their talent and tireless work, Incite would not be the beautiful work that you now hold in your hands.

Sincerely,

A handwritten signature in cursive script, appearing to read "Ch D Ross". The signature is written in dark ink on a light-colored background.

Dr. Charles D. Ross
Dean, Cook-Cole College of Arts and Sciences

1 Feature Article

Little Shop of Horrors

Matthew Jackson
Longwood Theater Department

Longwood University's theater department is very small and close-knit, so opportunities to actively work on main-stage productions are not rare. As a freshman, I had many chances to fill important roles in productions, which proved to be very challenging and rewarding experiences.

During our production of Little Shop of Horrors in the spring, I was faced with a very unique challenge in helping to design and operate the enormous ten-foot, man-eating Audrey II puppet. When the process started, I had no idea how this daunting task was going to be possible, but the faculty did an excellent job keeping me involved in the building process so I could learn. Eric built the interior structure with a frame consisting of two pipes bent to provide the shape of the length and width, and a cardboard roof to create the height. Melissa then attached foam ribs to the cardboard surfaces to provide the rounded shape for the upper half before wrapping the entire thing in thinner foam. My fellow puppeteer, Sarah Breitenberg, and I helped Melissa sew and glue it all together.

I couldn't believe how awesome the puppet looked once it had its basic shape, but we had yet to answer the question of how it would be rigged to me when I operated it. Eric and Melissa had toyed with all sorts of ideas ranging from rigging it like a bass drum in a marching band, to having it hang on a stationary post. It was too heavy to have all of the weight hanging on my shoulders like a drum would, and the stationary pole limited the movements that I would be capable of greatly. I remembered when I went hiking in Maine when I was young, and the backpacks we used; they had metal frames that made it so the majority of the weight rested on our waists rather than our shoulders. I explained the principle to Eric and Melissa, and we created a makeshift frame out of plywood to rig to my

back. After tweaking the design a bit by adding additional straps and padding I could comfortably support and manipulate the puppet.

An incredibly sharp green to blue fade paint job from Eric made the killer plant radiant on stage. It adorned ferocious teeth, multicolored warts, voluptuous lips, and a working tongue. We had about two weeks to rehearse with the puppet before the show opened, so there was plenty of time to work the puppet into the show. I got a good workout and had a lot of fun at rehearsal, and was well prepared to perform the show. The opening weekend went fabulously, as did the matinees we did for high school students during the week. The second weekend held a few scary moments where the puppet broke on stage, but I was always able to fix it before it became a major problem.

Working on Little Shop of Horrors was a terrific learning experience for me. I was astounded by how amazing the effects I helped to create turned out, and am incredibly proud of the work I did. After the show closed I felt fortunate to have had that opportunity so early in my college career, and eager to work on more productions next year.



Figure 1:

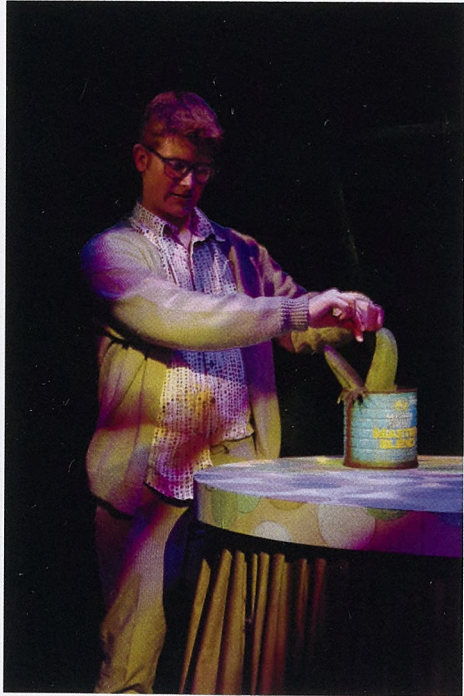


Figure 2:



Figure 3:



Figure 4:



Figure 5:

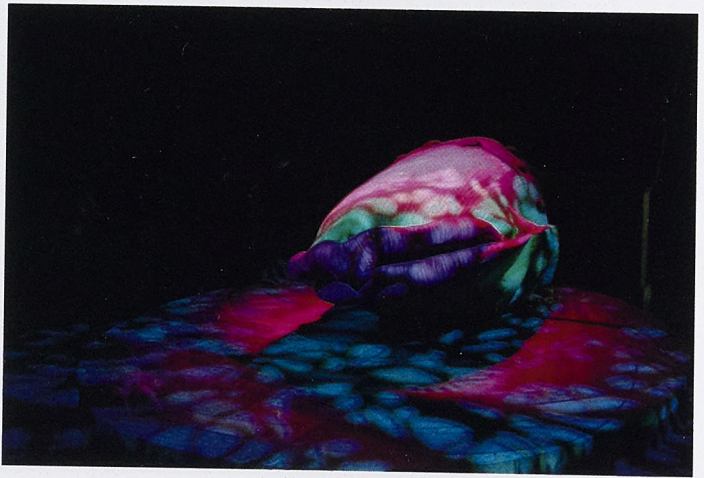


Figure 6:



Figure 7:

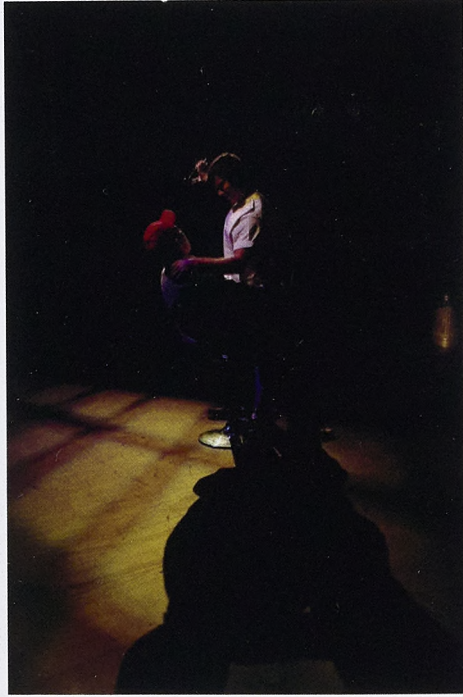


Figure 8:



Figure 9:

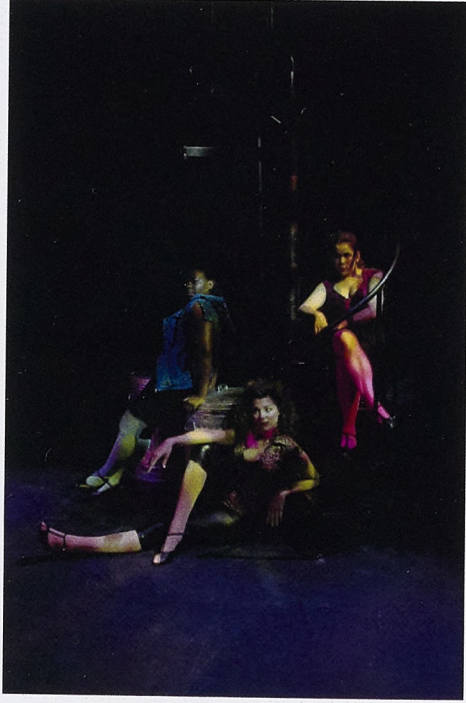


Figure 10:



Figure 11:



Figure 12:



Figure 13:

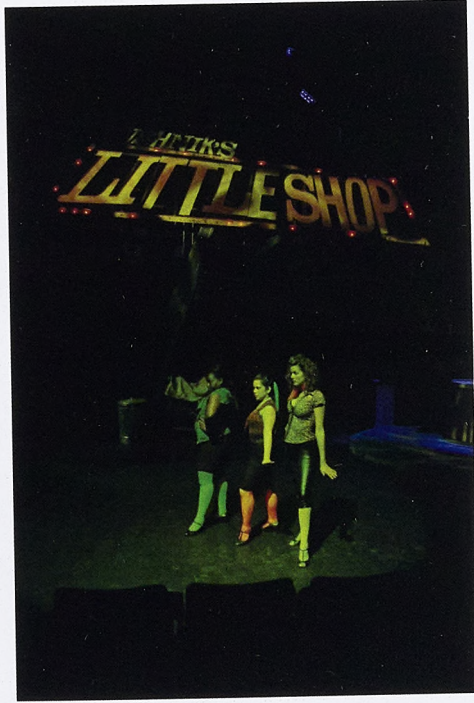


Figure 14:



Figure 15:

2 The Natural Sciences

Who Has the Hottest Hot Sauce in Farmville: A Quantitative Comparison of Sauces from Local Restaurants

Cheryl Peck and Charles Hoever
Faculty Mentor: Dr. Sarah Porter
Department of Natural Sciences

Abstract

The purpose of this experiment was to compare the “hot” wing sauces from several local restaurants and measure the concentration of capsaicin, the main capsaicinoid found in most peppers, by using high performance liquid chromatography (HPLC). By measuring standards with known concentrations and comparing the areas of the capsaicin peaks that appeared, the concentration of capsaicin in the sauces was determined. The concentrations for Wingshak’s XXX and Death sauces were both found to be below the calibration range. Charley’s sauce had a Scoville unit of 10998 while Mulligan’s Hot contained a capsaicin concentration of 24 ppm, which is equivalent to 0.0126 %w/w and a Scoville unit of 2023. The second Mulligan’s sauce, Inferno, had a concentration a little higher of 36 ppm. This is equivalent to 0.0189 %w/w and a Scoville unit of 3046.

Introduction

The goal of this research was to develop an instrumental method to determine capsaicin concentration in sauces and compare the analytical results to a traditional “tasting” method of determining hotness. The hotness of the hot peppers that are present in hot sauces is due to a group of compounds called capsaicinoids. The most abundant capsaicinoids are capsaicin and dihydrocapsaicin, shown in Figure

1, which are responsible for 90% of the heat in hot peppers [2]. The Scoville unit is a historical measure of heat which can be used to compare the amount of heat in different peppers and sauces. It was originally determined by trained tasters evaluating the pungency of peppers based on bite and duration of bite. This method proved not to be reliable since it was based solely on a single person's perspective and it was subjective. Scoville units can now be determined by the concentration of capsaicin in parts per million (ppm), converting to weight percent, then multiplying by 16.1×10^6 , which is a threshold pungency value [2]. The concentration of capsaicin can be determined using liquid chromatography. The size of the peak from the chromatogram collected directly corresponds to the concentration of the capsaicin extracted.

In order to separate the capsaicinoids from other components in peppers, an extraction method and high performance liquid chromatography (HPLC) are needed. The liquid chromatograph separates mixtures based on polarity [3]. Analytes are mixed with a mobile phase and passed along a stationary phase (column). The retention time measures the time it takes for each component in the sample to get to the end of the column. The more polar components of the mixture are eluted first while the least polar compounds are eluted last. Standards of pure capsaicin diluted in ethanol are used to determine the retention time when the capsaicin should elute. The area of capsaicin peaks in the standard chromatograms are compared to the capsaicin peak areas in the hot sauce chromatograms, which allows for the determination of the concentration of capsaicin contained in the hot sauces [1]. This quantitative method allows for a comparison between what a panel of tasters believes is the hottest hot sauce and what is the hottest based on a chemical analysis.

Methods

For the chemical analysis, the reagents used were a capsaicin standard solution with a concentration of 1000 ppm, which was diluted in 100% ethanol, hot sauces for testing, and ethanol. Hot sauces from Charley's, Wingshak, and Mulligan's were tested. In order to get the capsaicin concentration of each sauce, the capsaicin must be isolated from other components in the sauce by extracting, diluting,

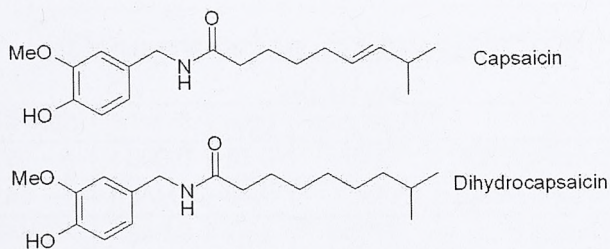


Figure 1: Two Common capsaicinoids.

and filtering each sauce twice. Fifteen grams of the desired sauce were obtained and transferred to a 125 mL Erlenmeyer flask and diluted to the 50 mL mark with ethanol. The sauce was then slowly boiled on a hot plate for 30 minutes. Once cooled, it was filtered into a 100 mL volumetric flask using filter paper and diluted to the mark with ethanol. A small portion, about 5 mL, was filtered with a 0.45 μ m syringe filter to remove small particulate matter. This filtered sample was injected into a Varian HPLC with a Prostar UV detector, which separates the capsaicinoids from other components in the sauce. The mobile phase was a 50/50 mixture of acetonitrile and 0.1% phosphoric acid. The chromatographic column was 150mm x 4.6mm C18 (octadecylsilane) and the mobile phase flow rate was 1 mL/min. Five standards ranging from 1.02 ppm to 51.0 ppm and extracted hot sauces were run through the HPLC in order to obtain their capsaicin peak areas. The standards allow for comparison of the unknown capsaicin levels in the different hot sauces [2].

The taste test consisted of a panel of tasters (nine participants in total). Each participant was asked to taste each sauce and rank it on a scale of 1 to 5 (1 being mild and 5 being hot). Two rankings were collected: the first "overall" ranking asked participants to compare the five sauces to one another and rank them mildest to hottest. The second "individual" ranking asked participants to rank the sauces independently of one another based on their perception of how hot the sauces

Table 1: Analytical results for five hot sauces.

Sauce	Peak area	ppm	% w/w	Scoville unit
A-Wingshak's XXX	247	0.74	0.0004	63
B-Wingshak's Death	192	0.49	0.003	41
C-Charley's	27900	130	0.0683	10998
D-Mulligan's Hot	5204	24	0.0126	2023
E-Mulligan's Inferno	7790	36	0.0189	3046

were.

Results and Discussion

In order to determine the concentration of capsaicin in each sauce, a calibration curve was made, and is shown in Figure 2. Plugging in the peak area of capsaicin in each sauce for y in the equation of the best fit line and solving for x gives the concentration of capsaicin. After solving for x , the concentration value is multiplied by a dilution factor. The dilution ratio factor takes into account the amount of ethanol that was used when diluting the hot sauce during the extraction process. Both of Wingshak's sauces were below the calibration range, generating a capsaicin level of less than 1 ppm. Trial D, Mulligan's Hot, was found to have a concentration of 24 ppm. The other Mulligan's sauce, Inferno, had a concentration of 36 ppm. As shown in Table 1, Charley's was discovered quantitatively to be the hottest with a capsaicin level of 130 ppm and a Scoville unit of 10998. Values reported in this table were based on a single measurement; however, each sauce was analyzed several times to ensure the validity of the method.

In comparison, Charley's Scoville unit ranks towards the middle in comparison to other sauces which are commonly used in the food industry. The fact that this Scoville unit does not include dihydrocapsaicin must be taken into account. Most food industries include both capsaicin and dihydrocapsaicin in their Scoville units.

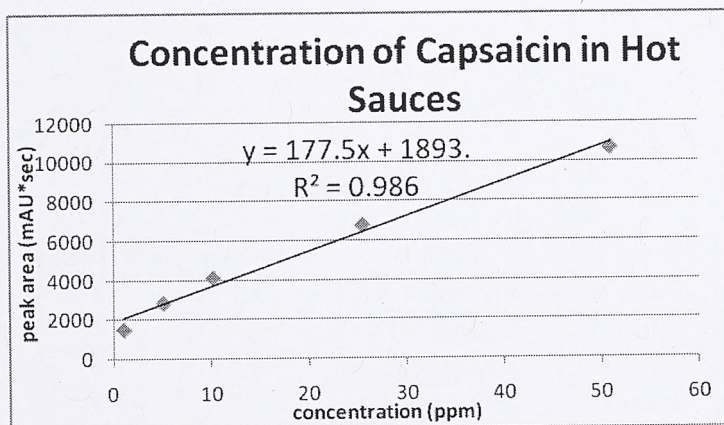


Figure 2: Calibration curve for capsaicin.

The results of the tasting panel are summarized in Tables 2 and 3. Table 2 shows the overall rankings of the sauces, in comparison to one another, with 1 being the mildest sauce and 5 being the hottest sauce. Based on the taste test panel, sauce C from Charley's was what everyone believed to be the hottest while Wingshak XXX was believed to be the mildest. Wingshak Death and the two Mulligan's sauces were very closely ranked. Table 3 shows the individual rankings of the sauces (independent of one another). Again, these rankings show that Charley's sauce was clearly the hottest while the others were very similar. The taste testing panel proved that people could tell what sauce is the hottest but they were unable to rank the milder sauces to what was quantitatively discovered. The overexposure or underexposure of hot foods and sauce could have influenced the opinions of our taste test panel. The comparison of these results indicates that taste-testing is an inaccurate method of quantifying hotness in food.

Given that the extraction method used was not specific for capsaicin, it is important to be able to determine which peak is the capsaicin in the liquid chromatogram. This determination is made by comparing the retention time of the capsaicin in each standard to the same retention time in the sauce. This ensures that chromatograms are measuring the peak for capsaicin and not other ingredi-

Table 2: Overall Rankings

Sample ID	Identity	Average	Std. Dev.
Sauce A	Wingshak's XXX	1.9	1.2
Sauce B	Wingshak's Death	2.4	1.1
Sauce C	Charley's	4.6	1.0
Sauce D	Mulligan's Hot	3.1	1.3
Sauce E	Mulligan's Inferno	3.0	1.2

Table 3: Individual rankings

Sample ID	Identity	Average	Std. Dev.
Sauce A	Wingshak's XXX	2.6	1.2
Sauce B	Wingshak's Death	3.2	0.6
Sauce C	Charley's	4.6	0.5
Sauce D	Mulligan's Hot	3.6	1.2
Sauce E	Mulligan's Inferno	2.8	1.2

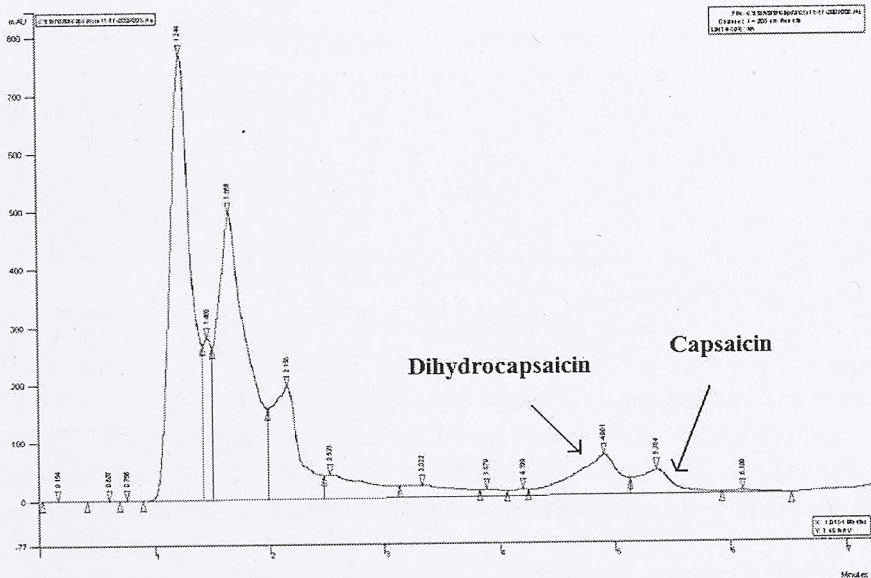


Figure 3: Chromatogram of a hot sauce (Wingshak's Death) showing capsaicin and dihydrocapsaicin.

ents that were not always caught during the filtration process. Figure 3 shows an example of one of the hot sauce chromatograms. The peaks at the early retention times are other components of the sauces and the ethanol used for extraction. The peak at 5.4 minutes is capsaicin (based on standard retention times) and the peak at 4.8 minutes is dihydrocapsaicin.

Conclusions

The results of this experiment helped to determine which of the sauces from several local establishments was the hottest based on capsaicin levels. However, the overall goal of the research was to develop a method of extraction for capsaicinoids in hot sauces as well as to understand the process of liquid chromatography.

The Scoville heat unit has been the standard comparison for the food industry for years, so by comparing our results to food industries we are able to better understand why our tested sauces ranked as they did. These results could have been improved by a more specific extraction method. During some extractions some sauce was lost in transferring, which may have caused a deviation in the final concentration. Better accuracy when transferring the hot sauce would help improve quantification. Having a larger assembly of people on our tasting panel could have given more accurate tasting results.

This experiment leads to possible future work in quantifying dihydrocapsaicin in hot sauces and peppers. A more accurate representation of the Scoville units for a sauce or a hot pepper can be obtained by measuring all of the capsaicinoids rather than capsaicin alone. This research will be continued as an experiment in the quantitative analysis (CHEM 350) laboratory course, which will allow refinement of the analytical method and testing of more sauces and possibly fresh peppers.

Acknowledgments

The authors would like to thank the owners of Wingshak, Mulligan's, and Charley's for their generous donation of hot sauces. The authors also thank Dean Charles Ross, Dr. Chris Gulgus, and Dr. Keith Rider, as well as the student members of the tasting panel for donating their time and taste buds to further this research.

References

- [1] Vincent K. Attuquayefio and Ken A. Buckle. Rapid sample preparation method for hplc analysis of capsascins in capsicum fruits and oleoresins. *Journals of Agricultural Food Chemistry*, 35:777-779, 1987.
- [2] James D. Batchelor and T. Bradley. Determination of the scoville heat for hot sauces and chilies: An hplc experiment. *Journal of Chemical Education*, 77:266-267, 2000.
- [3] Thomas A. Betts. Pungency quantitations of hot pepper dauces using hplc. *Journal of Chemical Education*, 76:240-244, 1999.

Student Biography

Cheryl Peck is a sophomore at Longwood University majoring in Chemistry with a minor in Biology. Currently I am an active member of Alpha Chi Sigma, the chemistry fraternity, as well as a tutor for general chemistry. I plan on applying to both veterinary schools as well as graduate schools for chemistry.

Charles Hoever is a sophomore at Longwood University majoring in Computer Science with a minor in Math. Currently I am an active member of Student Educators for Active Leadership, the Baseball Club, the Football Club, and a member of Alpha Chi Sigma. I am currently undecided about my career choice.

Faculty Biography

Dr. Sarah Porter has taught at Longwood for three years. She holds a Ph.D. in analytical chemistry and an M.S. in forensic science from VCU, and a B.S. in chemistry from U.Va. Her research interests include chemometrics (the application of statistical methods to chemical data) and forensic analytical chemistry. She has held a position as a breath alcohol instructor with the Virginia Department of Forensic Science and worked as a bench chemist for Wyeth Consumer Healthcare. She teaches general chemistry for majors and non-majors, and analytical chemistry courses.

Precipitation Effects on the Growth of White Oaks and Virginia Pines on the Mt. Vernon Plantation

Brittany Anderson

*Faculty Mentors: Dr. M. Leigh Lunsford, Department of Mathematics and
Dr. Daniel Druckenbrod, Department of Environmental Sciences*

Abstract

This research investigates the relationship between tree growth and precipitation for two common long-lived species in the eastern deciduous forest of the Mount Vernon Plantation. Using tree ring cores of select Mount Vernon Virginia pine (*Pinus Virginiana*) and white oak (*Quercus alba*), we cross dated annual ringwidths with divisional climate data overlapping back to the year 1895. Significant associations were found between precipitation and tree ring growth using ARSTAN [1] and DendroClim 2002 [3] programs and by performing basic statistical analysis including Two-Way ANOVA. It was determined that there is an association between precipitation and growth, and an interaction between precipitation and the type of tree species that contributes to tree ring growth.

Introduction

In January 2009, dating and measuring began of tree cores obtained in the Summer of 2008 from the Mount Vernon Plantation as part of a project for the Mount Vernon Ladies Association. Field work also continued through the Summer of 2009. After collecting the data and running initial tests on tree growth, there grew an interest in exploring the associations between precipitation and tree growth.

Initial results bearing the association between precipitation and tree growth were found using the sophisticated computer program DendroClim 2002. These results spurred an investigation into whether or not a significant association between tree growth and seasonal precipitation amount exists using simpler statistical analysis. Also investigated was whether or not the type of tree species had an association with tree growth and any interaction with precipitation amounts. Statistical analysis including two-way ANOVA were used to find results similar to DendroClim 2002.

Methodology

Tree data used in this analysis were collected from George Washington's Mount Vernon Plantation in Virginia. The forested areas of the plantation were divided into approximately one hectare grid plots based on latitude and longitude. Within the hectare, GPS was used to approximate the center of the hectare. A red and white striped plot center stake was tossed over the shoulder at approximately the center of the hectare to declare plot center for the plot to be analyzed. From the center stake, ground tapes were used to measure outwards about 13.4 meters in all directions. All trees lying within this plot were recorded with species name, diameter at breast height (dbh), and canopy dominance. Still within this plot, two trees representative of the dominant tree species were cored for a sample using bore bits. Each coring attempted to reach the center of the tree to gain the earliest tree ring of growth. Finally, within the entire hectare, one to two trees were selected that appeared to be trees that had been present during George Washington's era.

Each core was carefully mounted and sanded to clearly reveal the starting and ending rings of the core sample. The first step in the analysis of the tree rings was to count backwards from the outer ring. The outer ring was labeled with the year the core was obtained. Counting backwards from this ring to the tree center, it was possible to determine the lifetime range of the tree in years [5]. The next step was to measure the width of each individual ring in a given core sample. To do this, the program MeasureJ2X was used to measure the width in millimeters of each year's growth in a tree sample.

Generally, a wide ring width indicates a large amount of tree growth and a small ring width indicates a small amount of tree growth. However, when a tree is young, the tree rings appear wider, suggesting excessive growth [4]. This can be deceiving because when a tree is young, the circumference is small and the amount of growth is exaggerated. As a tree matures, it takes more growth to produce a thicker ring as the circumference gets larger. To eradicate the variability of early tree ring size, the program ARSTAN uses the measurements of the tree samples' ringwidths to produce a chronology by detrending and standardizing a series of tree ring measurements (Arstan, 2007). This produces chronologies of standardized tree growth independent of tree age.

Initially we used the program DendroClim 2002 to compare the tree ring measurements to precipitation (DendroClim 2002). Precipitation measurements were obtained from the National Oceanic and Atmospheric Administration (NOAA), confirmed back to 1895. Mount Vernon, VA, lies in Virginia's Region 4 of precipitation records. These monthly and yearly averages for Region 4 were used for Mount Vernon precipitation records. Monthly and yearly measurements of precipitation are in units of inches to the nearest 100th of an inch. DendroClim 2002 uses sophisticated statistical techniques, including bootstrapped correlations and response functions between climate and tree growth applied to evolutionary and moving intervals for different time periods, to reveal patterns and correlations between precipitation and tree growth. The initial analysis using DendroClim 2002 suggested that for *Pinus Virginiana*, growth was most significant in the months of May and September. For *Quercus alba*, DendroClim 2002 suggested growth was most significant in June. These results spurred the further investigation of precipitation's relationship to growth.

ARSTAN Output

As stated above, ARSTAN produced detrended data that gave tree growth independent of tree age. ARSTAN inputs raw growth data and detrends that data so it has an average yearly growth indice (average growth=indice of one). In Figure 1 below we see this process. The first graph shows raw growth, exemplifying how a tree grows more in its early years of growth. The second and third graphs show

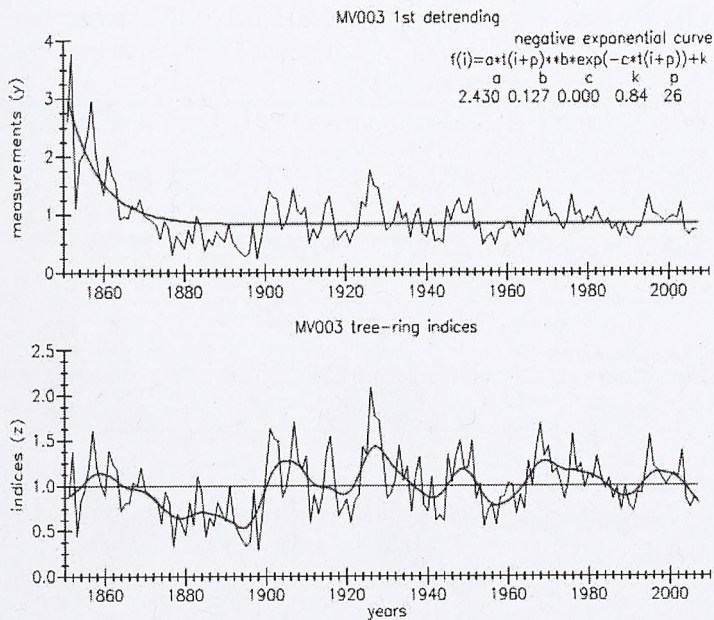


Figure 1: ARSTAN output for oak tree MV003.

the applications of the first and second detrending attempts to normalize this difference in growth by tree age. The last graph shows the final ARSTAN detrending with an indice of tree growth centered at 1.0 (no units).

Categorizing Virginia Region 4 Precipitation

To analyze the associations between precipitation and tree growth, it was decided that the quantitative data of precipitation amounts should be made categorical. These categories were determined based on quantiles derived from the precipitation records from NOAA. The interquartile range (IQR) was used to determine the lower and upper bounds of the precipitation range for yearly precipitation, Spring and Summer precipitation, and Fall and Winter precipitation. The classifi-

Precipitation Classification	Spring / Summer X-Rainfall Amount	Fall / Winter X-Rainfall Amount	Annual X-Rainfall Amount
Below Average	$X < 19.74$	$X < 15.5125$	$X < 37.095$
Average	$19.74 < X < 25.04$	$15.5125 < X < 20.0075$	$37.095 < X < 43.165$
Above Average	$25.04 < X$	$20.0075 < X$	$43.165 < X$

Table 1: Classifications calculated from IQR for the corresponding time period.

cations were labeled as Below Average Precipitation=1, Average Precipitation=2, and Above Average Precipitation=3. Table 1 lists the calculated classifications for each time period.

Results

We ran a two-way analysis of variance (ANOVA) using SPSS with the independent variables tree species and precipitation level for Yearly precipitation, Spring/Summer precipitation, and Fall/Winter precipitation. The assumptions for Two-Way ANOVA were as follows: we had a simple random sample of Virginia Pines and White Oaks from all trees at Mt. Vernon Plantation, Virginia; the trees' growth are normally distributed for each combination of precipitation class and type of tree; and the standard deviations of the trees' growth are roughly the same for each combination of precipitation class and tree type. In Figure 2 we see that the histograms for the six combinations of tree species and precipitation level are approximately normal and variances are roughly the same. In particular we see that the smallest variance is no more than $\frac{1}{2}$ the largest variance, which satisfies the equal variance assumption and is given in most standard statistics books [6].

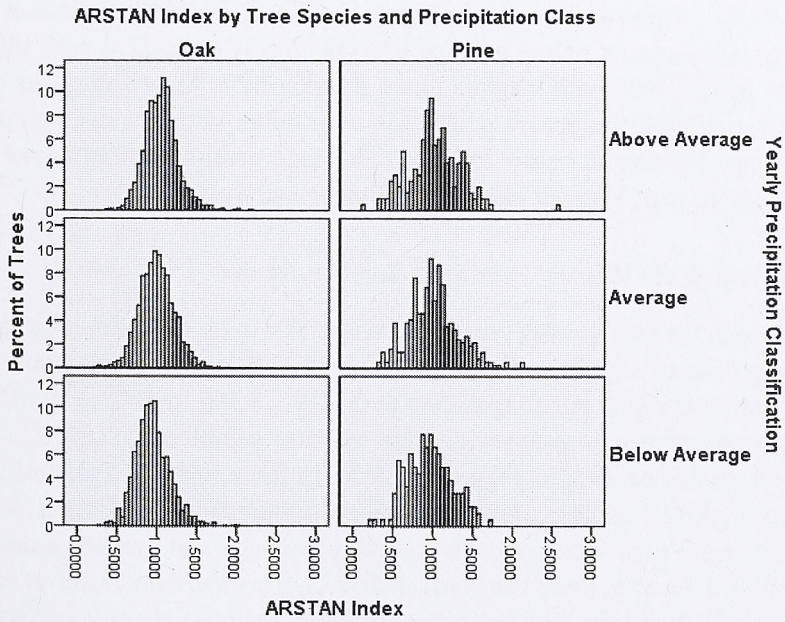


Figure 2: Histograms for each combination of species and precipitation class

Results from Spring/Summer Precipitation Analysis:

The tree species type does not have a bearing on the amount of growth in this season, not passing tests of significance in the two-way ANOVA test. However, the main effect of precipitation amount was found significant at the 1% level ($F(1,2)=36.335$, $p=0.000;0.01$). The interaction between the precipitation and the type of tree species was also found to be significant at the 1% level ($F(1,2)=5.304$, $p=0.005;0.01$). This can be seen in Figure 3 below. In the months that make up Spring and Summer, below average precipitation is associated with the least amount of tree growth, with Virginia pines growing more than white oaks during average precipitation. It appears white oaks cope better with non-average precipitation events, because at below and above average precipitation amounts white oaks grow more than Virginia pines in the Spring and Summer.

Results from Fall/Winter Precipitation Analysis:

In Fall/Winter, the tree species type is not associated with the amount of growth, not passing tests of significance in the two-way ANOVA test. The main effect, precipitation, was found to be significant at ($F(1,2)=3.495$, $p=0.03;0.05$). The interaction between species and precipitation was also significant at ($F(1,2)=2.983$, $p=0.05$). This can be seen in Figure 4 below. In the months of Fall and Winter precipitation, there was little growth at average amounts of precipitation. Virginia pines grow more than white oaks in the below average and average amounts of precipitation. However, there is a stark change in growth effects in above average precipitation. White oaks grow significantly more at above average precipitation than do Virginia pines. In fact, white oaks grow better at above average precipitation than any other precipitation category in the Fall and Winter.

Results from the Yearly Precipitation Analysis:

In a yearly window, it is clearly shown that the least amount of growth occurs with below average precipitation. The main effect, precipitation, was found to be significant at ($F(1,2)=16.820$, $p=0.000;0.01$). The interaction between species and precipitation was also significant at ($F(1,2)=2.482$, $p=0.084;0.10$), as seen in figure 5 below. The Virginia pines gain a bit more growth than white oaks do in

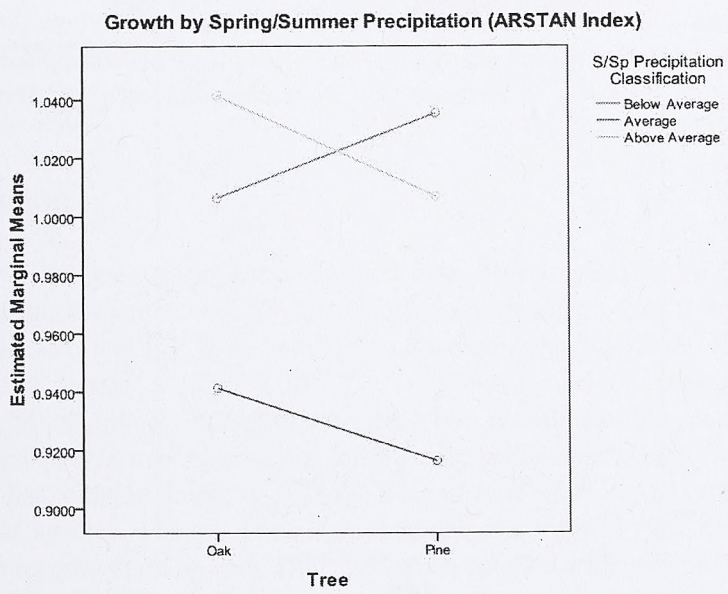


Figure 3: Interaction and main effect for Spring/Summer precipitation and tree growth.

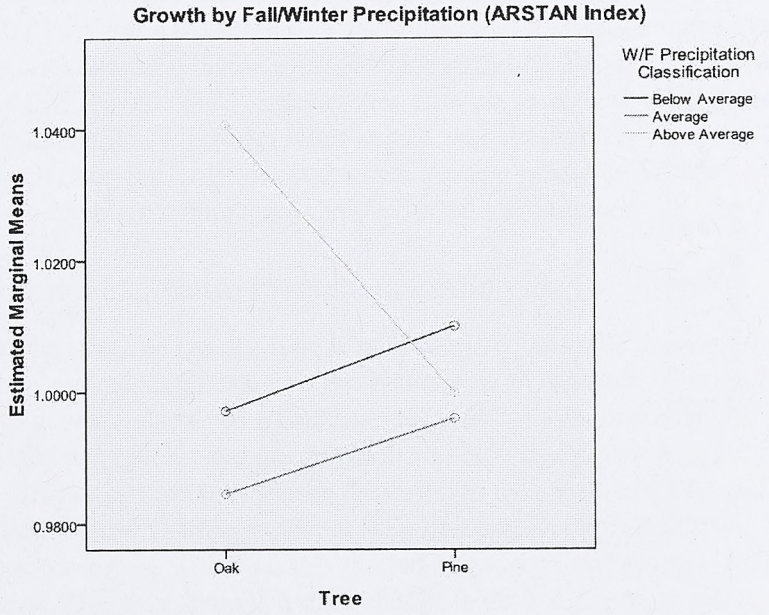


Figure 4: Interaction and main effects for Fall/Winter precipitation and tree growth.

below average precipitation and in average precipitation amounts. The greatest growth occurs at above average precipitation. However, it is important to note that above average precipitation is significantly more effective on white oaks. For Virginia pines, it does not generate much more growth than average precipitation amounts. It could be suggested that Virginia pines reach a precipitation absorption threshold where above average precipitation amounts do not enhance the growth of the tree. While it appears white oaks do not grow well at below average precipitation compared to Virginia pines, it is important to note the Spring and Summer results showing white oaks' ability to grow more than pines at below average precipitation, which is not indicated in the yearly results.

Conclusion

While these analyses are less sophisticated than those run in DendroClim 2002, they also suggest there is a significant association between tree growth and amount of precipitation, and that there may be an interaction among these associations based on tree species.

There is a significant association between tree growth and amount of precipitation. Intuitively, it makes sense that more precipitation equals better tree growth. Seasonal precipitation amounts did have a significant effect on tree growth. The type of tree species, whether a tree is a white oak or a Virginia pine, did not have any effect on growth on its own. However, when coupled with precipitation, there was a significant difference in growth based on the relationship between yearly, Spring/Summer, and Fall/Winter precipitation and the type of tree species. This could be due to the individual species' ability to cope with amount of rainfall in a certain season. Overall, trees grow the least in below average precipitation and the most in above average precipitation. It is important to note that in our yearly analysis, the difference in growth for Virginia pine was small between average and above average precipitation. White oak growth was strongly associated with above average precipitation, growing the most under these conditions. Based on life history traits of white oaks, it could be speculated that the trees were older and perhaps had better situated root systems [2]. Also, due to life history traits, oaks have a higher leaf area than do pines. This suggests that, in times of high precipi-

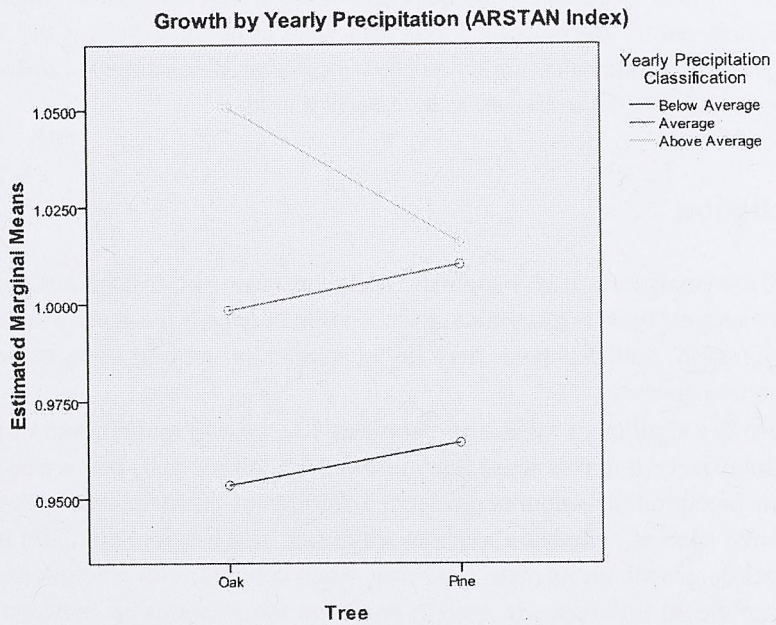


Figure 5: Illustrates the interaction and main effects of yearly precipitation averages and tree growth.

tation, they are capable of transpiring more water. Pines, however, are more likely to conserve water, supplying an advantage in times of low precipitation. Should this be the case, it could be conjectured that white oaks could better handle extensive precipitation amounts as opposed to younger, shallower root systems of Virginia pines.

References

- [1] ARSTAN. Arstan 41d. Tree-Ring Laboratory, Palisades, NY, March 2007.
- [2] Russel M. Burns and Barbara H. Honkala. *Silvics of north america*. Agriculture Handbook, U.S. Department of Agriculture, Washington, DC, Page 877 Volume 2.
- [3] DenroClim2002. Downloaded from <http://woods.geography.unr.edu/dendroclim2002.htm>.
- [4] D. Druckenbrood, M. Mann, D. Stahle, M. Cleveland, and H. Shugart. Late 18th century precipitation reconstructions from James Madisons Montpelier plantation. *American Meteorological Society*, pages 57–71, 2003.
- [5] H.C. Fritts. *Tree Rings and Climate*. Blackburn Press, New Jersey, 2001.
- [6] David S. Moore, George P. McCabe, and Bruce A. Craig. *Introduction to the Practice of Statistics*. W.H. Freeman and Company, New York, 6th edition, 2009.

Student Biography

I am a December 2009 Biology graduate from Longwood University. I was an active member of the Biological Honors Society and spent a full year in the lab and in the field working on the climate science at the Mount Vernon Plantation. I am currently pursuing my Master of Science in climate sciences at Hawai'i Pacific University.

Faculty Biography

M. Leigh Lunsford is an associate professor of mathematics at Longwood University in Farmville, VA. She earned a B.S. in mathematics from Mississippi State University in 1985 and a PhD in applied mathematics from the University of Alabama System (Huntsville) in 1995. Her research interests are diverse, including assessment of student understanding of mathematics and applying mathematics to solve problems in other fields. In her spare time she enjoys cooking (and eating!) gourmet food, gardening, and spending time with her mathematician husband and four cats.

Daniel L. Druckenbrod is an assistant professor of environmental sciences at Rider University in Lawrenceville, NJ. He earned a B.S. in biological sciences at the University of Notre Dame in 1997 and a Ph.D. in environmental sciences at the University of Virginia in 2003. His research uses tree rings, computer models, historical documents, and field surveys to study long-term changes in forests and their environments. His recent projects investigate forest dynamics since the colonial era at historical sites, including George Washington's Mount Vernon Plantation and Thomas Jefferson's Monticello Plantation.

Design and Synthesis of Novel Ion Binding Molecules for Self-Assembly and Sensing Applications

J. Ervin Sheldon

Faculty Mentor: Dr. Christopher Gulgas

Department of Physics

Abstract

In this research, a novel molecule, C_5 , decorated with carboxylic acid, amide, and thiourea functional groups was synthesized via a five-step route. Characterization of the product and each synthetic intermediate was accomplished using $^1\text{H-NMR}$ methods. Compound C_5 was designed for self-assembly in the presence of suitable cation-anion pairs, which represents the next phase of this project. The design of C_5 is discussed herein and incorporates anion and cation-binding domains, where multiple molecules of C_5 represent "legs" of a larger structure. Our design predicts that when the three "legs" are introduced to a lanthanide cation and an anion, the "legs" will twist around these two charged species, forming a helical structure. Upon UV excitation, the energy transfer between the organic ligand and the cation of choice, europium, results in observable luminescence, which can be utilized as a fluorescent signal.

Introduction

Ions are ubiquitous in biological and environmental systems, and are incorporated into many industrial products at a wide range of concentrations. Specifically, sensors that utilize a change in optical properties for signaling are of interest and researched heavily. An ion is a charged atom or molecule. Anions are negatively charged such as Cl^- , Br^- or F^- . Cations are positively charged and usually

consist of metal species such as Eu^{3+} , Na^+ or Mg^{2+} . Cations can be bound by anionic ligands (Figure 1), or negatively charged molecules. Self-assembled triple helical structures have been previously designed and synthesized through the binding of two different cations to two distinct sites. In this project, we investigate whether helical structures can be self-assembled through the use of distinct anion and cation binding sites.

Similar to the manner in which cations are bound, anions can be bound by positively charged species through a phenomenon called hydrogen bonding. In designing a molecular system for ion-dependent self-assembly, there must be separate cation and anion binding regions. A thiourea group (Figure 1), can be used to bind an anion and is very similar to a urea group, except oxygen is replaced with a sulfur atom. In both ureas and thioureas, two hydrogen atoms are in the same plane and pointed in the same direction (Figure 1). The sulfur and nitrogen atoms will draw electron density toward themselves and away from the two hydrogen atoms. This electron movement (dipole) will cause each hydrogen atom to become partially positive. These hydrogen atoms will now form hydrogen bonds to negatively charged anions.

Ion sensing and ion recognition are of interest because ions play many important roles in living organisms. Ion sensing can be useful whenever there is a need to measure ion concentration in a given media. One way to measure ion concentration is qualitatively, with the naked eye. Many sensors or indicators will simply change the color of the solution when ions are present. Fluorescence is another method that measures the amount of light that is emitted from a molecule and is more sensitive and quantitative than colorimetric methods. Fluorimetry, with which anion concentration can be measured using ion sensors, is a particularly valuable technique. However, in order to exploit the benefits of fluorimetry, a fluorescent ion or molecule must be incorporated into the design of the sensor molecule. We have chosen a lanthanide metal ion, Eu^{3+} , both to analyze the cation binding ability of the target structure (Figure 1), and to generate a fluorescent signal to monitor anion binding to the structure.

Much of the current research involves quantitatively measuring metal cations in various media. Metal cations are of interest because of the roles they play in biological processes. The divalent mineral cations Ca^{2+} and Mg^{2+} play many diverse roles in the functions of cells and in extracellular processes. Calcium ions

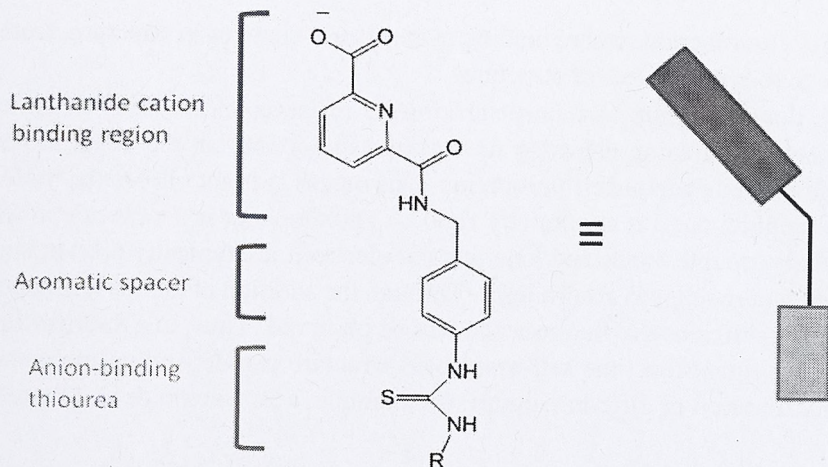


Figure 1: Structure of the organic ligand for dual cation/anion binding and directed assembly.

are essential for a wide variety of biological functions, including vital extracellular processes, such as blood clotting, intracellular adhesion, and skeletal integrity, as well as intracellular processes, such as the regulation of hormonal secretion, cell division, and cell motility. There are many different sensors in use today. Many different shapes and sizes have been investigated to maximize binding constants. For example, to bind metal ions, crown thioethers have been used to position themselves around metal cations. However, for the purposes of this research, anion binding events that lead to self-assembled structures and (potentially) changes in fluorescent behavior are of highest interest.

Investigating the ion binding and sensing abilities of these new structures will be useful for continued research and ligand design, but another main interest in this project is the self-assembly process. The above molecule (Figure 1) represents only one leg of our tripodal molecule. We seek to determine if three of these novel molecules can bind an anion and a Eu^{3+} cation simultaneously, forming a helical structure. This process, called ion-templated self-assembly, is of interest because of how it relates to biological processes. Specifically, self-assembly relates to

how enzymes function, where binding events cause changes in structure, from the active site to higher levels of structure.

The thiourea groups are only substituents of larger molecules. When using fluorimetry as an anion detection device, it is important that the larger molecule be made up of an adequate fluorophore. This means that not only is the molecule a chromophore, but it is structurally rigid. A chromophore is a molecule in which aromaticity, double bonds and lone pairs of electrons are typically present and interact with each other to absorb light. Through the addition of anions it is hypothesized that a difference in fluorescence will be observed. Thus, in a fluorimeter, the fluorescent signal from the self-assembled structure can depend on the presence and concentration of different anions, for example, a Br^- anion or an F^- anion.

Methods

Compound C_1 . Dipicolinic acid (16.69g), H_2O (40mL), benzyl alcohol (115ml), and concentrated H_2SO_4 (5.5ml) was added to a 250ml roundbottom flask. The mixture was allowed to reflux for two hours. NaHCO_3 (800ml) was then added to the mixture in a 2L beaker. The mixture was then extracted twice with dichloromethane (DCM) (800ml portions). The top layer was collected and the bottom layer was the side product diether. The pH of the top layer was then lowered to approximately 3 to precipitate monoester out of solution. The white crystals were collected via Buchner funnel. A third extraction was then run on the mother liquor with DCM (800ml). The aqueous phase (bottom) was collected to obtain extra monoester. MgSO_4 was used to collect water and the remaining solution was rotovaporized. 3.650g of pure crystal (C_1) was yielded. $^1\text{H-NMR}$ (CDCl_3 , 60 MHz) δ_{H} 8.22-8.44 (m, 3H), 7.44 (s, 5H), 5.48 (s, 2H).

Compound C_2 . C_1 was dissolved in DCM (20ml) at 0°C while stirring in a 100ml roundbottom flask. The flask was capped throughout this reaction step. 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC, 1335mg) was added to the stirring solution. A color change from clear to orange was observed almost immediately. The reactants were allowed to mix for 35 minutes. The amine (1000mg) was then dissolved in DCM (10ml) in a separate flask. The dissolved amine was added to the 100ml roundbottom flask, dropwise, over a period of 10 minutes.

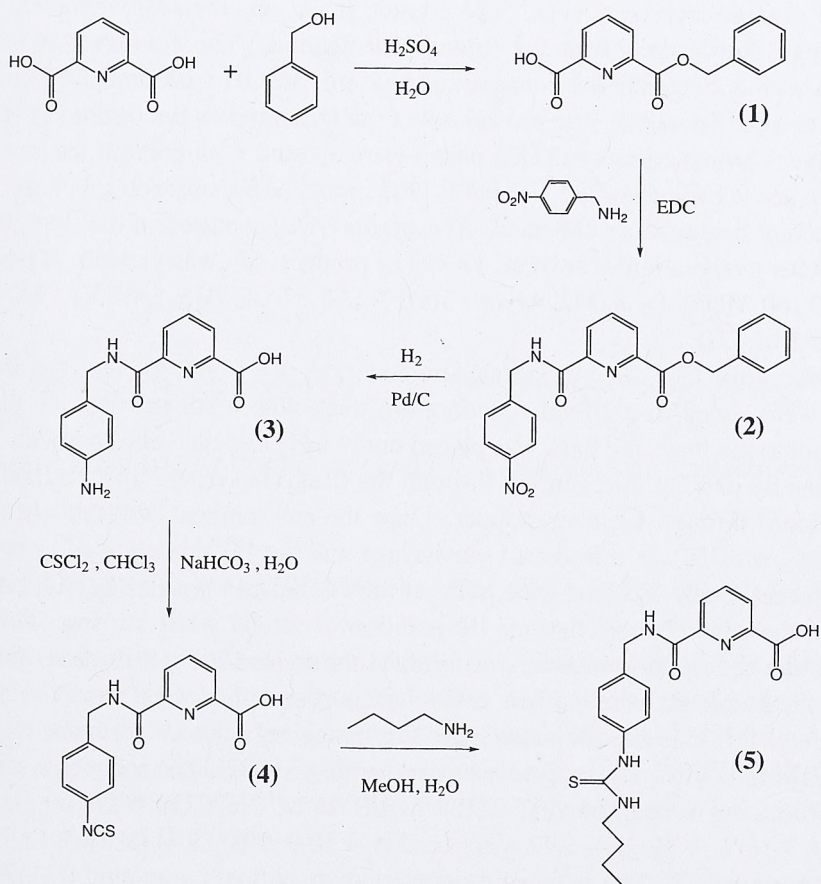


Figure 2: Synthetic scheme for the synthesis of C_5 , the bifunctional strand for helical self-assembly.

This new mixture was allowed to stir for 40 minutes. H₂O (20ml) was then added and the pH was brought down to 4 using 3M HCl. The mixture was extracted and the organic layer was kept. The organic layer was then rotovaporized and the orange powder was kept for column purification. The column was set up and ran with a 2% methanol concentration (20mL MeOH : 1000mL DCM). The yellow colored band that first moved down the column was the desired product. Thin layer chromatography (TLC) plates were spotted with column solvent and tested to see if they absorbed UV light. Once spots began absorbing UV the column solvent began being collected. The product was captured in the first eleven vials. After evaporation of solvent, 1.489g of product, C₂, was yielded. 1H-NMR (CDCl₃, 60 MHz) δ_H 8.00-8.49 (m, 5H), 7.27-7.57 (d, 7H), 5.49-5.43 (d, 2H), 4.71-4.81 (d, 2H).

Compound C₃. The monoester-monoamide, C₂ (1.489g), and the Pd⁰/C (1.4g) were added to a 100ml roundbottom flask with a stirbar. Before adding methanol to the flask, the flask was placed under a N₂ enriched environment. This was done by passing nitrogen gas through the flask via syringe tip (attached to a N₂ balloon) through a rubber stopper. Once the environment was thought to be 100% N₂, MeOH was introduced via syringe and the N₂ was allowed to bubble through the liquid. We then switched out the N₂ balloon with a H₂ balloon and allowed the gas to bubble through the solution overnight while stirring. The following day the reaction mixture was drained through celite in a Buchner funnel. The celite and flask were washed with small portions of MeOH. Once the liquid was free of Pd⁰/C it was rotovaporized. The remaining oil was left under vacuum for 4 days to completely evaporate any remaining MeOH. The reduction yielded about 706.5 mg of compound C₃. 1H-NMR (D₂O w/ Na₂CO₃, 60MHz) δ_H 8.08 (s, 3H), 7.16-7.30 (d, 2H), 6.72-6.86 (d, 2H), 4.50 (s, 2H), 3.34 (s, 1H).

Compound C₄. The reduced monoester-monoamide, compound C₃ (.706g), was added to a mixture of H₂O (50ml) and NaHCO₃ (1.75g) in an attempt to deprotonate and solubilize C₃. At the same time CHCl₃ (150ml) and CSCI₂ (3ml) were added to a 500ml roundbottom flask under stir. To the same 500ml roundbottom, a 10% aqueous solution of NaHCO₃ (100mL), was added dropwise. The first 50mL of H₂O with dissolved C₃ was then added dropwise, very slowly via addition funnel. The mixture was allowed to stir for 2 hours. The aqueous layer was pink and milky. The reaction yielded 240mg of C₄. 1H-NMR (DMSO, 60

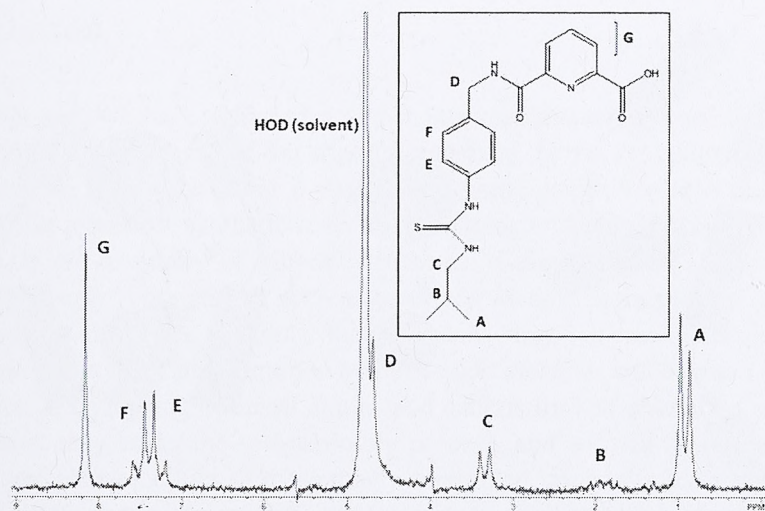


Figure 3: 60MHz NMR of compound C_5 , with hydrogen signals assigned.

MHz) δ_H 8.24-8.29(m, 3H), 7.38-7.42 (s, 4H), 4.54-4.64 (d, 2H), 2.44-2.57 (m, 4H).

Compound C_5 . Iso-butylamine (20mg) was dissolved in MeOH (3ml) and added to C_4 , which was already dissolved in H_2O (2ml) containing Na_2CO_3 (24mg). The vial was swirled around by hand and allowed to sit overnight. The MeOH was evaporated by N_2 flow which yielded 39mg of 5. 1H -NMR (D_2O , 60 MHz) δ_H 8.07 (s, 3H), 7.36 (d, 2H), 7.23 (d, 2H), 4.60 (s, 2H), 3.25 (d, 2H), 1.61-2.13 (m, 1H), 0.83 (d, 6H).

Discussion and Findings

The multistage synthesis yielding compound C_5 started with dipicolinic acid, refluxed with benzyl alcohol and extracted with DCM for a 15.0% yield of compound C_1 . This compound allows only one site on the dipicolinic acid parent structure to be further modified. We then stirred C_1 with the p-nitrobenzylamine

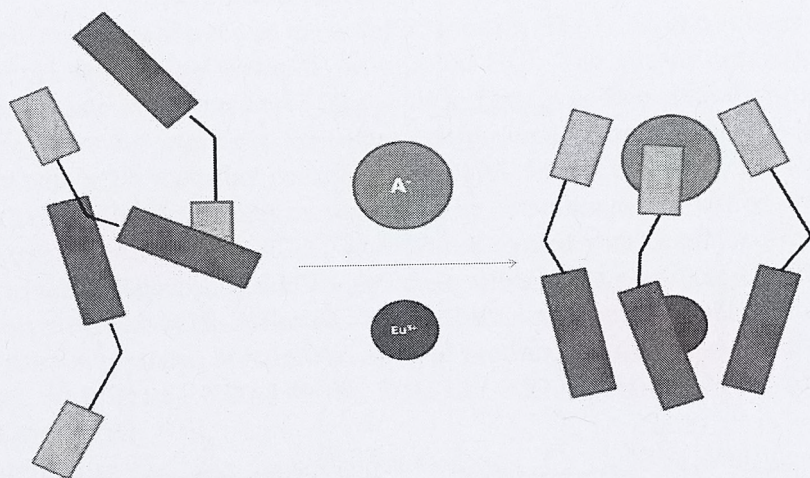


Figure 4: Proposed anion and cation-dependent self-assembly process.

and EDC, followed by silica column purification, for a 55.0% yield of compound C_2 . This intermediate now incorporates an aromatic spacer to begin creating the anion binding site through synthetic chemistry. Next, we took C_2 and reduced it with Pd/C and H_2 gas. This reduction yielded us 51.3% of compound C_3 . This compound is a necessary intermediate in the synthesis of the isothiocyanate group, which is the precursor for the thiourea portion of the target molecule. Additionally, in this reduction step, the cation-binding portion of the structure is formed by cleavage of the benzyl ester group. We then went on to create compound C_4 by stirring C_3 and $CSCl_2$, which yielded 30.5% of a common precursor for generating a family of possible “legs” to study self-assembly. Finally, we wanted to make sure that we could do the necessary chemistry to produce the thiourea portion of the molecule, so we stirred C_4 with iso-butylamine, for a 50.8% yield of compound C_5 . This compound has been successfully characterized by NMR and is a representative molecule of a family of potential “legs” to investigate anion and cation-dependent self-assembly.

Conclusion

In this project we have achieved a viable intermediate and we are ready to begin connecting the "legs" of our tripodal molecule by use of a europium cation. The work we have done so far is essential to future work. We have successfully mapped out a feasible synthetic route for producing a family of molecules to participate in self-assembly of tripodal structures. Compounds $C_2 \dots C_5$ have not been previously reported and are characterized as new molecules. The second phase of this project is to induce the individual "legs" of our molecule to self-assemble into a tripodal orientation when we add an anion and a cation as shown in Figure 4. By adding different anions and cations for self-assembly, we expect to see how they affect the self-assembly process, and we will be measuring the fluorescent characteristics of these newly assembled, tripodal molecules via fluorimetry. Different anions are expected to create varying structures with distinctive fluorescent properties, which may give us the opportunity to use our triple helicates as useful anion sensors.

Acknowledgments

The authors acknowledge the Longwood University Department of Chemistry and Physics for instrumentation and materials in support of this research project.

Student Biography

My name is Jonathon Sheldon and I was born in Elmira, New York. My parents moved to Rockville, Maryland soon after I was born and that is where I spent the majority of my youth. I am currently a chemistry major at Longwood University and I expect to graduate in May 2010. I am a member of the Alpha Chi Sigma fraternity and I plan to go to graduate school to study organic chemistry.

Faculty Biography

Dr. Christopher Gulgas is an assistant professor in his second year at Longwood University. He earned a B.A. in chemistry at the College of Wooster and a Ph.D. in chemistry at the University of Cincinnati, both located in Ohio. Dr. Gulgas teaches organic and inorganic chemistry and has research interests in luminescent lanthanide complexes and sensing materials.

3 Mathematics and Computer Science

A Statistical Analysis of Algorithms for Playing SameGame

Richard Hayden

Faculty Mentor: Dr. Phillip Poplin

Department of Mathematics

Abstract

We developed multiple algorithms that integrate with a simulator that attempts to solve a NP-Complete computer puzzle game, known as SameGame. SameGame consists of a grid composed of colored tiles in which a player removes groupings of two or more tiles, attempting to clear all tiles from the grid. After the development and testing of twenty-four solver algorithms on each of the five-thousand grids, we determined those algorithms that left the least number of tiles in the grid on average. A two one sided significance difference test (TOST) was adopted for determining whether two algorithms were equivalent, and a review of the sample means of each algorithm was ranked from smallest to largest, or best to worst respectively. The algorithm that maximized the ratio of tiles in a group to the total remaining tiles was determined to be the most effective algorithm at minimizing the average number of tiles remaining. [3] [2] [4] [1]

Introduction

SameGame is a simple computer based matching tile game. In the last 25 years multiple variations have been developed; however, the game play and rules have remained the same. The grid, an arbitrarily-sized matrix, is initialized with randomly generated colored tiles (Figure 1(a)). Tiles of the same color connect adjacently, either horizontally or vertically, to one another forms a group. A player clicks on a group to remove the group from the board. Only groups of two or

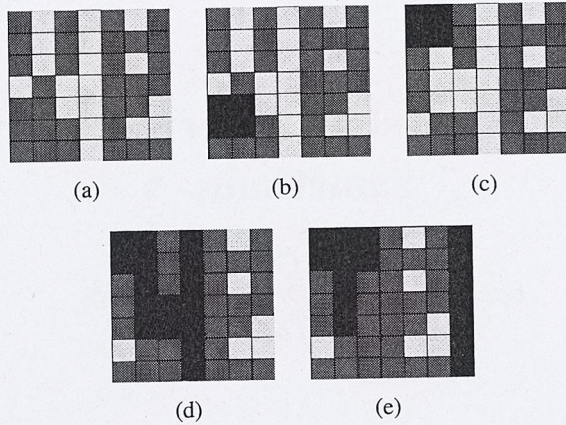


Figure 1: SameGame Tile removal and Gravity

more tiles may be removed. The goal is to minimize the number of tiles left in the grid. The grid utilizes a form of gravity that causes those tiles above the area of a removed group to shift down into the empty spaces (Figures 1(b) and 1(c)). Additionally, when a column in the grid is empty of all tiles all columns to the right shift left (Figures 1(d) and 1(e)).

SameGame is also known as “Chainshot!” and was initially developed in 1985 by Kuniaki Moribe [3], and is considered to be the father of modern match three games, including Bejeweled, Luxor, and Collapse. SameGame’s popularity was renewed with the addition of KSAME in the KDE operating system. Interestingly, sufficiently complex SameGame grids, those with at least two columns and five colors are not only members of the match three family of games, but they are also part of the NP-Complete family of problems [2]. NP-Complete problems are those that, in worst case scenarios, require a super polynomial amount of time find the absolute solution. As a result, this seemingly simple game of tile removal is actually extremely complex.

Methodology

Due to the NP-Complete characteristic of SameGame, developing an algorithm that will find an absolute solution, to any arbitrary starting grid every time is impossible if the grid is sufficiently large. Therefore, we wished to develop several algorithms that would remove as many tiles from a given grid as possible. Therefore, we developed strictly heuristic algorithms that found only approximate solutions by looking at specific factors and using well defined methods [4]. Once the algorithms were fully developed and coded it was necessary to evaluate each algorithm equally which required the development of a simulator. The simulator not only generated random SameGame grids but also used each algorithm and provided quantifiable data used for evaluation. Once the algorithm's development and simulation was complete we used statistical analysis to determine which, if any, of the algorithms was considered to be the "most effective" The most effective s the algorithm which left the smallest number of tiles in a grid on average. While it would be advantageous if every grid was fully solvable (meaning zero tiles remaining), the simulator does not guarantee this characteristic. Therefore, instead of comparing algorithms to an absolute minimum, algorithms are compared to one another.

Algorithms

A total of twenty-four algorithms were developed and tested. Once developed, the algorithms were coded in C++ and were integrated with the SameGame simulator. We will discuss eight of these algorithms in further detail since each uses different techniques to solve SameGame grids.

Algorithm One: Evaluation is based on a predefined path and an initial location. It begins by attempting to remove the group containing the tile in the top left corner and subsequently checks each tile along the rows of the grid from left to right and top to bottom. Once the grid has been completely traversed, the algorithm restarts at the initial location. This process continues until the grid has been exhausted of all groups.

Algorithm Two: Identical to Algorithm One except it begins at the bottom left tile and moves bottom to top.

Algorithm Three: Identical to Algorithm One except every time a group is removed it starts over at the initial position. This process continues until all groups have been exhausted.

Algorithm Four: Identical to Algorithm Three except it begins at the top right and moves left.

Algorithm Five: This algorithm looks one step ahead; every group in the grid is evaluated by looking at how the grid responds if that group is removed. The group selected to be removed will be the one that generates the highest ratio of tiles in a group to the total number of tiles. This is repeated until all groups have been exhausted.

Algorithm Six: Evaluation is determined by selecting the smallest group of tiles that is closest to the top left of the grid. This is repeated until all groups have been exhausted.

Algorithm Seven: Evaluation is determined by a random number generator that is used to select an arbitrary group in the grid. This is repeated until all groups have been exhausted.

Algorithm Eight: Evaluation begins at the bottom left tile and moves vertically and to the right. Each time a group is removed, it starts over at the initial tile. This is repeated until all groups have been exhausted.

Simulator

Our SameGame simulator uses the standard C++ random number generator for assigning one of five random colors to each of the tiles in a grid. Then a user specifies which algorithm should be used in order to remove the groups in the grid and attempting to completely remove every tile. Once all the groups have been exhausted from a grid, the simulator returns the number of tiles remaining for that specific board. In addition to the user specifying which algorithm to use, the user may alter the dimensions of the grid, the number of colors to be used, and the number of trials to run. It is important to note that this simulator by no means generated strictly solvable grids.

Design

We analyzed 15 by 15 grids with tiles colored with one of five possible colors. This satisfies the complexity requirements for each grid to be considered an NP-Complete problem [2]. We pooled a sample size of 5000 grids and had each algorithm evaluate each grid. This allowed us to make conjectures based on comparative data, and allowed for an experiment that used a matched pairs design. That is a design where each algorithm was compared to each other algorithm in a pairwise format.

A **Two-One-Sided-Test (TOST)** of equivalence procedure was adopted in order to determine which algorithms would be considered equivalent [1]. Thus, we made judgments on those algorithms whose means were extremely close and reduced the number of mean comparisons. Following the TOST procedure, we considered the individual means of each algorithm in order to rank the algorithms from best performance on average, to worst performance on average.

Analysis

During the course of the analysis several assumptions were made. We assumed that the outcomes of the TOST procedure are valid, even though the algorithms cannot be assumed to be independent, since they were used on the same set of boards. The histograms for each of the algorithm's number of tiles remaining was unimodal and fairly symmetric. Additionally, the QQ-plots showed little deviation from normality, which supports the normality assumption. Lastly, we allowed a magnitude of difference of no greater than one tile for two algorithms to be considered equivalent because the number of tiles remaining must be a non-negative integer, and a difference in two averages of that amount to a value of less than one may not show any difference in the algorithms.

After data was collected from the simulator it was necessary to look at the sample statistics and how the number of tiles remaining was distributed for each algorithm. Although we ran the simulator for all 24 algorithms, we will only look at the outcomes of the eight representative algorithms, which include the more impressive algorithms. We first used the statistical software package R to generate Boxplots of the number of tiles remaining, for each algorithm, to see if

any obvious visual differences were noticeable (Figure 2).

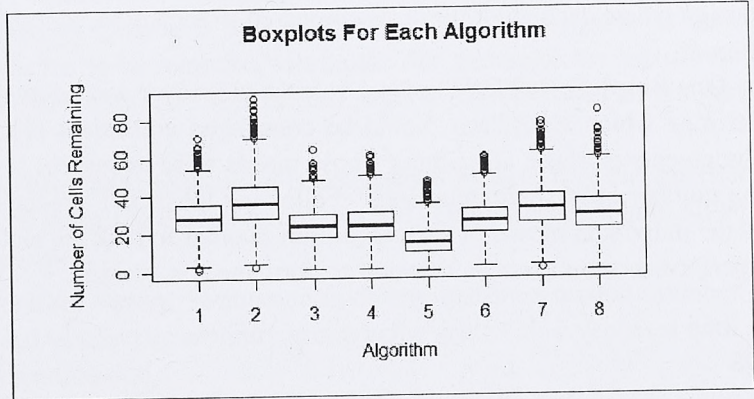


Figure 2: Comparative Graph of Each Algorithm's Boxplot

Obviously, we can tell that some algorithms are better than others, with algorithm five appearing at first glance to be the best; that is, it has the least number of tiles remaining. However, it is also of note to see that some of the algorithms (i.e. three and four) seem to be too close to draw an immediate conclusion. Next, we wish to determine how the data is distributed and for that we use histograms and QQ-plots. Consider algorithm one's histogram (Figure 3) and QQ-plot (Figure 4):

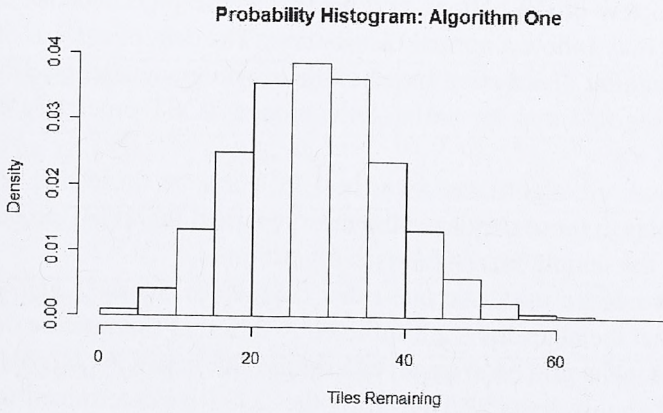


Figure 3: Histogram of Data for Algorithm One

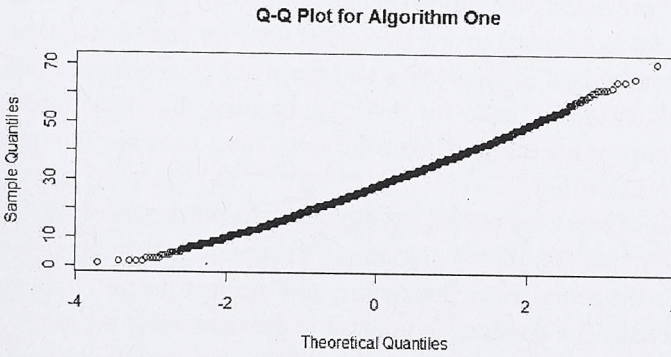


Figure 4: QQ-Plot for Algorithm One

The data in the histogram seems to be unimodal and exhibits little skewness to either the right or left. Additionally, the qqplot seems to be fairly linear with

the exception of a few of the bottom data points. These plots indicate the data for algorithm one may follow a normal distribution. The data of each of the other algorithms has a similar distribution based on their histograms and qq-plots, thus indicating normality and making the aforementioned TOST procedure a viable test for this data.

In order to rank the algorithms from best to worst, or those that leave the least number of tiles to those that leave the most, we used the TOST procedure in conjunction with the sample means for each algorithm.

The TOST procedure uses two one-sided confidence intervals and tests the null hypothesis that the algorithms are sufficiently different (in our case one more or one less tile left in the grid on average) against the alternative hypothesis that the two algorithms are equivalent [1]. Thus using the TOST we determined which algorithms actually differed and which algorithms were sufficiently similar to claim equivalence. We then used the mean to rank the algorithms.

In order to use the TOST procedure we had to determine two parameters. First, we used an alpha level of 0.05 which is the probability of rejecting the null hypothesis when it is actually true. Second, we used the allowable difference or magnitude which previously mentioned is one. Due to the nature of the test, being a two one-sided test as opposed to one two-sided test, our confidence level is 0.90. This test is frequently used in biometrics and the study of pharmaceutical effects. Therefore, it was an ideal choice for this data because the algorithms could be considered a treatment on the grid, and the remaining tiles are the quantifiable outcomes of each algorithm.

The table below provides several examples of the outcomes of the TOST test which includes the two algorithms compared, the confidence interval for the difference of means, the actual mean difference, and whether the null hypothesis was accepted or rejected. The confidence interval is the parameter we use to evaluate whether we accept or reject the null hypothesis. We reject the null hypothesis for those algorithms that have a confidence interval entirely between -1 and 1, and fail to reject the algorithms that have a confidence interval outside of $[-1,1]$.

As it seen in Table 1, algorithms three and four are considered equivalent, which one may conjecture from the boxplot shown earlier. However, other pairings that seem equivalent from the boxplot (Figure 2) actually fail the test of equivalence. We now determine the mean which is summarized in Table 2.

Algorithms Tested	Mean Difference	Confidence Interval	Rejected or Not Rejected
One and Two	-8.2298	[-8.597512, -7.862088]	Not Rejected
Three and Four	0.0078	[-0.289826, 0.3054263]	Rejected
One and Five	2.339	[2.024236, 2.653764]	Not Rejected
Five and Seven	-17.6868	[-18.00951, -17.36409]	Not Rejected
Two and Eight	7.024	[6.642596, 7.405404]	Not Rejected

Table 1: Example Outcomes of TOST Procedure

Algorithm	1	2	3	4	5	6	7	8
Mean	28.5	36.73	24.48	24.47	15.39	26.16	33.08	29.78
Standard Deviation	9.888	12.33	8.968	9.124	7.784	9.235	11.48	10.55

Table 2: Mean and Standard Deviation of Number of tiles Remaining for each Algorithm

Based on the TOST and the mean number of tiles left we ranked the algorithms. Algorithm five is considered the best having a mean number of tiles left at 15.39. Algorithms three and four are second due to their equivalence. Algorithm six ranks in third with mean a of 26.16. Algorithm one takes fourth with a mean of 28.5, Algorithm eight ranks fifth with a mean of 29.78. Algorithm seven ranks in sixth with a mean of 33.08. Algorithm two ranks in last with mean of 36.73 tiles remaining.

Conclusions

Algorithm five is the best of all eight because it has the smallest mean for the number of tiles remaining. I conjecture that this is due to the nature of the algorithm; it acts as a greedy algorithm would act, by selecting the group that generates the highest ratio of tiles in a group to total tiles. It limits the amount of chaotic behavior that is caused by removing groups. It selects the group that groups the most tiles for the following removal, thus limiting the amount of broken groups. This conjecture is further supported by the fact that algorithms three and four's rank is equivalent and rank in second place. While they are simpler and do not directly look at the ratio of tiles in groups to total number tiles, they do act on the top of the grid. The top of the grid is the area that seems to disrupt the grid the least. Groups that are at the bottom and middle of the grid are unaffected until the groups at the top are eliminated, reducing chaotic behavior in the grid. The remaining Algorithms are ineffective compared to these three.

Therefore, we would conclude that while NP-Complete problems are impossible to evaluate every time for arbitrary inputs and a significantly complex problem (in our case a 15 x 15 grid), choosing an appropriate evaluation algorithm drastically increases the likelihood of determining a viable solution. Skeina [4] states that when it comes to time constraints, heuristics will often find a solution to the problem but one cannot be sure if it is the best solution. We would argue that, as people develop more and more algorithms to solve such a problem, eventually new patterns emerge that provide the means to find better solutions.

Future Work

Through the course of this study several questions and opportunities for further research came up. Many versions of SameGame and variants not only evaluate a success based on tiles left but also on an accumulated score. Do those algorithms that are effective for reducing the number of tiles also generate a higher score? We also tested a grid that was 15 x 15 tiles in dimension, so would increasing or decreasing the dimensions effect how the algorithms were ranked? Does increasing or decreasing the number of colors assigned to the tiles make some algorithms more effective than others? Lastly, based on how the algorithms we tested succeeded, are there additional algorithms that we could develop that would further reduce the number of tiles left?

Acknowledgements

I would like to thank my research advisor Dr. Poplin for taking a genuine interest in this subject area and never for one second letting up on the pressure. His guidance and suggestions allowed a finished project to come to fruition. Taking the time to discuss and question every idea and step of progress I made was at times frustrating but always appreciated. Dr. Marmorstein was an invaluable resource when it came to brainstorming new programming ideas. Furthermore the entire mathematics and computer science department were always supportive and listened to my ramblings during the entire process of the research. Thank you all.

References

- [1] L. Barker, E. Luman, M. McCauley, and S. Chu. Assessing equivalence: An alternative to the use of difference tests for measuring disparities in vaccination coverage. *American Journal of Epidemiology*, 156:1056–1061, 2002.
- [2] T. Biedl, E. Demaine, M. Demaine, R. Fleischer, L. Jacobsen, and J. Munro. The complexity of clickomania. *MSRI Publication*, 42, 2002. Cambridge University Press.

- [3] J. Juul. Swap adjacent gems to make sets of three: A history of matching tile games. *Artifact Journal*, 2, 2007.
- [4] S. Skiena. *The Algorithm Design Manual*. Springer-Verlag, New York, 2nd edition, 2008.

Student Biography

I transferred to Longwood University in 2007 and declared my major in Mathematics. I will graduate in December 2009, with a Bachelors of Science in Mathematics. While I enjoy pure theory coursework, I have taken a great deal of pride in writing computer programs to solve math problems in the applied courses. It has become a passion. I hope to continue this line of work and study following graduation.

Faculty Biography

Dr. Phillip Poplin is an Associate Professor of Mathematics at Longwood University. He earned his B.S. degree from University of North Carolina – Charlotte, his M.A. in Mathematics from Appalachian University and his Ph.D. in Mathematics from North Carolina State University in Raleigh, NC. He has been at Longwood University since 2003. Before coming to Longwood University, he taught at Wake Technical Community College and North Carolina State University.

Intersecting Cylinders at Arbitrary Angles

Yuri Calustro

Faculty Mentor: Dr. Phillip Poplin

Department of Mathematics and Computer Science

Abstract

In the second semester of calculus, students learn to find the volume of solids using integration. It is common practice to further explore this concept by finding the volume of the intersection of two cylinders that intersect at right angles. This research examines an extension of this problem, that the two cylinders do not intersect at a right angle, but rather an arbitrary angle, α . After determining the equations and limits for two cylinders of the same radius, r , intersecting at an arbitrary angle, α , the volume of the intersection is calculated through integration. This knowledge may be applied in determining the total volume of a chain of n cylinders in which two cylinders intersect at each joint. The figure created will resemble a regular n -sided polygon, represented by a series of pipes connected at various angles.

Introduction

In Calculus, students are presented with various solids of increasing complexity and asked to compute their volumes. One of the intermediate examples during this sequence is that of intersecting cylinders of equal radius that intersect at right angles [1]. With the first cylinder centered along the z -axis and the second along the x -axis, we can express the equations of the two cylinders with equation (1) and equation (2), respectively, where r represents the radius of each cylinder.

$$x^2 + y^2 = r^2 \tag{1}$$

$$y^2 + z^2 = r^2 \tag{2}$$

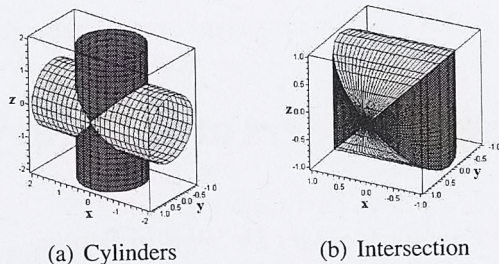


Figure 1: Two Perpendicular Cylinders

Since both cylinders are centered along their respective axis, their intersection will be centered at the origin, as seen in Figure (a). In order to determine the volume of this intersection, illustrated in Figure (b), we must determine the bounds for our variables with respect to our cylinders. By solving for z in equation (2) and x in equation (1), we determine the bounds for each variable as:

$$\begin{aligned}
 -\sqrt{r^2 - y^2} < z < \sqrt{r^2 - y^2}, \text{ with } -r < y < r \\
 -\sqrt{r^2 - y^2} < x < \sqrt{r^2 - y^2}, \text{ with } -r < y < r.
 \end{aligned}$$

Using these limits of integration we can calculate the volume in terms of the radius of the cylinder.

$$\begin{aligned}
 V &= \int_{-r}^r \int_{-\sqrt{r^2 - y^2}}^{\sqrt{r^2 - y^2}} \int_{-\sqrt{r^2 - y^2}}^{\sqrt{r^2 - y^2}} dz \, dx \, dy = \int_{-r}^r \int_{-\sqrt{r^2 - y^2}}^{\sqrt{r^2 - y^2}} 2\sqrt{r^2 - y^2} \, dx \, dy \\
 &= \int_{-r}^r 4(r^2 - y^2) \, dy \\
 &= \frac{8}{3}r^3 + \frac{8}{3}r^3 = \frac{16}{3}r^3
 \end{aligned}$$

This is a popular example of a triple integral used to find the volume of intersecting cylinders such that both have equal radii. We now ask: what would we expect if the two cylinders, resembling those in Figure (a), were not perpendicular? How would this change the volume of their intersection, shown in Figure (b)?

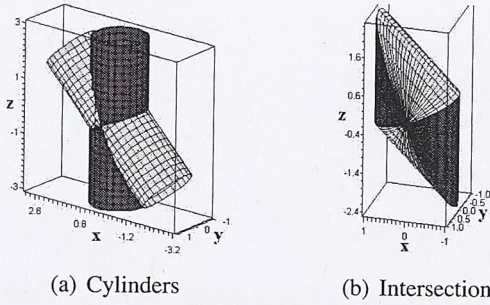


Figure 2: Two Non-Perpendicular Cylinders

In this article we will illustrate the construction of these non-perpendicular cylinders, represent their intersection, and discuss the relationship between the angle formed by two cylinders and the volume of the intersection.

Constructing the Cylinders C and C_α

The cylinder expressed in equation (1) will be used to represent C , a given stationary cylinder centered along the z -axis. A second cylinder of equal radius, represented by C_α , will intersect C at an arbitrary angle, α , measured from the z -axis towards the x -axis in the first quadrant of the xz -plane such that the center of C_α passes through the origin. We note that for any angle $\alpha > \frac{\pi}{2}$ it will have a supplementary angle, q , such that $0 < q < \frac{\pi}{2}$, and thus we could let $\alpha = q$ and calculate the same volume. This allows us to determine the bounds for α , $0 < \alpha < \frac{\pi}{2}$, without restricting its domain.

As an example of the relationship between the cylinder, r , and α , a cross-section is taken of the yz -plane of C_α such that $r = 1$ and $\alpha = \frac{\pi}{3}$. This creates an ellipse centered at the origin, as seen in Figures (a) and (b).

In order to further show this relationship, another cross section is taken in the xz -plane such that three parallel lines are formed by the top line of C_α , center axis of C_α , and bottom line of C_α as seen in Figure (a). By comparing Figures (a), (b), and (a) we see that C_α is composed of a series of ellipses of the same size and

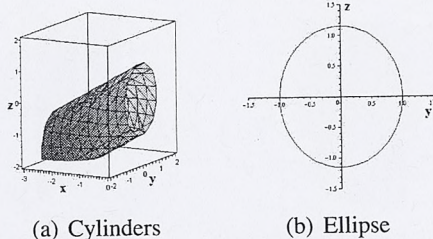


Figure 3: Ellipse Created by Cross-Section of C_α in the yz -Plane

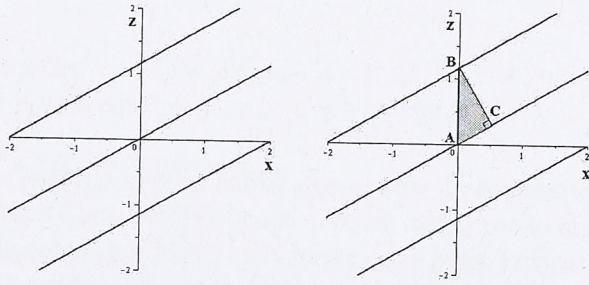
shape expanding in the positive and negative x -direction along the center axis of C_α . In general, we can show how the equation for C_α is dependent on α and r . Since the center of C_α is in the xz -plane, any point on the line will have a y -coordinate of zero. Thus, since any point on the cylinder is a minimum distance r away from the center axis and any ellipse formed by a cross section will have a y -coordinate of zero, it is seen that the minor radius of the ellipse is r . Now, we must determine the relationship of α and r to the major radius of the ellipse and the slope of the center axis of C_α .

We start by creating a right triangle ABC , shown in Figure (b), where A is the origin, B is the intersection of the top line of C_α and the positive z -axis, C is the point on the center axis of C_α in quadrant I such that $\angle ACB$ is a right angle, and $\angle BAC = \alpha$. It is also worth noting that since \overline{BC} is perpendicular to the center axis of C_α , we know that $\overline{BC} = r$. Using the Law of Sines, we can then determine the major radius, shown as \overline{AB} in equation (3).

$$\frac{r}{\sin(\alpha)} = \frac{\overline{AB}}{\sin\left(\frac{\pi}{2}\right)}$$

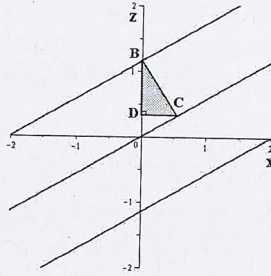
$$\overline{AB} = \frac{r}{\sin(\alpha)} \quad (3)$$

The next major component of the equation is determining the slope of the center axis of C_α . This can be calculated by creating another triangle, BCD as seen in Figure (c), where D is a point on the z -axis such that \overline{DC} is perpendicular to the z -axis and $\angle BCD = \alpha$. Thus, by finding the negative inverse of the slope



(a) Cross-Section

(b) $\triangle ABC$



(c) $\triangle BCD$

Figure 4: Parallel Lines Created by Cross-Section of C_α in the xz -Plane

of \overline{BC} , or m_{\perp} , we are able to find the slope of the center axis of C_{α} , or m , shown in equation (4).

$$\begin{aligned} \frac{r}{\sin(\frac{\pi}{2})} &= \frac{\overline{CD}}{\sin(\frac{\pi}{2} - \alpha)} & \frac{r}{\sin(\frac{\pi}{2})} &= \frac{\overline{BD}}{\sin(\alpha)} \\ r \cos(\alpha) &= \overline{CD} & r \sin(\alpha) &= \overline{BD} \\ m_{\perp} &= \frac{-\overline{BD}}{\overline{CD}} = \frac{-r \sin(\alpha)}{r \cos(\alpha)} = -\tan(\alpha) \\ m &= \cot(\alpha) \end{aligned} \tag{4}$$

As previously mentioned, we can now define C_{α} as a series of sliding ellipses. In the general form of an ellipse, given in equation (5), a and b represent the major and minor radii, respectively; h represents the shift of the center along the z -axis; and k represents the shift of the center along the y -axis. Also, since the center shifts in the x -direction as it shifts in the z -direction from the origin, $(0, 0)$, with a slope of m , we let $h = mx$. Note that equation (6) represents an ellipse, with minimum and maximum radii in terms α and r , expanding from the yz -plane such that the center shifts along a slope determined by α as x increases and decreases.

$$\frac{(z - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1 \tag{5}$$

$$\frac{(z - \cot(\alpha)x)^2}{\left(\frac{r}{\sin(\alpha)}\right)^2} + \frac{y^2}{r^2} = 1 \tag{6}$$

The Volume of the Intersection

Given the equations for C and C_{α} in equation (1) and equation (6) respectively, we must determine the limits of integration for x , y , and z in order to find the volume. By solving for x in equation (1) and z in equation (6) we have the following bounds:

$$-\sqrt{r^2 - y^2} < x < \sqrt{r^2 - y^2}, \text{ with } -r < y < r$$

$$\cot(\alpha) - \sqrt{\frac{r^2 - y^2}{\sin(\alpha)^2}} < z < \cot(\alpha) + \sqrt{\frac{r^2 - y^2}{\sin(\alpha)^2}}, \text{ with } -r < y < r.$$

This creates the triple integral used to calculate the volume of the intersection.

$$V = \int_{-r}^r \int_{-\sqrt{r^2 - y^2}}^{\sqrt{r^2 - y^2}} \int_{\cot(\alpha)x - \sqrt{\frac{r^2 - y^2}{\sin(\alpha)^2}}}^{\cot(\alpha)x + \sqrt{\frac{r^2 - y^2}{\sin(\alpha)^2}}} dz dx dy$$

Evaluating the above integral, the volume of the intersection of any two cylinders at an angle α with equal radii, r , is given by equation (7).

$$V(\alpha, r) = \frac{16r^3}{3 \sin(\alpha)}, \text{ with } 0 < \alpha < \frac{\pi}{2}, r > 0 \quad (7)$$

We note that by letting $\alpha = \frac{\pi}{2}$ we get the same result discussed at the beginning where it was observed that the intersection of two perpendicular cylinders would result in the same answer: $V = \frac{16r^3}{3}$

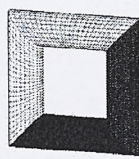
A Chain of Intersecting Cylinders

Consider a chain of n intersecting cylinders used to create an n -sided regular polygon akin to a series of congruent tubes connected pairwise at angle α . A regular polygon is defined as a polygon that has all sides equal and all interior angles equal.

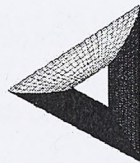
For a regular n -sided polygon with cylinders as sides, each interior angle is

$$\alpha = \frac{\pi(n - 2)}{n} = \pi - \frac{2\pi}{n}, \text{ for } n \geq 3.$$

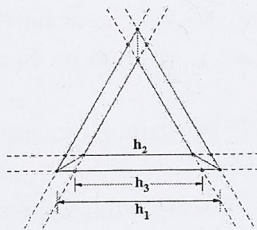
By using a plane to bisect the angle formed at the joint of two cylinders, each side of the geometric figure becomes a cylinder bound by planes on either end. As seen in Figure (b), this cross section is an isosceles trapezoid. An isosceles trapezoid is defined as a trapezoid where the non-parallel sides are of equal length and both angles on either of the parallel sides are equal. This trapezoidal cylinder, C_t , whose cross-section is shown in Figure (c), has a base length of h_1 , a length



(a) 4-Sided Polygon



(b) 3-Sided Polygon



(c) Cross-Section of 3-Sided Polygon

Figure 5: N -Sided Regular Polygons composed of Intersecting Cylinders

of h_2 for the top of the trapezoid, and acute interior angles of $\frac{\alpha}{2}$. Furthermore, the length h_3 defines the length between intersecting cylinders on the exterior of the polygon at opposing ends of each trapezoidal cylinder.

Assuming all cylinders have equal radii, it is possible to determine the total volume of a regular n -sided polygon by summing the volume of each of the n trapezoidal cylinders. It can be shown, using Calculus, that the volume of each C_t is given by:

$$V_t = \pi r^2 \left(\frac{h_1 + h_2}{2} \right) \quad (8)$$

Since it can be shown that α and h_2 are dependent on the radius and number of sides, it is possible to rewrite equation (8) in terms h_1 , r , and n . Note that we have already determined that $\alpha = \frac{\pi(n-2)}{n} = \pi - \frac{2\pi}{n}$. For equation (8), we create a

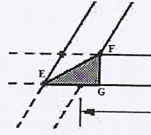


Figure 6: Triangle EFG

triangle $\triangle EFG$ in the bottom left corner of Figure (c), shown in Figure 6, such that \overline{EF} is the diagonal on which the two intersecting cylinders are separated by a plane, $\angle FEG$ is $\frac{\alpha}{2}$, and \overline{EG} is half the difference between h_1 and h_2 .

By solving for \overline{EG} we can calculate h_2 in terms of h_1 .

$$\tan\left(\frac{\alpha}{2}\right) = \frac{2r}{\overline{EG}}$$

$$\overline{EG} = \frac{2r}{\tan\left(\frac{\pi - \frac{2\pi}{n}}{2}\right)} = \frac{2r}{\cot\left(\frac{\pi}{n}\right)}$$

$$\overline{EG} = 2r \tan\left(\frac{\pi}{n}\right)$$

Then, since \overline{EG} is half the difference between h_1 and h_2 , we can rewrite h_2 , as seen in equation (9).

$$h_2 = h_1 - 2\overline{EG} = h_1 - 4r \tan\left(\frac{\pi}{n}\right) \quad (9)$$

By substituting this new value into equation (8), we are given equation (10), a new equation for determining the volume of the trapezoidal cylinder.

$$V_t(r, n, h_1) = \pi r^2 \left(h_1 - 2r \tan\left(\frac{\pi}{n}\right) \right) \quad (10)$$

Therefore, the total volume of an n -sided polygon composed of cylinders can be calculated in terms of h_1 , r , and n , as shown in equation (11).

$$V = n \cdot V_t(r, n, h_1)$$

$$V(r, n, h_1) = n\pi r^2 \left(h_1 - 2r \tan \left(\frac{\pi}{n} \right) \right) \quad (11)$$

Lastly, we must consider the bounds for which a solution exists. In the case of $n = 3$, or three connected cylinder forming an equilateral triangle seen Figure (b), since α is an acute angle, the smallest length on a given trapezoidal cylinder will be h_2 . This means that in order to have a valid solution, $h_2 > 0$, and thus, by using equation (9), it must hold that $\frac{h_1}{r} > 4 \tan \left(\frac{\pi}{n} \right)$ the case of $n \geq 3$.

Future Work

In the ordinary problem of two perpendicular intersecting cylinders, the next most common steps are to calculate the volume of the intersection with a third cylinder intersecting at right angles relative to the first two or to calculate the volume of two cylinders with different radii. One of the main reasons for considering intersections for perpendicular cylinders with equal radii is that the symmetry created allows for easy calculations. This idea could be generalized to the problem of finding the volume of three intersecting cylinders at arbitrary angles and radii. Using the cylinders C and C_α , developed above, a third cylinder, $C_{\beta\gamma}$, can be included such that the center axis is β radians away from the positive x -axis towards the yz -plane and γ radians away from the positive z -axis towards the xy -plane. This method could be generalized further to find the volume of an arbitrary number of intersecting cylinders of varying radii.

Acknowledgements

I would like to thank my mentor, Dr. Poplin, for his guidance throughout this research and for helping me discover a deeper fondness for a discipline often met with spite. Without your guidance this wonderful opportunity would not have been possible. I would also like to thank my former supervisor Trent Armitage for quitting the political campaign on which I would have done an internship in place of this research.

References

- [1] James Stewart. *Single Variable Calculus*. Thomson Brooks/Cole, CA, 3rd edition, 2005.

Student Biography

I am a senior Mathematics Major and Economics Minor from Arlington, Virginia. I will graduate in May 2010 and plan to attend graduate school to earn a Master's Degree in Economics. I was once told I enjoy Math too much.

Faculty Biography

Dr. Phillip Poplin is an Associate Professor of Mathematics at Longwood University. He earned his B.S. degree from University of North Carolina – Charlotte, his M.A. in Mathematics from Appalachian State University and his Ph.D. in Mathematics from North Carolina State University in Raleigh, NC. He has been at Longwood University since 2003. Before coming to Longwood University, he taught at Wake Technical Community College and North Carolina State University.

4 The Social Sciences

Putting a Foot in the Revolving Door: Strategies for Reducing Teacher Attrition

Candice Fleming and Rebecca Franklin
Faculty Mentor: Dr. Lee D. Millar Bidwell
Department of Social Sciences

Abstract

The number of teachers leaving the profession each year is alarming. Teacher attrition contributes to a shortage of teachers nationwide and drains schools of talented classroom instructors. Teacher attrition has become such a problem that at least one author has dubbed the teaching profession a “revolving door.” In this paper many factors that contribute to the high rate of teachers leaving the profession are identified, including the demands of the No Child Left Behind Act, teacher burn-out, lack of administrative support, low funding, low pay, and poor job environment. Along with identifying the obstacles to teacher retention, we propose solutions to the problems that create the revolving door, including modifying the No Child Left Behind Act, professional development, support groups, induction programs, instructional leadership and improving new teacher recruitment.

Introduction

“The United States is currently facing a teacher retention crisis” [15]. The high rate of teacher turnover significantly contributes to the national teacher shortage [18][9]. Statistics abound that document the high rate of turnover within the teaching profession and show that attrition within the teaching profession is much higher than in other occupations. According to the Bureau of National Affairs, over the past decade employee departures from most occupations average about

11.9 percent per year; however, attrition within teaching over the same time period ranges from 13.2 to 15.7 percent annually [9]. Across the board, teachers are leaving the profession in record numbers, yet the problem is most evident among new teachers. Within the first five years of teaching, between 40 and 50 percent of teachers leave the profession [11]. Gonzalez, Brown and Slate [5] found "one out of every five beginning teachers leave the profession after the first year" (p.1). The high attrition among teachers has led Ingersoll to dub the teaching profession a "revolving door." Teacher attrition creates many problems in the educational system. Administrators spend much time, energy and money recruiting teachers, only to see them leave. Attrition strains those teachers who remain in the profession, as unfilled positions contribute to overcrowded classrooms and the few remaining senior faculty members are called upon to shoulder the leadership responsibilities that less experienced teachers are not yet ready to assume. Most importantly, student achievement is hindered by the higher teacher-student ratios resulting from unfilled, vacated positions. Smaller class size contributes to "substantial gains" in student test scores [1]. The purpose of this paper is to identify factors that contribute to the high rate of teacher attrition, and offer ideas for improving teacher retention to ultimately provide students with the most talented and motivated educators available.

Problems

Government Policies: No Child Left Behind Act

Over the last twenty years, education has undergone massive amounts of reform. Most recently the No Child Left Behind Act has created new regulations demanding that standardized tests be used to measure student knowledge and achievement and hold teachers and schools accountable. The tests are beneficial as a way of monitoring student success, but Farber [4] explains, "teachers are continuously reminded and excoriated for their failures, but they are rarely praised for their successes" (p.58). If the student does not pass, the teacher is often blamed. With standards that must be taught, teachers are pressed to incorporate more material into an already cramped curriculum and feel they have little say in what they teach and how they can teach in their classrooms.

One of the provisions mandated under the No Child Left Behind Act is that all teachers must be “highly qualified” by the end of the 2005-2006 school year. According to the No Child Left Behind Act, teachers who are “highly qualified” must “have at least a bachelor’s degree and demonstrate competencies in each content area as defined by their state” [22]. Under all these strict requirements, many people will choose to pursue other professions, which ultimately will reduce the number of highly qualified teachers. In short, the demands of the No Child Left Behind Act limit teachers’ autonomy and interfere with job satisfaction, which may deter many possible candidates from the teaching profession, and contributes to teacher turnover.

Teacher Burnout

Farber believes that one of the main reasons that teachers are leaving the profession is due to teacher burn-out. Burn-out is defined by Farber as “a work-related syndrome that stems from an individual’s perception of a significant discrepancy between effort and reward” (p. 24). In other words, burn-out occurs when teachers do not see or feel the rewards of their hard-work and determination, and they begin to feel ineffective at their job and therefore decide that the profession is not worth the time. Johnson [11] explains that many teachers who left the profession did so because they became overwhelmed with the expectations and they felt little success after hard-work (p.62). As teachers are continually given more roles to fill, they easily become frustrated and exhausted.

Teachers are no longer held accountable for just teaching core subjects; they now hold the responsibility of socializing students, advising students, and teaching basic skills that may not be taught at home. A teacher’s workload can become more stressed when facing the challenges associated with educating low performing students. Schools with low performance often lose their teachers to schools with higher performing students [7]. The schools with lower performance levels are also at risk for sanctions if they do not meet the No Child Left Behind Act standards [12]. Teachers may avoid these schools in search of a more stable school. Furthermore, new teachers often are given teaching assignments with the most challenging students [3] – students who are low performing and are vulnerable to failing or dropping out of school (“Understanding and reducing,” /citedigest).

The challenges associated with a difficult teaching assignment may lead to early teacher burn-out.

Lack of Administration Support

The success of a peaceful learning and teaching community is a vital part of an administrator's responsibilities. Research shows that it is imperative for teachers, especially those in urban schools, to receive ongoing support from their administration [8]. Many times administrative support can be given after observations occur in the classroom. However, according to Peterson [17], little time is spent by secondary principals on direct instructional leadership activities, like observations, because most of the principal's time during the day is spent managing the school's resources and dealing with interruptions. Administrative support is linked to teacher motivation, commitment and improved instruction.

Teacher Compensation

Areas with less funding cannot offer competitive wages to retain teachers [25]. For teachers who leave, pay is the most important factor followed by working conditions [12]. "The evidence suggests that teachers who stay in teaching migrate from lower to higher paying districts, and from lower to higher performing schools, particularly in high-stakes accountability environments" . Low pay is a particular concern in attracting and retaining teachers to urban areas where the cost of living is high [3]. Some research suggests that teachers would be more willing to remain in a challenging urban school district if they received more pay [12].

Concern about low wages causes retention problems not only within certain school districts, but also within the profession as a whole. When graduates choose to enter the teaching profession, they understand that the salary is not always going to be high. Many teachers who leave the profession feel that they could earn more in another field and they were underpaid for what they did in the classroom [11]. Furthermore, teachers often feel that they are not compensated fairly for all the extra duties they must perform outside of the classroom, such as bus duty, playground duty, lunch duty, and time spent on class work at home [5]. As the

demands on teachers increase, the salary remains the same.

Poor Working Conditions and Low Funding

A poor job environment is a major reason why teachers leave the profession. Violence and overcrowding create less than desirable working conditions for teachers. Many students and teachers fear going to their own schools because of the possibility of violence. A study linking attrition and urban violence found that the constant threat of violent behavior within urban schools leads to teacher stress, one of the major reasons teachers have for leaving urban schools [23]. Overcrowded classrooms can prevent teachers from developing individualized relationships with students, affect the ability of a teacher to manage the classroom, and may make a teacher feel less involved and less effective [4]. Behavioral issues that arise in the classroom have a great impact on the teacher's goals for the classroom. Gonzalez et al. (2008) explain that "students come to class with so many different problems and issues that it can become overwhelming to the teacher" (p.7). If behavioral issues constantly affect a classroom, the teacher is going to spend less time actually teaching.

Low funding of schools is a key obstacle to attracting and retaining teachers in schools and the profession. In poorly funded schools, teachers are less likely to have the resources they need and have rundown facilities in which to work (Claycomb & Hawley, 2000), which deter teachers from working in poor areas. Teachers tend to be more satisfied in "communities with greater economic and social resources" (Ouyang & Paprock, 2006, p. 343). Each year, 232,000 teachers change schools searching for better working conditions that are normally found in wealthier, higher performing schools ("Understanding and reducing," 2008). Teachers who work at poorly funded schools also are more likely to leave the profession altogether than those who work in better-funded schools [25].

Solutions

Improving Teacher Retention

Although there are many obstacles to attracting and retaining teachers, several solutions have been suggested to increase teacher retention. Solutions include modifying the No Child Left Behind Act, professional development, support groups, induction programs, instructional leadership and improving new teacher recruitment.

Lifting Restrictions of NCLB

Modifying the No Child Left Behind Act to allow states to measure student achievement and teacher effectiveness through value-added assessment, rather than high stakes tests may give teachers a greater sense of autonomy, relieve pressure to cover curriculum too quickly, and improve their job satisfaction. Value-added assessment measures student achievement by demonstrating gains in student knowledge over a school year rather than the percentage of students who pass state tests. Students' knowledge in various subjects is measured at the beginning of the school year as a pre-test and is measured again at the end of the school year, and schools are required to demonstrate increases in learning for all students. Unlike the current system of high stakes tests mandated by the NCLB, value-added assessment models push high and low achieving students to demonstrate gains in knowledge. Currently, high achieving students often are not challenged to pass state mandated tests, which simply require mastery of minimally acceptable skills. Furthermore, value-added assessment requires teachers to individualize instruction to students' needs, allowing them to be creative and demonstrate their professional competency, rather than mechanically teach to a test.

Additionally, the licensing restrictions created under the No Child Left Behind Act add to the obstacle of attracting and retaining teachers, so the obvious solution is to ease those restrictions or provide alternative routes to certification. Broadening the criteria that can be used to reach "highly qualified teacher" status by including "allowance for years of experience teaching a subject, review of past students' scores on achievement test[s], [and] evaluation of continuing education

credits” may increase retention of veteran teachers [15].

Preventing Burn-Out through Support Groups

Work related stress is a main cause of teacher burn-out.. Rieg, Paquette, and Chen [19] believe that “having the ability to deal with stressors is vital in teacher retention” (p.212). Therefore, a reasonable solution to the problem with teacher retention is to provide teachers with the knowledge on how to manage work-related stress.

Scherff, Ollis, and Rosencrans [20] propose that “one approach to combating stress and fostering encouragement among teachers is offered by membership in support groups. Research shows that support groups reduce stress and feelings of isolation while cultivating enthusiasm, competency, and reflection” (p.45). Discussing issues with other staff members facilitates advice, sharing, and counseling. Support groups can include a variety of different teachers from different backgrounds, experience, and concentrations. Due to the technological advances of the 21st century, the uses of online support groups are increasing dramatically.

Although critics contend that support groups create more obligations for already overburdened teachers, support groups allow participants to collectively share ideas and solutions to various problems, which can save time and reduce stress. Sparks and Hammond [24] explain that “the implementation of only one or two brainstormed ideas can make a significant difference to the affected teacher. Not only may the situation improve, but they [sic] will have gained a sense of power” (p.39). A teacher can gain a sense of control and autonomy back, which can decrease the chance of the teacher leaving the profession.

Induction and Mentoring Programs

Many new teachers are left to either “sink or swim” in their first years of teaching [10]. Without the proper support, new teachers have a high rate of attrition (Ingersoll & Smith, 2004). Mentoring and induction programs can be implemented to help retain new teachers and provide another method of preventing teacher burnout [21] “During the past twenty years, teacher mentoring programs have become the dominant form of teacher induction ...”[10]. Mentoring programs,

which are widely adopted in other countries, are gaining popularity in the United States [21] . “These programs provide support, [and] orientation and mentoring for beginning elementary and secondary teachers to ease the transition into their first professional teaching experiences” [21].

Orientation into the new school or district, veteran teacher mentors, teaching networks, and additional training for the new and veteran teachers can be a part of an induction and mentoring plan within a school system [21]. Orientation can help new teachers to become familiar with the school in which they will be working. Mentors can help guide new teachers, give advice when new teachers run into unexpected problems, and help them manage stress. Teacher networking can also provide support for new teachers. Teachers can share lesson plans and advice with the new teachers and help the new teachers feel like they are supported. Ingersoll and Smith [10] found that teachers who spend time planning, working and networking with other teachers are less likely to leave after their first year. Brownell et al (2005) believe if schools “ease entry to the classroom for bright persons who are willing to teach, provide them with sufficient mentoring and professional developmentteacher shortages will be eliminated” (p. 10).

Instructional Leadership

While administrators have the ability to lead mentoring programs to provide support for teachers, there are a variety of other ways that administrators can support teachers. Along with mentoring programs, principals also should be instructional leaders. According to Gregory [6], instructional leadership is one of the important components of an effective school administration. Instructional leadership can be as simple as the principal hosting in-service training to educate teachers on better teaching practices. Programs can be hosted by guest speakers, who may be experts in particular topics, or by any administrator or teacher with expertise. In-service programs are free, but can provide teachers with an abundance of applicable knowledge and support for their classroom.

Principals can work to reduce school violence and improve teachers’ working conditions by implementing violence prevention plans, along with training and awareness programs for teachers [23]. Better school security also could encourage teachers to come to a school and remain there [16]. Furthermore, administra-

tors can provide instructional leadership through observing classrooms to provide feedback that will help teachers improve in their pedagogy and curriculum application.

Good management and communication can also improve the work environment for teachers [13]. Principals play a vital role in good school communication. Principals and other administrators should communicate regularly and effectively with parents, teachers and staff. Effective communication allows for community involvement and an open and honest environment. Teachers, staff, parents and students should feel comfortable sharing concerns with administrators. Open communication also allows for fair, informed decisions to be made for all of the parties involved and may enhance job satisfaction.

New Teacher Recruitment

The practices administrators use to recruit teachers can help with attracting and retaining teachers. One method to improve teacher recruitment is to offer some type of bonus. McCreight [14] advocates “offering incentives for teachers to take jobs in subjects and geographical areas with shortages” (p. 24). Offering incentives for teachers in shortage areas can help attract teachers to less desirable areas and to subjects for which schools have difficulty filling vacancies. In addition, McCreight suggests “modify[ing] the salary structures to link pay to teacher skill or accomplishments” (p. 24). Allowing salary to reflect skill and accomplishment gives teachers greater desire to stay in the teaching force as a possible way to increase their salary.

Increasing entry-level pay also may aid in attracting teachers to lower performing schools [12]. Money offered towards housing, along with loan forgiveness programs and scholarships, could help attract new teachers to challenging schools. State tax relief also could be an incentive for teachers in challenging teaching situations [2]. To attract and retain teachers in challenging environments, they need to be compensated with “both pay and career advancement” [12]. “Opportunities for increased pay combined with other rewards for strong performance may provide an important incentive to attract and retain more highly qualified teachers to challenged schools” .

Addressing Funding Shortages

One of the most challenging problems in public education is addressing the unequal and inadequate funding of schools. Ideally, federal, state, and local funds would adequately support all schools. However, the reality is that economic recession and a strong political opposition to tax increases means that school systems are unlikely to easily increase revenue. One solution is for schools to spend the funds at their disposal more effectively. Wenglinsky [26] argues that “some spending measures play a role in student achievement” (p. 217), whereas other spending patterns “create dead ends in that they do not lead to increases in achievement” (p. 218). Schools are likely to see the greatest gains in student achievement by spending money on (1) hiring more teachers to reduce teacher-student ratios (2) increasing salaries to retain the best teachers, and (2) hiring highly competent central office administrators. Spending money on capital outlay projects and school-level administrators does not impact on student achievement [26].

Conclusion

All of these solutions work to reduce the obstacles to attracting and retaining high quality teachers. Any combination of these solutions can be influential in keeping teachers within the school districts in which they are needed most. By implementing these solutions, teachers and administrators can be the change that under-achieving students need to see. To provide a high quality, equal education to all students, high quality teachers need to be recruited and retained. With these solutions in place, the dream of equity will hopefully be achieved.

Acknowledgments

This paper is part of a larger project conducted in the Spring of 2009 for an Honors Sociology of Education course. The authors acknowledge the contributions to the project of the other students in the class: Marie Black, Andrea Candea, Jennifer Curfman, Melanie Moomaw, Chelsea Normandeau, Alicia Peterson, Brandi Roberson and Jessica Stott. The authors also thank Tatiana Pashkova-Balkenhol

for her assistance with library research and technology, and Dr. Geoffrey Orth, Director of the Cormier Honors College, for his support of this project.

References

- [1] B.J. Biddle and D.C. Berliner. *Small class size and its effects*, volume Schools and Society: A Sociological Approach. J. H. Ballantine and J. Z. Spade (editors) Pine Forge Press, 3rd edition, 2008.
- [2] M. Brownell, A. Bishop, and P. Sindelar. Nclb and the demand for highly qualified teachers: Challenges and solutions for rural schools. *Rural Special Education Quarterly*, 24(1):9–15, 2005.
- [3] C. Claycomb and W. Hawley. Recruiting and retaining effective teachers for urban schools: Developing a strategic plan for action. *National Partnership for Excellence and Accountability in Teaching*, March 2000.
- [4] Barry A. Farber. *Crisis in education*. San Fransisco, 1991.
- [5] L. Gonzalez, M. Brown, and J. Slate. Teachers who left the teaching profession: A qualitative understanding. *Qualitative Report*, 13(1):1–11, 2008.
- [6] R. Gregory. Leading change through cultural competence. *AASA Journal of Scholarship and Practice*, 5(4):34–38, 2009.
- [7] D. Inamn and L. Marlow. Teacher retention: Why do beginning teachers remain in the profession? *Education*, 124(4):605, June 2004.
- [8] R. Ingersoll. Teacher turnover, teacher shortages, and the organization of schools. Center for the Study of Teaching and Policy, September 1999.
- [9] R. Ingersoll. The teacher shortage: Myth or reality? *Educational Horizons*, Spring, 2003.
- [10] R. Ingersoll and R. Smith. Do teacher induction and mentoring matter? Technical report, NASSP Bulletin, January 2004. pp. 28-40.

- [11] Susan Johnson. *Finders and keepers*. Published by Jossey-Bass, San Francisco, CA, 2004.
- [12] C. Kelley and K. Finnegan. Teacher compensation and teacher workforce development. In M.A. Smylie and D. Miretzky, editors, *Developing the Teacher Workforce*, volume 1, pages 253–273. University of Chicago Press, Chicago, 2004.
- [13] T. Kowalski. Effective communication for school administrators: A necessity in an information age. *AASA Journal of Scholarship and Practice*, 5(4):55–56, 2009.
- [14] C. McCreight. Teacher attrition, shortage and strategies for teacher retention. ERIC Document Reproduction Service No. ED444986, August 200.
- [15] S.E. McLaurin, W. Smith, and A. Smillie. Teacher retention: Problems and solutions. ERIC Document Reproduction Service No. ED507446, November 2009.
- [16] M. Ouyang and K. Papcock. Teacher job satisfaction and retention: A comparison study between the u.s. and china. ERIC Document Reproduction Service No. ED492688, February 2006.
- [17] K. Peterson. Secondary principals and instructional leadership: Complexities in a diverse role. *National Center on Effective Secondary Schools*, February 1989.
- [18] Ingersoll Rand. Is there really a teacher shortage? Technical report, A Research Report co-sponsored by Center for the Study of Teaching and Policy and The Consortium for Policy Research in Education., University of Washington, Center for the Study of Teaching and Policy, 2003.
- [19] S. Rieg, K. Paquette, and Y. Chen. Coping with stress: An investigation of novice teachers' stressors in the elementary classroom. *Education*, 128(2):211–226, December 2007.

- [20] L. Scherff, J. Ollis, and L. Rosencrans. Starting the journey together: A teacher educator and her students navigate their first semester in the secondary english classroom. *Issues in Teacher Education*, 15(2):43–59, September 2006.
- [21] S. Shakrani. Teacher turnover: Costly crisis, solvable problem. Technical report, Education Policy Center, University of Michigan, January 2008.
- [22] R. Simpson, P. LaCava, and P. Graner. The no child left behind act: Challenges and implications for educators. *Intervention in School & Clinic*, 40(2):67–75, November 2004.
- [23] D. Smith and B. Smith. Perceptions of violence: The views of teachers who left urban schools. *High School Journal*, 89(3):34–42, February 2006.
- [24] D. Sparks and J. Hammond. Managing teacher stress and burnout. Technical report, ERIC Clearinghouse on Teacher Education, February 1981.
- [25] unknown. Understanding and reducing teacher turnover. In *Education Digest: Essential Readings Condensed for Quick Review*. ERIC Document Reproduction Service No. EJ799028, 2008.
- [26] H. Wenglinsky. How money matters: The effect of school district spending on academic achievement. In J. H. Ballantine and J. Z. Spade, editors, *Schools and Society: A Sociological Approach to Education*, pages 219–231. Wadsworth/Thompson Learning, Belmont, CA, 3rd edition, 2004.

Student Biography

Candice Fleming is a junior at Longwood University and a Liberal Studies/Elementary Education major. She is currently secretary of Kappa Delta Pi, the International Honor Society in Education, and she is also a member of the International Buddy Program and the Honors Program.

Rebecca Franklin is a junior, Liberal Studies Elementary Education major. She plans to teach in lower elementary school after she graduates. She is a member

of Phi Kappa Phi at Longwood University. She is also a Longwood Ambassador and a Resident Assistant on campus. She has a heart for at-risk children and she believes that effective, passionate teachers will be the people to shape the future!

Faculty Biography

Dr. Lee Bidwell, Professor of Sociology, has been teaching at Longwood University since 1990. She received a B.A. degree in sociology and political science from Maryville College in 1984, and a master's degree (1986) and Ph.D. (1991) in sociology from the University of Tennessee, Knoxville. She studies family issues and is a Certified Family Life Educator.

The Effect of Presentation on Spanish Vocabulary Recall

Ashley Yocum

Faculty Mentor: Dr. Stephanie Buchert

Department of

Abstract

The present study was designed to examine whether a certain presentation style of Spanish words would help participants to remember them. Participants viewed one of three Power Point presentations and experienced either a Spanish word and the English translation, the words and an image of the object, or the words and a keyword image that linked the pronunciation of the Spanish word with the English translation. In each case, the participants heard the pronunciation of each Spanish word. Then the participants recalled the English translation when provided with the Spanish word. The results suggest that while the keyword image alone does not prompt recall, using that method and having previous knowledge will aid in remembering Spanish vocabulary words.

Introduction

While it is very important to learn a foreign language because it improves one's horizons, it is very difficult for students, especially the older they are because there is a critical time period in which children must learn a language. After this time period has passed, it is very difficult for people to learn another language. Learning a foreign language will be easier and faster if the student has a technique that helps.

The keyword method is a two-step mnemonic device used to learn foreign vocabulary in second language acquisition. The first step consists of identifying a

keyword in the native language (L1), which should be concrete and as phonetically similar as possible to the word in their target language (L2). The second step consists of establishing a visual association between the keyword from the L1 and the L2 word. For example, if the L2 word in Spanish were huevo (=egg), the keyword in English would be wave; and therefore the visual association would be an egg waving [2]. This method has been shown to work for both young children and college students [3].

The first researchers to study the keyword image method were [3]. In their study, participants learned a list of sixty Spanish vocabulary words. The researchers tested the keyword method against other recall methods. The researchers tested the keyword image method against any other method of memorization of the individual participant's own choosing [3] and they found that overall the keyword image method produced a higher rate of recall over the other methods of memorization such as rote memorization. In a study by [5], the researcher tested the keyword image method on medical terminology classes. Participants saw keyword images to help them learn medical terminology for two lessons at three time periods. This study was replicated a second semester. The data suggest that participants using the keyword image method scored higher than a traditional method for both initial learning and long-term memory. This method was tested in both a classroom setting and individualized learning, and it was shown to be effective in both [5].

Another study where researchers examined the keyword image method was done by Campos, Amor, and Gonzales (2004). In the first experiment, the participants who spoke Spanish as their native language attempted to learn a list of sixteen Latin words (eight with high image vividness, eight with low image vividness) using either the rote method or the keyword image method. Participants using the keyword image method saw images generated by either the experimenter, themselves, or by their peers. Recall was tested immediately and then a week later. The researchers found that participants using the keyword image method had high recall rates for high vividness images when immediately recalled. However, participants using the keyword image had no differences in recall rates for both low vividness words or for delayed recall. While there were higher recall rates for the keyword image method when the words were recalled immediately, those using rote methods experienced no decline after a week (Campos, Amor,

& Gonzalez 2004). They repeated the experiment and participants attempted to learn a list of 26 Latin words. Again, the researchers found that participants using the keyword image method had a significantly higher recall rate than participants using rote memorization methods (Campos et al., 2004).

Another set of researchers who studied the keyword image method were [4]. They studied the effects of rote rehearsal, context, keyword, and context/keyword methods on immediate and long-term retention of English as a foreign language (EFL) vocabulary in natural classroom settings. Rodriguez and Sadoski randomly assigned eight 9th-grade EFL classes to one of four learning conditions: rote rehearsal, context, keyword, and context/keyword condition. The researchers tested the participants by cued recall either immediately or after a 1-week delay. Results showed that the context/keyword method produced higher recall to any of the other three methods after 1 week. The data suggest that this method is an effective tool in a foreign language classroom.

Lastly, in a recent study by [1], a series of experiments was conducted to test the keyword image method. The first experiment consisted of participants using the keyword image method or rote memorization to learn a set of vocabulary from various languages. The second experiment consisted of participants rating keyword images as memorable or not to test whether the quality of the image affects the memorization. And the last experiment consisted of participants using the keyword image method or rote memorization to learn a set of vocabulary from the same language [1]. In all three experiments, the keyword image method was shown to have higher recall rates than rote memorization.

Researchers have shown that participants using the keyword image method have higher recall rates than participants using other memorization techniques [3], but the keyword image method has rarely been compared specifically against non-keyword images or against only words. We hypothesized that participants who saw a keyword image would have a higher recall rate than the participants who saw either an image of the object or just the Spanish word and its English translation without any image.

Methodology

Participants

Participants included 31 undergraduate students (17 males and 14 females) between the ages of 18 and 29, ($M = 19.35$, $SD = 2.138$). There were sixteen freshmen, six sophomores, 7 juniors, and 2 seniors enrolled in Longwood University. Fifteen of the participants had previous knowledge of Spanish, while the other sixteen participants had no previous knowledge. Participants signed up for the study through Sona-Systems, an online participant pool, and they were compensated with one point extra credit within their respective psychology classes. The treatment of the participants was in accordance with the ethical standards of the American Psychological Association (APA).

Materials and Procedure

Participants were divided into three groups. Each group viewed a different PowerPoint presentation. In the words-only group, participants saw one Spanish word and its English translation (Figure 1). In the image group, participants saw one Spanish word, its English translation; and an image of the word (if the word was *huevo*, participants saw a picture of an egg - Figure 2). Lastly, in the keyword image group, participants saw the Spanish word, its English translation, and a keyword image (Figure 3), which linked the pronunciation of the Spanish word with the English word (e.g., for the Spanish word *huevo*, which means egg, the participant would see an image of an egg waving hello, associating the pronunciation of the Spanish word with the English word "wave").

The participants saw 12 Spanish words (See Table 1 for specific words used). All the groups saw each word on a PowerPoint slide for a total of 5 seconds, and then the PowerPoint slide automatically advanced to the next slide. When the slide switched to a new word, the researcher pronounced the new Spanish word for all participants. After viewing all the words, participants tried to recall the English translation when provided with the Spanish word (See Appendix A for example). The average number of words correctly recalled was calculated for each group.

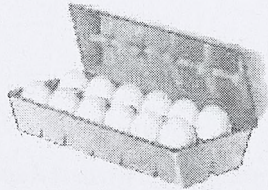
Huevo

=

Egg

Figure 1:

Huevo =



Egg

Figure 2:

Huevo =



Egg

Figure 3:

Spanish Word	Keyword	English Translation	Image Used
Payaso	Pie	Clown	Clown with a Pie
Perro	Pear	Dog	Dog with a pear
Pato	Pot	Duck	Duck in a pot
Ropa	Rope	Clothes	Dress with a rope belt
rbol	Bowl	Tree	Tree in a bowl
Pan	Pan	Bread	Pan of bread
Sopa	Soap	Soup	Softsoap bottle in can of soup
Mujer	Hair	Woman	Woman with blonde hair
Huevo	Wave	Egg	Egg waving
Cebolla	Boy	Onion	Boy with onion head
Pollo	Pole	Chicken	Chicken dancing on pole
Cama	Comma	Bed	Comma sleeping in bed

Table 1: List of Spanish Words used in Experiment

Results

We performed a two-way Analysis of Variance (ANOVA) comparing whether the participants had previous Spanish experience (yes or no) and which method of learning they experienced (words only, realistic image, or keyword image) had effects on the averages of the words correctly recalled for each group and found there were no main effects for either knowledge of Spanish, $F(2,25) = .002$, $p = .966$) or type of presentation the participants experienced (words only, realistic image, keyword image), $F(1,25) = 1.285$, $p = .294$.

There was a statistically significant interaction, $F(2,25) = 3.708$, $p = .039$) between whether the participants had previous knowledge of Spanish and the presentation group the researcher assigned the participants to. In the keyword image group participants who had previous knowledge in Spanish had a higher recall rate ($M = 10.33$, $SD = 1.73$) than those without previous experience ($M = 7.4$, $SD = 1.60$).

In the realistic image group, participants who had no previous knowledge of Spanish ($M = 9$, $SD = 1.45$) had a higher recall rate than those with previous knowledge of Spanish ($M = 7.5$, $SD = 1.82$).

Finally, in the words only group, participants who had no previous knowledge of Spanish ($M = 8$, $SD = 2.03$) than participants who had previous knowledge of Spanish ($M = 6.67$, $SD = 1.38$). See Figure 4 for a visual representation of the means of the interaction.

Discussion

The data showed that there was a statistically significant interaction between knowledge of Spanish and type of presentation style. Participants who had previous knowledge in Spanish and who viewed the keyword images along with the Spanish words and English translations had the highest recall rate, while the other groups had no statistically significant differences. Neither the presentation style, nor whether or not the participant had previous knowledge in Spanish by itself was enough to create a difference between the groups, but these two factors acted together to create an interaction. So for people learning Spanish, the keyword

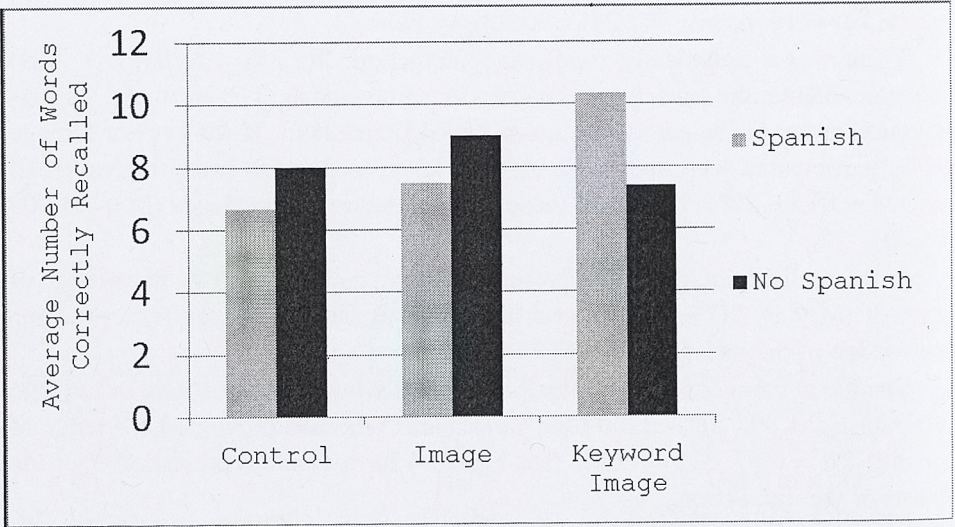


Figure 4: Combined means of correctly recalled translations for the groups separated by type of presentation and experience with Spanish instruction.

image will increase their ability to remember vocabulary words.

One possible reason for the results is that participants who had taken Spanish classes were already familiar with the words, and so their previous knowledge combined with the keyword images increased their higher recall rates. In future research, there would be a restriction so that only participants without previous knowledge of Spanish would be allowed to participate.

The current data does not fully support previous research. [3] showed that participants using the keyword image method had higher recall rates than participants not using the keyword image. The current data suggest that simple presentation styles are not enough to promote higher recall rates; there must be an external factor that contributes to the learning and memorization.

The current research has several limitations, primarily being that only a small number of participants had no previous knowledge of the Spanish language. There was an external factor contributing to the results because many of the participants had taken a class or two in Spanish prior to participating and therefore their previous knowledge could have affected their responses by already knowing the words being tested. A sample with more participants who had no previous Spanish knowledge may have demonstrated higher recall rates when viewing keyword images.

For future research, we would change the language of interest to either French or German so that all participants would be unfamiliar with the language of interest. Requirements for participating in future language studies should include only participants who had no previous experience with the target language. Also eliminating the image group might yield stronger differences in the recall rates between the groups.

In conclusion, current results suggest that while the keyword image method of presentation alone cannot aid a person in memorizing a set of Spanish vocabulary words, the keyword images are unique along with previous knowledge of the language aides in language recall. Instructors of foreign languages classes can use this technique to teach vocabulary to their students so that students will be able to expand their vocabulary in the language of their choice.

Acknowledgements

I would like to thank Dr. Buchert for reading multiple drafts and revisions of this article and for her guidance and support throughout this entire research project.

References

- [1] A. Beaton, M. M. Gruneburg, C. Hyde, A. Shufflebottom, and R. N. Syskes. Facilitation of receptive and productive foreign vocabulary using the keyword method: The role of image quality. *Memory*, 13(5):458–471, 2005.
- [2] A. Campos, A. Amore, and M.A. Gonzalez. The importance of the keyword-generation method in keyword mnemonics. *Experimental Psychology*, 51(2):125–131, 2004.
- [3] M.R. Raugh and R.C. Atkinson. A mnemonic method for learning a second language vocabulary. *Journal of Educational Psychology*, 67(1):1–16, 1975.
- [4] M. Rodriguez and M. Sadoski. Effects of rote, context, keyword and context/keyword methods on retention of vocabulary in efl classrooms. *Language Learning*, 50(2):385–412, 2000.
- [5] E.D. Trout-Ervin. Application of keyword mnemonics to learning terminology in the college classroom. *Journal of Experimental Education*, 59(1):31–41, 1990.

Appendix A

Class Rank: Freshman Sophomore Junior Senior

Sex: Male Female Age:

Have you taken any Spanish classes: Yes No

If so: How many years taken: How recent:

Have you taken other language classes:

German French Latin Chinese Other None

If so: How many years taken: How recent:

Please write the English translation for each Spanish word

1. Payaso = _____

2. Perro = _____

3. Pato = _____

4. Ropa = _____

5. Arbol = _____

6. Pan = _____

7. Sopa = _____

8. Mujer = _____

9. Huevo = _____

10. Cebolla = _____

11. Pollo = _____

12. Cama = _____

Student Biography

My name is Ashley Yocum and I come from Richmond, Virginia where I earned my high school diploma at Meadowbrook High School in 2005. I am a Longwood senior earning a Bachelor's of Science Degree in Psychology with minors in English and Spanish. After graduation in May 2010, I plan to begin my career, and eventually I hope to earn a masters and doctorate in Experimental Psychology and conduct research at the university level.

Faculty Biography

Dr. Stephanie Buchert has been a faculty member in the Psychology Department at Longwood University since 2004. She earned a Ph.D. and an M.A. in Experimental Psychology from Kent State University, and holds B.A.s in Psychology and Anthropology from Bloomsburg University. Her research interests include cognitive development, language development, and pedagogy.

How Attractive Are You? Individual's Sensitivity to Number of Sexual Partners

Danielle M. Jagoda and Cristina M. Valdivieso
Faculty Mentor: Dr. Stephanie Buchert
Department of Social Sciences

Abstract

We investigated whether the number of sexual partners an individual had affected how attractive others perceived them. We instructed each participant to read a brief description of a male or female, depending on the sex of the participant. Three groups of descriptions were presented: a person with a higher number of sexual partners, one with a lower number of sexual partners, and one with no mention of sexual partners at all. The participants then filled out a survey based on how they perceived the individual. Results showed that there was no significant difference between the number of sexual partners and the participants' ratings on the individual's attractiveness. However, there was a positive correlation between the number of sexual partners the participants had and their willingness to engage in unprotected sexual activity. This could suggest that more experienced individuals, though not perceived less attractive, participate in more risky behavior.

How Attractive Are You? Individual's Sensitivity to the Number of Sexual Partners

Evidence has been provided that attractive traits are important in mate choice and may be sexually preferred [8]. Since attractive individuals are perceived as sexually desirable, interactions with attractive individuals may result in greater sexual arousal and higher motivation to have sex [2]. Dijkstra and Buunk [1] presented the idea that because an unattractive female is not seen by the opposite sex as a source of risk for sexually transmitted diseases, she evokes unsafe sex behavior in

men. Contrary to Dijkstra and Buunk's study, Epstein et al. found that the more attractive a person is, the more likely one is to engage in unprotected sex with that partner. Therefore, the attractiveness of a potential partner can be a significant risk factor for engaging in unsafe sexual practices. Highly physically attractive targets, even with no sexual history mentioned, are generally rated as more sexually experienced than less physically attractive targets [2].

Fink, Brewer, Fehl, and Neave [3] found that women with higher instrumentality reported a greater number of lifetime sexual partners than women who were expressive, perhaps because the women are less dependent on the investment of a male partner. Independence may encourage women to seek short-term rather than long-term relationships, resulting in a greater number of sexual partners. The authors also found that instrumental men reported a younger age of first sexual intercourse than expressive men. Overall, men are seen by society as having a higher number of lifetime sexual partners than women. This could be due to mating strategies since women's greater selectivity may make it harder for them to fulfill their sexual needs, whereas men's sexual needs can be met by an opportunistic strategy [7]. Men are more willing to have sex with a potential partner than women because the risk of becoming pregnant, getting infections, or contracting a sexually transmitted disease implies a higher cost for women than men. On those grounds, women set higher standards for partner characteristics, whereas men are more willing to seize opportunities [5].

Women, as well as men, sometimes gauge their own attractiveness by the number of sexual partners and related sexual activities they have had. Thus, people with a greater interest in casual sex overestimate their own attractiveness [9]. Women who engage in casual sex with many sexual partners (women with unrestricted orientation) are generally more naturally attractive [6]. Some have suggested an evolutionary explanation for this phenomenon because unrestricted women seek men with "good genes" such as attractiveness. Since some variation in female sociosexuality is heritable, the women can transmit to their offspring both their genes for an unrestricted lifestyle of sociosexuality and their partners' physical attractiveness. Another more likely possibility is that attractive women get more frequent sexual offers from men and therefore are tempted more often to engage in casual sex.

The sexual history of an individual seems to be positively related to perception

of risk, since highly experienced individuals are seen as more risky. Therefore, a potential partner may perceive a highly experienced individual to be less attractive when knowing his or her sexual history and evaluating the risk along with it. Dijkstra and Buunk found that participants perceived physically attractive women to be more promiscuous than less attractive women, and felt that having unprotected sex with a physically attractive woman implied a relatively higher risk. However, a man will sometimes underestimate their risk with a physically attractive female if he feels there is a reasonable chance of having sex with her [1].

A woman with a higher number of sexual partners was rated by others as more masculine and also perceives herself as more masculine (Mikach & Bailey, 1999). It is possible that women who participate in casual sex recognize that this is a male trait and so can identify more with men (Mikach & Bailey, 1999). Fisher [4] showed that males reported larger numbers of sexual partners when they were told by the researcher that women are now more permissive and sexually experienced than men. In addition, men, in order to maintain the traditional dominance of men in the sexual arena, rely on the strategy to "round up" their estimated number of sexual partners. Perhaps increasing the count of sexual partners was seen as an easy way of maintaining the status quo for men to be more sexually active. The research indicated that men can be influenced by social norms and expectations very easily.

Previous researchers have mainly studied the relationship between physical attractiveness and having more sexual opportunities, a higher sexual drive, or whether attractive male or females have more sexual partners. Previous research has not indicated whether the knowledge of one's sexual history negatively or positively influenced how attractive the person was perceived by others.

Our research focused on how the number of sexual partners a male or female has had affects how physically attractive others perceived them. For our study we hypothesized that a male or female with a higher number of sexual partners will be perceived as less attractive than a male or female with a lower number of sexual partners. We expected to find that, despite other characteristics such as schooling, job aspirations, and family life, knowledge of an individual's sexual history will hinder the attractiveness of that individual.

Each participant received a brief description of a person. The control group received a description featuring no mention of sexual history in the description. A

Taylor is 20 years old. She loves going to the beach and water skiing. Taylor is currently a full time student at a local college and interns at a doctor's office in hopes to one day go to medical school to become a doctor herself. On the weekends Taylor likes to go out with her friends and have a good time. Taylor's parents are still together and she has one brother and one sister. She does not smoke and has had three sexual partners. Everyone sees Taylor as a very outgoing and friendly person.

Figure 1: Description given to participants in the low group with a mention of three sexual partners.

second group had a description featuring an individual with three previous sexual partners mentioned. The other experimental group had a description of an individual with ten previous sexual partners mentioned. For an example of the description given to participants (see Figure 1). The participants read the description and answered a questionnaire about the individual. The questionnaire was designed to investigate how attractive the participant found the individual and whether they would engage in any sexual activity with the person.

Method

Participants

The study included 94 Longwood University students (ages ranged from 18-23 years). Participants included 74 females and 20 males. The researchers granted each participant one point extra credit towards a psychology class.

Materials and Procedure

The researchers gave each participant a brief description of an individual of the opposite sex which included what the individual likes to do, aspirations in life, information about family life, and either no mention of sexual activity, three sexual partners, or ten sexual partners. The researchers then gave each participant a questionnaire to rate their thoughts and feelings about the individual they read about. The questionnaire had fifteen questions and used a Likert Scale from 1-7. The participants read the brief description of the male or female and then filled out the questionnaire. The dependent variable was measured by the participants' responses on the questionnaire regarding how the number of sexual partners described affected their attraction to the person in the scenario. For each question the participants rated their feelings about the individual on a scale with one being not at all, four being neutral, and seven being definitely.

Results

Our analysis focused on the participants' responses on the Likert scale items in relation to their assigned condition. A one-way analysis of variance (ANOVA) showed a significant effect of the independent variable on the participants' willingness to have sex with the described person, $F(2, 87) = 4.70, p = .012$ (see Figure 2). A Tukey posthoc test revealed significant differences between the group that read about a person with a high number of sexual partners ($M = 2.91; SD = 1.62$) and the group that read about a person with a low number of sexual partners ($M = 3.60; SD = 1.82$).

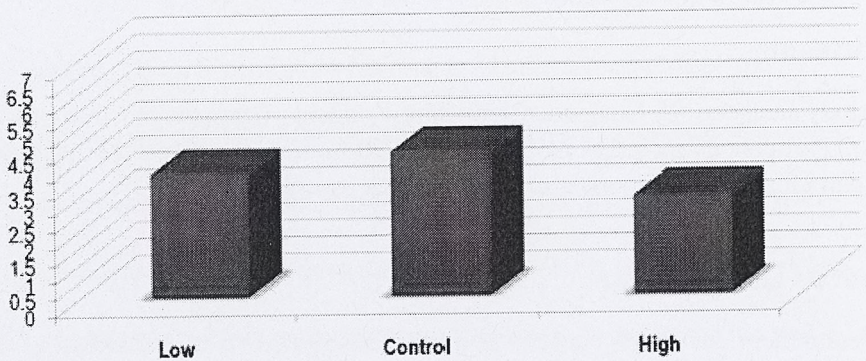


Figure 2: Mean ratings of each group on whether or not they would engage in sex with the described individual.

When asked if they would engage in unprotected sex with the described individual, participants' responses were significantly different depending upon their group assignment, $F(2, 87) = 5.71, p = .005$. Those who read about a person with ten sexual partners ($M = 1.28; SD = .666$) were less likely to say they would have unprotected sex with the described person than those who read the low number scenario ($M = 1.65; SD = 1.18$).

When asked if the participants could see themselves in a relationship with the individual, the higher number of sexual partners group ($M = 4.05; SD = 1.57$) was far less likely than any other group to report that they could, $F(2, 87) = 3.96, p = .023$. This was also true for the higher number of sexual partners group ($M = 3.21; SD = 1.85$) when participants were asked if they would engage in sexual activity other than sex with the individual $F(2, 87) = 3.67, p = .029$.

A Pearson r showed that there was a positive correlation between the number of sexual partners that a participant reported for him or herself, and their willingness to engage in sexual activity with the fictitious individual, $r(87) = .413, p = .089$. The higher the number of sexual partners the participant had, the more likely they were to engage in unprotected sex with the person from the scenario.

Discussion

This study was conducted to investigate whether a person's sexual history information affects his or her perceived attractiveness. We found no significant difference between the number of sexual partners the described individual had and perception of attractiveness. However, there were significant differences between the number of sexual partners the participants reported having and the willingness of the participant to engage in sexual activity. This implies that knowledge of the sexual history of an individual may alter the relationship between attractiveness and intentions to have sex with a person. The correlation showed that the higher the number of sexual partners the participant had, the more likely they were to engage in unprotected sex with the individual. Thus, these results provided some evidence that even if the number of sexual partners an individual has does not alter their attractiveness, it does alter their likelihood to find sexual partners.

Overall, the results from this experiment can help to answer many questions people have about society's view on sexual history, and how it compares to perceptions of attractiveness. The results could be used to educate college students on the implications of risky sexual behavior. Future research could be conducted to find if a high number of sexual partners is linked to the perception that the individual is promiscuous, participates in risky behavior, or is more likely to have a sexually transmitted disease. Also, future researchers could aim to find if this perception changes the participants' likelihood of engaging in sexual activity with that individual.

References

- [1] P.B. Dijkstra, B.P. Buunk, and H. Blanton. The effect of target's physical attractiveness and dominance on std-risk perceptions. *Journal of Applied Social Psychology*, 30(8):1738–1755, 2000.
- [2] J. Epstein, W.D. Klinkenberg, D.J. Scandell, K. Falukner, and R.E. Claus. Perceived physical attractiveness, sexual history, and sexual intentions: An internet study. 56, 2007.

- [3] B. Fink, G. Brewer, K. Fehl, and N. Neave. Instrumentality and lifetime number of sexual partners. *Personality and Individual Differences*, 43(4):747–756, 2007.
- [4] T.F. Fisher. Sex of experimenter and social norm effects on reports of sexual behavior in young men and women. *Archives of Sexual Behavior*, 36(1), 2007.
- [5] T. Greitemeyer, S. Hengmith, and P. Fischer. Sex differences in the willingness to betray and switch romantic partners. *Swiss Journal of Psychology/Schweizerische Zeitschrift für Psychologie/Revue Suisse de Psychologie*, 64(4), 2005.
- [6] S.M. Mikach and J.M. Bailey. What distinguishes women with unusually high numbers of sex partners? *Evolution and Human Behavior*, 20(3):141–150, 1999.
- [7] J. Ostovich and J. Sabini. How are sociosexuality sex drive and lifetime number of sexual partners related? *Personality and Social Psychology Bulletin*, 30(10), 2004.
- [8] G. Rhodes, L. Simmons, and M. Peters. Attractiveness and sexual behavior: Does attractiveness enhance mating success? *Evolution and Human Behavior*, 26(2):186–201, 2005.
- [9] J. Weeden and J. Sabini. Subjective and objective measures of attractiveness and their relation to sexual behavior and sexual attitudes in university students. *Archives of Sexual Behavior*, 36(1):79–88, 2007.

Student Biography

My name is Cristina Valdivieso and I am originally from Suffolk, VA. I am a double major in Psychology and Sociology at Longwood University. I will be graduating in May of 2010. After graduation I will be attending the University of North Carolina at Wilmington to pursue an M.A. in Substance Abuse Treatment Psychology.

My name is Danielle Jagoda and I am originally from Smith Mountain Lake, VA. I am a Psychology major at Longwood University. I will be graduating in May of 2010. After graduation I will be attending Marymount University in Arlington, VA to pursue an M.A in Forensic Psychology as well as an M.A in Community Counseling.

Faculty Biography

Dr. Stephanie Buchert has been a faculty member in the Psychology Department at Longwood University since 2004. She earned a Ph.D. and an M.A. in Experimental Psychology from Kent State University, and holds B.A.s in Psychology and Anthropology from Bloomsburg University. Her research interests include cognitive development, language development, and pedagogy.

5 English and Modern Languages

Culturally Relevant Practices for Teaching Code-Switching to African-American Students in Kindergarten Classrooms

Jameka Jones

*Faculty Mentor: Faculty Mentor: Dr. Robin Smith
Department of English and Modern Languages*

Abstract

This article seeks to explore current teaching practices of kindergarten teachers in a public school system in the area of culturally relevant teaching practices. This was accomplished through a case study in which the researcher observed several kindergarten teachers in their classrooms. The author then compared and contrasted her observations with scholarly research on accommodating different dialects in the classroom in order to make recommendations for teachers.

Introduction

As our country becomes more and more diverse, so do our classrooms. While students are expected to learn "standard" English in the classroom, they are often exposed to a different dialect at home. This article speaks directly to the accommodation of the African-American Vernacular English (AAVE) dialect. Research shows that teaching practices that merely correct students' grammar without explanation can be detrimental to students' learning. This article will explore the AAVE dialect, assess current methods of dealing with grammar in classrooms, and seek to suggest teaching methods that will benefit pre-service and practicing teachers in accommodating AAVE in their classrooms.

An English dialect is a variation that resembles other varieties of English but at the same time differs systematically. AAVE has features such as omission of auxiliary verbs, absence of plurals, possessives, and a recurring "habitual be" that distinguish it from Edited American English (EAE) [3]. Its use among African-Americans varies, and it is also used by other ethnicities. Teaching instruction that merely corrects students without explaining why or how their dialect is different from EAE can lead to even more usage of vernacular features [4]. Poor teaching instruction is leading to national averages of achievement for African American students being lower than their "mainstream peers" [5]. Data from the National Assessment of Educational Progress continues to show that African Americans are scoring lower than non-Hispanic Whites in all academic content areas, and this can be due to the failure to gain strong reading and grammar skills [5].

As a pre-service teacher seeking to teach kindergarten, I sought to study a subject that would be pertinent to my future. Thus, I decided to delve into research that would show how the usage of AAVE was accommodated in kindergarten classrooms. According to researchers of language diversity, the problem lies not in the dialect but in perceptions of it. Students will often write the same way they speak because they learn grammar informally through what they hear before they are taught the formal rules. Researcher Rebecca Wheeler pointed out in *Code-switching: Teaching Standard English in Urban Classrooms* that many famed African-American authors use AAVE in their works but are not perceived as having deficient communication skills or speaking broken English. These authors have the ability to code-switch, moving from one language register or dialect to another, depending on the level of formality required by the communication context (i.e., switching from everyday vernacular English to Edited American English). Code-switching honors the language and culture of the home community, instead of negating it. Studies indicate that code-switching is an effective way to teach students EAE [4].

Many teacher preparatory programs do not incorporate the concept of code-switching or language diversity into coursework, making it unlikely that teachers will use the methods once they enter the classroom.

This article seeks to explore why code switching is needed in classrooms and to find culturally relevant teaching practices for code-switching with AAVE students in kindergarten classrooms. Though teachers may be knowledgeable in why

culturally relevant teaching practices should be used, they do not always actually use them in their classrooms.

Teachers need to be able to understand the different dialects that are spoken and written by their students because home dialects should affect how they teach in their classrooms. Since many teachers do not receive much training in this area, this study seeks to explore the current state of our classrooms and provide suggestions for teaching to students who speak a different dialect than Edited American English.

In addition to consulting scholarly research, I observed the teaching practices of three kindergarten teachers in a large school system in Northern Virginia. I then interviewed them regarding their pedagogy for teaching grammar to their kindergarten students. I analyzed and made use of best practices in order to find culturally relevant teaching practices for teaching code-switching in kindergarten classrooms.

Review of Literature

According to experts, these are the most pressing concerns related to best practices for accommodating the AAVE dialect in classrooms:

- Changing teachers' prejudices may be an important factor in helping students who use AAVE be successful in adapting their language. "Teachers' attitudes toward AAE are a common obstacle. . . . [T]eachers' positive attitudes toward AAE may facilitate the acquisition of SWE [Standard Written English]" [3, p. 69].
- According to Wheeler, teachers should "make mental notes or actual notes of the home speech patterns that occur in student speech or writing [and] tally the most common grammar patterns" (p. 60). Once teachers do this, they are able to see the most prevailing issues for their students and tailor lesson plans around those concerns.
- Webb and Redd [3] warn that teachers should not have AAVE users fill out worksheets that are "divorced from any meaningful communicative activity" (p. 81). Delayed feedback is also an issue that can be a disservice

to students. “When students write exercises for homework, they may not discover for days or weeks whether they have chosen the right answers. . . . A way to avoid this is assigning in-class, computer-assisted, or online exercises so that students can receive immediate feedback” [3, p. 81].

- “Instead of correcting’ student language, teachers should help students code-switch or translate’ their writing into whatever language variety is appropriate” [4, p. 55]

Rather than using terms such as “good English” or “bad English” in classrooms, teachers should use terms such as “informal” and “formal” to help students recognize what situations allow for various dialects to be used. “To help the students recognize the differences between formal and informal language, use chart paper to create a two-column chart and have students put examples in the chart” [4, p. 72] See Appendix A.

Methodology

The conceptual framework of my research consists of my belief that many people discredit AAVE as an English dialect and treat those who speak it as though they have a handicap. I wanted to understand how kindergarten teachers in public school classrooms accommodate students who speak a different home dialect than EAE. In this study, I observed three different kindergarten teachers’ teaching practices. Observations included different course subjects and interactions throughout the school day. The following day, as a group, the teachers answered questions regarding their pedagogy and interactions with their students related to grammar. I used a case study approach. After collecting my information, I used coding to organize my results.

With my study focusing on the teachers, I did not have enough interaction with the students to understand if they truly use AAVE, if they are able to use other dialects of English, or if the teaching practices of the teachers caused them to do better or worse. With this study, I can only point out how the teachers teach grammar and whether they actually use best practices.

When selecting where I would conduct this case study, I sought out a large and

diverse public school system. From there, I selected a nearby elementary school in which I had previously studied; I was already knowledgeable about the classroom routines and had a good relationship with the teachers since I had worked with them before. Three kindergarten teachers agreed to allow me to observe their teaching practices and participate in an interview about their teaching styles. Participant 1 was in her mid-20s, while Participants 2 and 3 were in their early to mid-30s. Their teaching experience ranged from six years to ten years.

The kindergarten classes at this particular school have the largest classroom size in the building. On average, there are 25 students in each kindergarten classroom. According to the school profile, 22% of the school speak English as a second language, and 36% are economically disadvantaged. Students represent the following groups: 46% African-American, 21% White Non-Hispanic, 10% Hispanic, 11% Asian/Pacific Islander, and 13% Other ([1]).

Prior to my observations, I had researched AAVE, as well as code-switching and teaching culturally diverse students. After collecting scholarly research, I composed a checklist of best teaching practices for teaching students who demonstrated usage of AAVE. (See Appendix A.) The checklist served as a tool to guide me through my observations. Examples of items that I looked for were how the teacher corrected students' grammar, whether or not teachers modeled Edited American English, and if teachers taught grammar in conjunction with writing. Based on my research question and checklist, I came up with five open-ended interview questions that asked participants to reflect on their knowledge of and experiences with AAVE and teaching grammar in the classroom.

Prior to observations, I briefly explained the topic of my research to the participants. I then chose two dates to conduct observations: one full day observation and one half day observation. Because Day 1 was field day for the elementary school, the classroom routine was slightly altered. The children spent two hours outside with field day festivities resulting in my being able to briefly converse with the teachers outside regarding their interactions with their students. I also was able to listen to the students and their dialog with their peers. The normal language arts lesson was not taught on this particular day due to the change in the schedule, so I was able to observe how the participants incorporated grammar into other course subjects and their teaching styles. Day 2 was spent observing more of how the participants taught grammar in conjunction with teaching other course

subjects, but I also had the opportunity to observe a writing workshop lesson. Participants reported they all conduct similar workshops each day as well. During the writing workshops, the participants teach grammar through whole-group activities, teaching new language arts concepts and then allowing the students to explore the concepts through writing stories, letters, etc.

A group interview was also conducted through electronic mail. While observing each participant, I used a checklist with a verbal frequency scale that rated the observed behavior as occurring always, often, or never. I also made note of specific instances where a teacher would correct a student's grammar or address/not address a student's grammar. After doing this, I used coding to analyze the interview transcripts to see how the participants' pedagogy aligned with their teaching practices.

Because of the time constraints with this research, it was difficult to see how teaching practices affected children's use of grammar. Had this been a longitudinal study, the results would be more reflective of how teaching practices affect students. Since this was a case study with observations in the same school, it may be difficult to generalize from the data.

Research Findings

All three participants had similar teaching strategies. Grammar instruction did not include the use of terms such as noun and verb. It was more informal without the use of technical terms. Lessons were designed so that students were passive and taught in a way that allowed students to receive instruction and then work independently so that the teacher could come around and conference one-on-one with students to offer help. A concept would be presented in a whole-group activity such as "complete sentences," and then students were dismissed to create stories that incorporated the concept. As the teacher and/or teacher assistant came around, they would help students convey their thoughts on paper. While doing this, the teacher would make sure students had complete sentences. A sentence that would be sufficient was "She is good" or "He is mad." If a student merely had "he mad," which is a sign of AAVE, the teacher would say "He IS mad" so that the child would change it; however, teachers did this without explanation*i.e.*,

teachers did not explain why “he mad” was not acceptable.

The three participants explained that their philosophy of teaching grammar is different than at higher grades because they want students to feel comfortable and safe in the school setting; they work on building a foundation through repetition of oral language. In their email communication, the participants stated that they feel it is unnecessary to make accommodations for dialects and that they focus on teaching acceptance.

While observing the three different participants, I saw a disconnect. The participants often modeled Edited American English in their writing and speech but would not always place as much importance on helping their students use Edited American English. Participant 1 explained that she would repeatedly correct students who were not using Edited American English. The participants said that should they encounter their students’ writing using AAVE, they would not tell them they were wrong or correct them because the students would become afraid to take risks and make mistakes. However, during an observed time of instruction, Participant 1 corrected a student by saying, “Make sure when you’re writing to say we were,’ not we was.’ It’s good English to say we were.”

Research on best practices indicates that making corrections like Participant 1 did is ineffective and can, in fact, make a student more likely to use vernacular features. “When a teacher tells a vernacular-speaking child that he or she shouldn’t say it like that’ or that the right way’ to show possession, plurality, past time, etc. is the Edited American English way, the teacher effectively seeks to repress, stamp out, or eradicate student language that differs from the standard written target” [4, p. 31]. In one instance Participant 1 referred to Edited American English as “good English.” I recall my grammar being corrected numerous times in grade school, and it caused me to be scared to speak because I felt I would be criticized and unable to get my thoughts across.

When I interviewed the participants, they seemed to understand that negating a student’s dialect in the classroom could be detrimental, but their teaching practices did not necessarily demonstrate this attitude. Also, in various instances participants did not help students’ to code-switch when they heard instances of AAVE being used in a formal setting. Judging by my own experience with grammar, this is typical. I have had plenty of teachers correct my writings with red pen but never explain to me why what I had written was incorrect; therefore, I

continued to make the same “errors” because I did not know what was wrong and could not change it in the future. This is what happens when we tell students that the way they are speaking or writing is incorrect and do not explain why or show them exactly how to make changes. In an increasingly diverse world, we are exposed to multiple versions of English, and we utilize them for different purposes. The way we talk in conversation on the Internet is much more informal than the way we speak to our superiors or career personnel. This does not mean that either is wrong, merely that there is a time and place for each dialect or register. For this reason we need to teach code-switching in our classrooms. Code-switching seeks “to contrast the home grammar with the school grammar so that instead of seeking to correct or eradicate home speech styles, language varieties are added to the child’s linguistic toolbox” [4, p. 38] . With Edited American English, the way we write is often different from everyday English. With AAVE, we can see that these everyday speech patterns have become a permanent feature of students’ verbal expression. Knowing this, teachers ought to seek to honor the home language of students by not dismissing it but using it in their instruction to teach situations that call for vernacular dialect or Edited American English. Helping students use contrastive analysis of the two dialects with charts such as Appendix B has proven to be an effective technique for teaching students to code-switch. Below are my suggestions for helping students both respect their home dialect and learn to speak and write in the prestige dialect, EAE.

Discussion

Recommendations for Teachers

- Familiarize yourself with various dialects and their features.
- Understand that the concept of “correct English” is a societal issue that does not negate the authenticity of a dialect.
- Do not correct language without explanation.
- Make and post a code-switching chart.

- Model code-switching in your classroom.
- Teach grammar in conjunction with writing, and include variety.
- Utilize texts that demonstrate current practices, such as [4]

Recommendations for Teacher Preparation Programs

- Include courses that train pre-service teachers in how to help their students code-switch between their home dialects and EAE.
- Include courses that emphasize the validity of all dialects. Questions for Future Research
- What do most teachers do to accommodate AAVE?
- What specific teaching practices are detrimental or beneficial to students in the long run?
- Are accommodations for dialects different, depending on the dialect?
- How does class size affect a teacher's ability to accommodate dialects?

Appendix A

Observed Behavior	Always	Often	Never
Teaches grammar in conjunction with writing			
Acknowledges different languages/dialects			
Corrects grammar in writing tasks			
Corrects grammar verbally			
Explains errors to students' in writing			
Explains errors to students in speaking/conversation			
Models EAE in writing			
Models EAE in speech			

Appendix B

Verb Patterns	Informal Use	Formal Use
Subject-verb agreement	She walk	She walks
Showing past time	I finish	I finished
Showing past time	She seen	She saw/had seen
Making negatives	She won't never	She won't ever
A versus An	A elephant	An elephant

This is an example of code-switching chart to help understand the differences between AAVE and EAE. By omitting the verb patterns column, the chart can become a classroom chart that students can utilize. The informal column shows sentences that use AAVE and the formal side shows sentences that are encouraged in students' writing. Teachers could allow students to add to the chart throughout the year [2].

References

- [1] Swans Creek Elementary School. 2008-09 school profile. URL <http://www.pwcs.edu/Departments/accountability/Profiles/Documents/SwansCreek.pdf>. Retrieved November 11, 2009.
- [2] C. Weaver. *Grammar to Enrich and Enhance Writing*. Heinemann, Portsmouth, 2008.
- [3] K.S. Webb and T. Redd. A teachers introduction to african american english: What a writing teacher should know. *National Council of Teachers of English.*, 2005.
- [4] R. Wheeler and R. Swords. Code-switching: teaching standard english in urban classrooms. *National Council of Teachers of English.*, 2006.
- [5] L. Zhang, S. Helensel, and H. Craig. African american english-speaking students: An examination of the relationship between dialect shifting and reading outcomes. *Journal of Speech Language and Hearing Research*, 52, 2009.

Student Biography

Jameka Jones is a Senior Liberal Studies major who is also pursuing minors in Spanish and Communication Studies. She plans to teach Head Start or kindergarten in Virginia in 2011. Outside of academics, she serves as President of the National Pan-Hellenic Council of Longwood University and holds numerous positions in her sorority. She also volunteers in the Farmville community and works at Cumberland County High School.

Faculty Biography

Robin Smith got her BA and MA in English literature from Longwood University and her PhD in instructional technology from George Mason University. Her research interests are the effects of digital technology on writing instruction and teacher preparation as well as English language, history, and social prejudices. She has three grown children, two of whom teach English.

Two Poems - Dust and Check out girls

Amy Ellis

Faculty Mentor: Mary Carroll-Hackett

Department of Creative Writing

Artist Statement

As a creative writer, I have learned the value of words – the way they sound, the way they feel as they roll off my tongue – and I have learned that poetry allows me to use my love of language to satisfy my hunger to describe how I feel and how I understand the world. Through my poetry, I have learned to develop my own voice and have found a place on the page to call my own. I have found that poetry allows me to pull off the mask I hide behind when I am around people, and expose what lies beneath an exterior personality I have carefully built, in order to blend in with the crowd. The stripping down of my exterior persona on the page allows me to work through my identity issues, intimate relationships, as well as a struggle I have recently begun with faith and trying to discover a sense of spirituality and how this affects the relationship I have with my family. However, I have learned that because of the highly confessional nature of my poems, there is a delicate balance between writing for myself and writing for an audience. With the intention of becoming a working writer, I had to learn this balance. I find that being able to portray situations and emotions that I have been through somewhat objectively allows me to not only soothe an inner drive to release but also attempt to give the reader an understanding of an emotion I've felt, a situation I have been through.

Though I tend to lean toward a confessional nature, I also use my poetry as not only a way to understand myself but as a way to understand the world around me and the way people interact with one another. I enjoy watching people and writing

people- new characters to introduce, even for a second. My interest in understanding the world around me has led me to attempt to explore the intimacy and depth in mundane, daily activities from going to the grocery stores to finding trash on the side of the street. I find that despite appearances, there is always something a little more complex hiding behind a jar of spaghetti sauce or the paperclip I untwisted a couple days before. The things people overlook always seem to be the things I enjoy writing about most, whether it's a conscious decision to ignore something overtly dark or a subconscious day-to-day activity that seems meaningless and routine. Poetry, for me, allows me to show the situations everyone faces and breathe a new sense of understanding as well as an alternate perspective.

Dust

God is the church with burgundy carpet
and the grey and white choir loft behind the preacher.
He is brass candelabras with light bulbs that never seem to burn out.
He is the choir in new crimson robes
paid for by donations from my grandmother's funeral.
God is the dust on the pews.
He is the Sunday dinner we consume after prayer
and communion of Welch's grape juice.
He is my grandmother's voice when the choir sings
hymns from old brown books that smell like rain.
God is her ashes thrown in Swift Creek the day she turned to dust.
He is the pipe organ in the Episcopal Church
where I saw a marriage under dusty copies of Ten Commandments.
He is the gray, stained carpet in the newly founded church
in a strip center next to the local pub.
God is the dust on second hand hymnals
in that strip-center worship service.

Check out girls

Lazy check out girls with wheat color hair ignore
the battered women in the store, arguing
over bruised apples and pears,
where spoiled peaches line shelves
and lettuce melts into green puss in dim refrigerator units.
Aisle Six holds broken tomato sauce jars.
A hungry infant screeches in a dingy baby carriage.
Children scatter from passive parents,
knocking over boxes of stale crackers in sale displays.
Tired women with eyes wrinkled like prunes scribble checks,
praying they won't bounce,
and two employees fuck on their lunch breaks
in the backseat of a rusty blue Chevrolet.
Tiny blonde sisters argue over the last box of animal crackers.
Moms brush them off, staring at calorie counts,
while husbands grab the wrong bag of baking potatoes.

Student Biography

Amy Ellis is currently a sophomore at Longwood University pursuing an undergraduate degree in Creative Writing with a minor in Children's Literature. She focuses primarily on writing poetry and occasionally writes fiction. After graduation, she plans to pursue a career in editing, in order to continue her writing habit.

Faculty Biography

Mary Carroll-Hackett took the MFA in Fiction from Bennington College in June 2003. Her work has appeared in *Carolina Quarterly*, *Clackamas Literary Review*, and *Reed*, among numerous other literary journals. Her first book, *What the Potter Said*, was released in July 2005. One of her stories, "Placing," received a 2009 recommendation from the PEN/O. Henry Prize Stories Series. She currently directs Creative Writing at Longwood University in Farmville, VA, where she also edits *The Dos Passos Review* and administers the Liam Rector First Book Prize for Poetry with Briery Creek Press.

Three Poems - Rosewood Massacre, 1923, and Jarring and Reverence

Ashley Maser

Faculty Mentor: Mary Carroll-Hackett

Department of Creative Writing

Artist Statement

The ability to construct images with the potential to evoke emotion in the reader's mind is a characteristic unique to poets. I was first introduced to poetry through Longwood University's Creative Writing Program, and my interest peaked in the works of confessional poets. Their combination of imagery and personal experience, the understandings which their work offers to the reader, fascinates me. As I experimented with language and narrative voice, reoccurring themes emerged in my poetry, specifically explorations of intolerance and morality. Growing up, I was often exposed to the views of openly prejudiced family and community members. In exploring my own personal experiences and crafting similar fictional representations in my poetry I gained a great deal of insight into the affect racism had on my identity. As a child, I was taught that the expression of our beliefs and thoughts is a right earned through age or through agreement, which meant correcting adults was out of the question. This gave rise to a strong sense of frustration, one I am now able to channel in my work. Though I enjoy the writing process I constantly remind myself that as poets we write to be read, that I must make my experiences significant to the audience. Ultimately, I aim to compose poetry which guides the reader in interpreting its images, allowing them to reach the same conclusions my experiences have drawn from me.

Rosewood Massacre, 1923

White ivory snakes through tipu timber,
deep rosewood grain glossed in sable,
my grandfather's initials etched in the surface
CRM

Thick fingers pressed against a letter opener,
his only calm amongst a clutter of
tax forms and tape dispensers,
staples and sticky notes,
model fire engines, mechanical pencils,
glasses that hung on his sagging ears
in place of a helmet's soot soaked shield.

His face singed in the heat of burning buildings,
hands charred, pulling at ashen bodies.
He could have been a hero in the massacre,
but not my grandfather, not an old bigot like him.
All he left to me, his ivory inlaid desk,
is a rosewood reminder of them.

Jarring

*No story is the same to us after a lapse of time;
or rather we who read it are no longer the same interpreters.*

– George Elliot

My grandfather wags his finger at me,
docked like a Doberman's tail
it's green on a shelf somewhere in Italy
he says, now I'm picturing his pointer

encased in glass and preserved
on our mantle, my grandfather
framed in his white sailor's uniform
standing beneath Pisa.

On our porch in June of 96 he tells us stories of Europe,
how he jarred pickles with the Germans, his hands
in factory machines, clearing the brine

of bodies on the beach, boys
with necks white and wet as sand,
hands clutching the metal barrels
pressed between their ribs.

In our kitchen, he drinks tea, coaxes it down,
patting his chest with absent fingers,
shirt pocket stretched around a pack of Winston-Salems.

People don't spice them right anymore
he says, *come out too sour or too sweet.*

I bet he was out front when he lost them,
gun barring his chest, muscles moving beneath
the anchor on his forearm

he pulls out a cigarette, you have to *sterilize*
the jars he says, sucking the flame back in his throat,
heat them up and kill the germs

burn the still there feeling, the consciousness
of lost limbsbeneath boats wisps of silt seep out
into the English channel and dissipate in the water
like spirits.

Reverence

I watch my uncle swing his axe into white oak, branches strain toward the shed, swollen shoots and tendrils pry under the eave. Below thin black gauze, a weathered weed barrier, roots work against mortar and brick. Each blow hollow the crack of bats and soft pitches ringing from a neighboring youth field.

Downstairs my aunt steams crabs, the smell of old bay and butter seep through Berber, she calls dinner and spreads a Sunday paper over the kitchen table, sets the bushel over the local news.

Remember Mrs. Harper's niece, pretty blonde girl? she asks. My mother cracks open a crab, shell splaying beneath her wooden mallet.

Well, she's married now, glancing over her glasses, she sucks the marrow of pink muscle from a claw, and he's a black boy the exposed white of tendons, pale, shell-less strands, soak newsprint.

My mother flips the crab on her plate, peels open its chest and I circle Lucy's blue dress on the damp paper, waiting for her to speak.

We leave the visceral mess of dinner strewn along the table and walk to the car, my uncle hammering his dull cadence, blunted edge to bark. I can't tell her what to say in her own house, she says. In summer, I imagine the oak will have wrapped itself in the rafters.

Student Biography

Ashley Maser is a native of Chesapeake, Virginia. She is currently studying English and Creative Writing at Longwood University in Farmville, Virginia. Her poetry is forthcoming in *The Foundling Review* and *Writers' Bloc*.

Faculty Biography

Mary Carroll-Hackett took the MFA in Fiction from Bennington College in June 2003. Her work has appeared in *Carolina Quarterly*, *Clackamas Literary Review*, and *Reed*, among numerous other literary journals. Her first book, *What the Potter Said*, was released in July 2005. One of her stories, "Placing," received a 2009 recommendation from the PEN/O. Henry Prize Stories Series. She currently directs Creative Writing at Longwood University in Farmville, VA, where she also edits *The Dos Passos Review* and administers the Liam Rector First Book Prize for Poetry with Briery Creek Press.

Three Poems – Dirty Thunderstorm, and Summer Hide 'n Seek Car Tag and Bliss

Erikk Shupp

Faculty Mentor: Mary Carroll-Hackett

Department of Creative Writing

Artist Statement

Poetry isn't "ladi dadi lets write about romance and flowers, hold hands and reiterate massive amounts of cliché". It's about making the reader think; think with cliché on the mind and slap them with originality. Poetry is about the sounds that carry subconscious meaning into the poem; about the beat, the music of words when read aloud. Poetry is about being the invoker, not an evoking cattle prod that tells the reader, "here, come and look at this. See that? That's what this means." It's more about letting the reader get shocked with the cattle prod and letting the reader react the way they see fit. Poetry to me is not just personal expression, but allowing others to discover something through my perspective.

Revision is a paint brush and a sledge hammer. I paint a lyrical picture but use too much paint; so the planned apple picture becomes the Jason Pollock granny smith with fig branches crusted over it, as it bobs in an ocean of fire (see, it just happened.) That's where the hammer comes in. I take that revision hammer and smack the crusted paint off of it and let the bare bones shine through. The poetry process comes as a creation and destruction and that's why I even enjoy revision.

Dirty Thunderstorm

Chaiten births the plumes of ash, a stratus evaporated from Lucifer's realm. Its limbs, clouds that once buried Pompey seething with excess static, beautiful/ destruction that would be Apocalypse, the enveloping black, breathing the four horsemen on their chariots, wrecking villas within the span of explosion. It looms over, granting survivors glimpses of hell, the essence of a perverted nature crawling the grounds with high volt tendrils, seeping, seething through the a young Chilean boy's nightmares/ It beckons the villagers to accept doom as it dissipates back to the earth, leaving behind a mercy they will never see in this life again.

Summer Hide 'n Seek Car Tag

A phenomenal way to escape the heat
before us kids ever cared
about the green house gases
or inflated petrol prices.

Bliss

Days where rain drifts
down slow to cool dry

places, we never thought to travel
Ethiopia, Sydney, Korea

Mexico, savory blends of a Chipotle burrito:
spicy peppers, sweet corn, salty pork; bitter

with a cup of espresso, eye opener,
staring at moving screens up until

dawn, entangled legs, she hears my heart
beat, the warmth from her lips press

so deep like limited realms of space,
dumb little glow flies stuck in wet tar.

Student Biography

Erikk Lee Shupp is currently an Undergrad Student at Longwood University's English Creative Writing Program. A young man hailing from Herndon, Virginia, he writes poetry, non-fiction and screenplays. He has had poems published in *Short, Fast and Deadly* and *The Willows Wept Review*. Shupp currently serves on the Student Editorial Board for *The Dos Passos Review*.

Faculty Biography

Mary Carroll-Hackett took the MFA in Fiction from Bennington College in June 2003. Her work has appeared in *Carolina Quarterly*, *Clackamas Literary Review*, and *Reed*, among numerous other literary journals. Her first book, *What the Potter Said*, was released in July 2005. One of her stories, "Placing," received a 2009 recommendation from the PEN/O. Henry Prize Stories Series. She currently directs Creative Writing at Longwood University in Farmville, VA, where she also edits *The Dos Passos Review* and administers the Liam Rector First Book Prize for Poetry with Briery Creek Press.

6 Visual Art

Analysis of the Wilton Diptych

Jamie Yurasits
Faculty Mentor: Erin Devine
Department of Art



Figure 1: The Wilton Diptych [2]

Over many centuries, the mysteries and meanings behind the Wilton Diptych have entranced researchers as they have sought to uncover them. This exceedingly rare piece of artwork, which illustrates the devotion of King Richard II to the Virgin and Child, has been considered to be the “most famous panel-painting to survive from medieval England.”[4] While little is known about where the Wilton Diptych was made and who created it, there is no question that it holds a deep

significance within its symbols and icons. Not only does the panel painting radiate a feeling of divinity with its allusion to the salvation of mankind by Christ, but it is also a source of commanding political propaganda. The religious and political focuses evident in the diptych help us to better understand the culture of this time period.

Regarded as an elegant and enigmatic masterpiece, the diptych was created during the late Fourteenth Century as a portable altarpiece for King Richard II's private religious devotion. Many believe the piece of artwork was made during the last four years of King Richard II's reign from 1395-1399[7]. A diptych is a painting, carving, or piece of metalwork created on two panels usually hinged together. The panels and gilded frames of the diptych are made from Baltic oak while the illustrations are painted on a prepared gold background in egg tempera-pigment mixed with egg which enhances the full purity of the color and covered in translucent glazes[7, *ibid.*]. The panel painting received its title from the Wilton House in Wiltshire where it was found and remained from 1705 to 1929[3]. The diptych can now be found in The National Gallery in London, England[2].

On the inside of the diptych, King Richard is presented by three saints to the Virgin and Child with a group of eleven angels. The saints include Richard's patron Saint John the Baptist, Saint Edward the Confessor, and Saint Edmund. Both Edward and Edmund were previous kings who were venerated as saints. Saint John is pictured holding a lamb, which symbolizes the Lamb of God, or Jesus Christ. Saint Edward is holding the ring that he gave to who believed was a pilgrim but according to legend was in fact St. John the Evangelist. Saint Edmund is carrying an arrow that represents the arrow with which the Danish Vikings killed him in 869[10]. The halo placed above Christ is decorated in pointilla pattern formed of dots incised using a fine point with the nails and a crown of thorns both prefiguring the Crucifixion[3]. One of the angels carries a staff with a pennon, or banner, topped by an orb on which a tiny island is painted. The barely visible island is believed to symbolize the island of Britain and refer to the dowry of the Virgin Mary. This island is a recent discovery that was only found when the diptych was cleaned and restored several years ago. The red cross of St. George on the pennon also refers to the Christ's Resurrection. On the exterior of the diptych, viewers can observe Richard's coat of arms. A lion stands on a cap of maintenance and a helmet above a shield bearing the Royal arms of England

and France, impaled with the mythical arms of Edward the Confessor[6]. His personal emblem of a chained white hart, also known as a stag, with a crown around its neck lying on various plants is also visible.

By studying the intricate details and various techniques evident in the diptych, we can recognize the distinguished style of this work of art. An important theme noticed throughout the work is heraldry: the study and art of armorial bearings, insignia, and symbols. We can see this theme through the inclusion of King Richard's coat of arms and emblems. The imaginary arms of Edward the Confessor are impaled with the arms of England, which indicates a specific date in time. Richard began to display his arms in this way only from 1395 onwards[2]. Heraldry is also apparent on the panel in which Richard and the angels are shown wearing the liveries of Richard the white hart. Flowering lines and delicate motifs combine to create the artistic style of the painting[5]. The subtle and gentle gestures of the Virgin and the angels emphasize the significance of line and composition in the diptych's refined style. We see the style again through the foreshortened placement of figures common at this time, such as the posture of the kneeling angel on the left side of the diptych. The artist makes use of studies from nature in the flowers that adorn the panel, once more affecting the artwork's period style[5, *ibid.*].

The creator of the Wilton Diptych has been theorized by researchers to be one of several different people. The actual artist of the diptych is unknown. Several experts have hypothesized that an Englishman or Frenchman could have been the possible creator of the diptych due to the fact that it was made for a king of England, while others propose that an Italian or a Bohemian was the artist responsible for this masterpiece[2]. Many of these types of early paintings cannot be matched with a specific painter. Before the 15th century, the practice of signing a completed piece of artwork was not widespread or popular. The majority of earlier artists would have never considered putting such a personal mark on the object that they had created, especially if it was to be used for religious purposes such as this diptych. During this age, a painter would usually work collaboratively with others, training as part of a studio that was run by a master artist. These master artists would also work with artists of similar status in order to efficiently combine different talents. Therefore, paintings were rarely the result of one hand' alone, and their makers did not consider themselves as unique individuals in the

way that artists have done in later years[3]. Because of this known partnership between multiple artists at this time, other researchers suggest the Wilton Diptych was the result of several different painters.

One of the few proven facts of the Wilton Diptych is that it was made for and commissioned by King Richard II as an item for his private devotion[4]. During his reign, King Richard was a strong proponent of the “fusion of secular and religious ideas.”[1]. The diptych is a vastly complex expression of this concept, in which every component of the painting contributes to a very personalized, private meaning. Due to this intense focus on the merging of government and religion, the Wilton Diptych formed a new and grand representation of the monarchy[1, *ibid.*]. Since the diptych was created for Richard personally, his preferences would have largely affected the artistic decisions concerning the work. On the panels, King Richard II and his patron saint are illustrated along with his personal arms and emblem, all features which King Richard most likely requested to be painted on the diptych. While his specific demands would have limited the subject matter of the work, they would not have restricted the different ways to portray and interpret its divine focus.

From the time when the diptych was recovered, experts have proposed divergent interpretations of the artwork’s deeper meaning. Some suggest the panel is “powerful political propaganda in support of an exalted image of monarchy.”[8] Because the diptych expresses an obvious focus on King Richard and illustrates him being blessed by the Christ Child, many consider the diptych an effort to suggest the monarchy holds heavenly power. The use of these religious figures and symbols is meant to imply an endorsement from a higher rule. Others believe religion and devotion are the more central themes. The work was clearly created as a focus of prayer with a specific purpose in mind[9]. Its religious center is enhanced by the thoughtful placement of punched gold leaf on key details of the painting that would be illuminated when seen by candlelight. Important details of the painting, such as those found in the banner, all allude to the salvation of mankind by Christ[6]. The red cross on the flag is also said to represent the Passion of Christ. One final piece of evidence that furthers the idea of salvation is seen on the orb atop the banner. The small island that is located on the orb presents the island of Britain as the dowry of the Virgin, which explains the hand gestures of the figures that are open in blessing and offering[6, *ibid.*].

There are several reasons behind my selection of this piece of artwork to research. Initially, I chose the Wilton Diptych because the vibrant colors included in the work and the realistic depiction of the people caught my attention. The luscious colors are essential in allowing the artwork to exude a sense of divinity and serenity. The figures illustrated on the diptych are near proportional and produce a closer sense of reality. Unlike most other religious works of this time period in which the Christ Child resembles the appearance of an undersized grown man, the Christ painted on the diptych is depicted in the form of an infant. His body features exhibit more child-like proportions and his small frame is cradled by the Virgin Mary in the same manner as a baby. The extreme attention to detail throughout the work of art was also intriguing to me. Each figure displays elaborate ornamentation on his or her robes and clothing which hold minute aspects that would go unnoticed without careful examination. I was attracted by the rarity and expensive qualities of the diptych as well. This artwork is a remarkably rare survival of a Late Medieval religious panel painting; only a few examples remain in this excellent of quality today. Furthermore, the materials used to create this piece of artwork were very valuable and highly expensive during the time in which it was created, making it an especially unique work of art.

Although the religious premise of the Wilton Diptych appears obvious at first glance, the panel painting holds many mysterious facets that keep researchers intrigued centuries after its creation. Constructed as an object of personal devotion for King Richard II, the diptych displays many allusions to the blending of worldly and holy beliefs through the complex details elaborately illustrated. The hidden political and sacred meanings of the diptych heighten people's captivated interest in this medieval masterpiece, granting them a significant glimpse into the culture of the middle ages.

References

- [1] Judith Bumpas. A medieval enigma. In *The Art Book*, volume 6.2, pages 6–8. 1999.
- [2] The Wilton Diptych. The national gallery. Retrieved from <http://www.nationalgallery.org.uk/server/php?show=>

conObject . 574 28 Oct, 2009.

- [3] The Wilton Diptych. The university of london. Retrieved form <http://www.history.ac.uk/richardII/wilton.html> 28 October, 2009, 2007.
- [4] C. Given-Wilson. *The English Historical Review*. 1996. pages 691-692.
- [5] E.H. Gombrich. *The Story of Art*. Phaidon Limited, New York, 12th edition, 1972.
- [6] Dillian Gordon. A new discovery in the wilton diptych. In *The Burlington Magazine*, volume 134.1075, pages 662–667. 1992.
- [7] Dillian Gordon. *Making and Meaning: The Wilton Diptych*. Yale UP, London, 1994.
- [8] Christopher Tyerman. *England and the Crusades, 1095-1588*. The University of Chicago, Chicago, 1988.
- [9] Nigel Warburton. *The Art Question*. Routledge, New York, 2003.
- [10] Francais Wormald. The wilton diptych. *Journal of the Warburg and Courtauld Institutes*, 17(3/4):191–203, 1954.

A Collection of Visual Art

Various Artists



Figure 1: "Nod" Alexander Leonhart

Artist Statement – Alexander Leonhart

My personal viewing of world was solved was by subtraction of a key element within the camera frame. These figures in this photography collection are connected through their lack of a physical face that is replaced with cloth. Morphing these fabrics one then creates a familiar face from their imagination.

Often we assume what is underneath. People wear all kinds of clothing that hides their body both in the physical and mental realms. These decorated figures are devices to ignite the thought behind assumption and have the viewer consciously make the decision of what kind of being they are viewing.

This project encourages the viewers to look with the photographer and complete the images. Adapting the folds into expressions the viewer finds out about



Figure 2: "Corriline" Alexander Leonhart

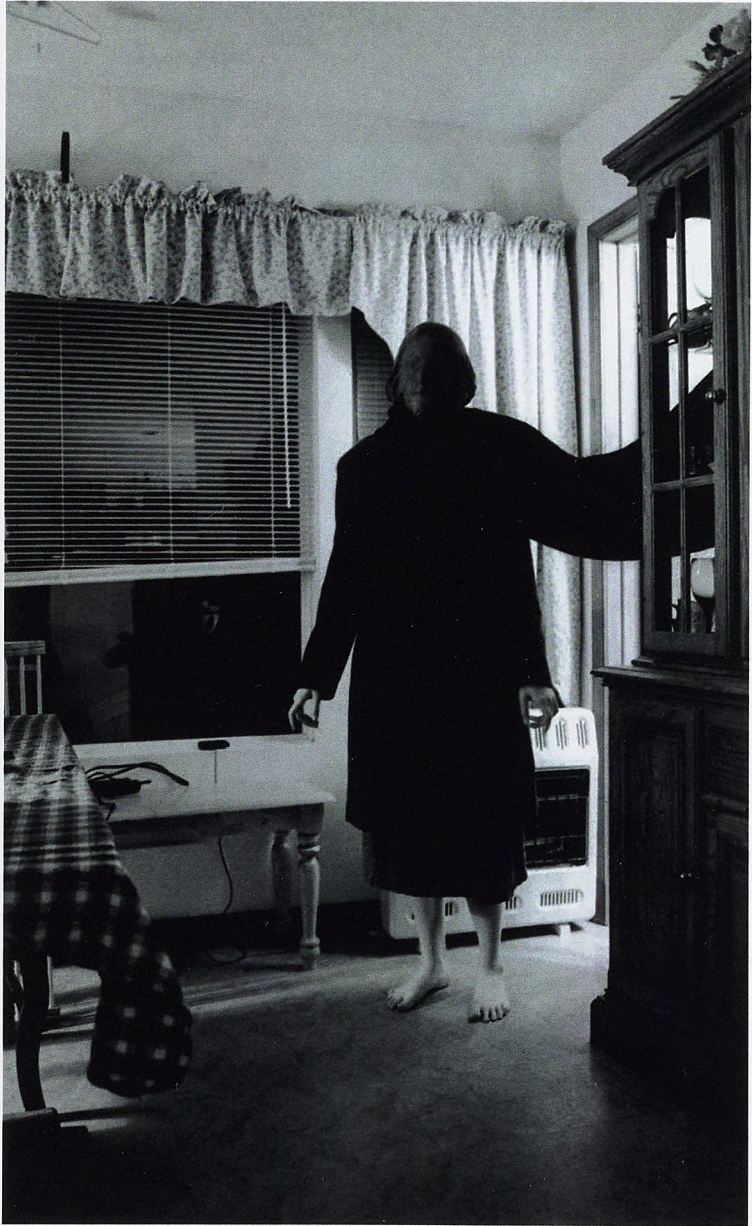


Figure 3: "Flying" Alexander Leonhart



Figure 4: "Familier" Alexander Leonhart

themselves while engaged in the decision making process. Happy, sad, some people might prefer to think there is no face underneath. These portraits solve looking by shielding the face of the person with fabric and allowing the viewer to use their own to imagination solve the conundrum of what they are seeing. Seeing is forgetting the name of the thing one sees



Figure 5: Kenny Wolfe and Sally Meadows

Artist Statement – Kenny Wolfe and Sally Meadows

Kenny Wolfe and Sally Meadows researched the history of papermaking and collaboratively investigated the sustainable use of reconstituting clothing as a source for paper pulp. Wolfe and Meadows cut up over forty pounds of old clothes, bed sheets, and fabric in order to make new paper. The process included slicing fabric into half inch squares, breaking down the cloth in a 2 pound Reina beater, suspending the slurry of fibers in a vat of water, and forming a western style sheet. Water was then removed from the sheet using a fifty-ton hydraulic press. Individual sheets of paper were placed into a restraint dried for twenty-four hours. Using this recycled pulp, they experimented with many different papermaking techniques in-

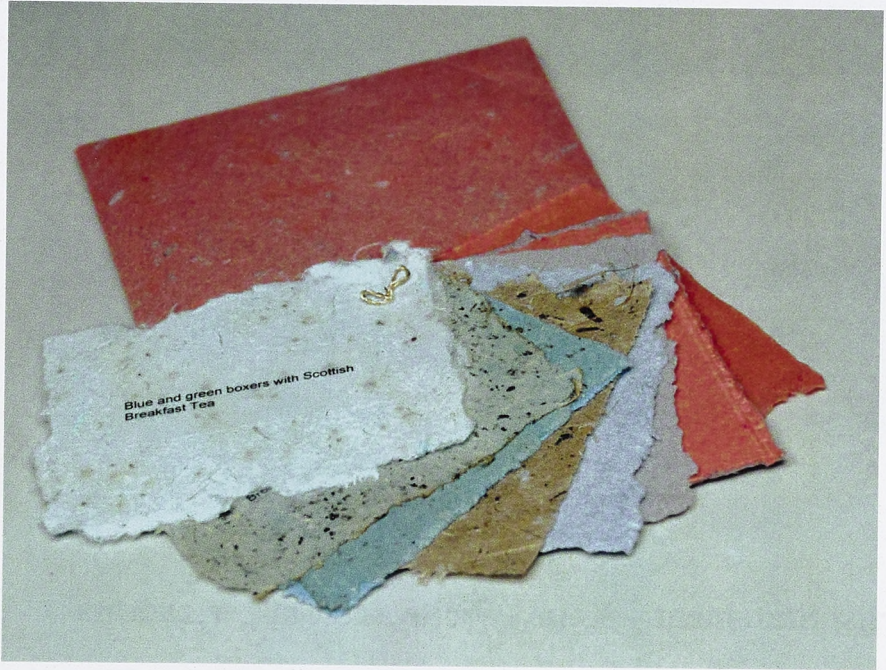


Figure 6: Kenny Wolfe and Sally Meadows



Figure 7: Kenny Wolfe and Sally Meadows

cluding double-couching, watermarking, cover and text weight thickness, and inclusions (such as photographs and tea). From these laborious results, they created impressive stacks of paper and paper sample books.

Student Biography

Kenny Wolfe is a senior graduating in the spring of 2010 with a BFA concentration in Photography. Throughout his papermaking independent study he focused on finding ways to incorporate photographs into his paper recipes using different methods such as inclusions and double-couching.

Sally Meadows is a senior graduating in the fall of 2010 with a BFA concentration in Art Education. Throughout the papermaking independent investigation she focused on finding various methods and materials that can be incorporated into high school classroom curriculum.

Faculty Biography

Kerri Cushman is an Associate Professor who joined Longwood University's Art Department in 2005. She holds an MFA in Interdisciplinary Book & Paper Arts from Columbia College Chicago, IL. Known for her sculptural artist books, her work has been shown in over 100 exhibitions both in the United States and internationally including Egypt, France, United Kingdom, Scotland, and Switzerland.



Figure 8: "Plant" J. Haley, Amy Jackson, Morgan Howard

Artist Statement – J. Haley, Amy Jackson, Morgan Howard

Eventually in the quest for ground, sustenance, and survival, plants will become carnivorous. Such plants will generate tentacles in order to wrangle or catch their prey, drawing victims in with its bright color. Certain parts of the plants will aid in digestion while other parts serve as poison. Using its tentacles, the plant drags its victim closer to its poisonous spoon shaped stamen. The deep purple ear-like leaves digest the victim thus sustaining the plant for two months until the next feeding.

Our idea was to present a plant of science fiction that invades the viewer's space forcing one to avoid the deadly grasp of the creature. The tentacles stretch out, grabbing the viewer while the conical stamen-like objects creep up the wall—away from the plant. These root-like tentacles slither, waiting to nab and incapac-

itate victims that lie outside its reach.

Our project is inspired by the combination of three plants; the Spoon Jade (*Crassula Portulacea*), the Staghorn Fern (*Platycerium Hotummii*) and the Deer's or Hare's Foot Fern (*Davallia Canariensis*). While examining these plants in the green house, each plant inspired terror in us. The ear-like growth of the Staghorn Fern coupled with tentacle appendages of the Deer's Foot Fern was reminiscent of a man-eating, villainous plant. The Staghorn Fern, considered an "air" plant, does not need soil and thus inspired the wall installation. The Deer's Foot Fern's spidery vine inspired an appendage that could incapacitate the victim in one grasp. The shaped leaves of the Spoon Jade plant added to the science fiction appeal of a creature with a mind of its own.

Student Biography

J. Haley- is an Art Education Major with a concentration in Printmaking and Book Arts. His work is influenced by contemporary and urban art. Through various experiences with paper, ink, and process his artistic vision vacillates between three-dimensional sculptural forms and graphic contemporary print media. In addition being an artist, J. is an accomplished and published chef.

Amy Jackson is a junior in the Art Department at Longwood University studying Printmaking and Book Arts. Her interests include bookbinding, conservation, and investigating paper as a sculptural medium. She spends her summers interning at Cattail Run handbook bindery in Winchester, VA. She has been saving books since 2007. She is a member of the Friends of Dard Hunter International Hand Papermaking Organization.

Morgan Howard- As a student studying Crafts, she values the physical aspect of material manipulation. Focusing on ceramics, her interest lies in hand-building sculptures and pottery. Her work explores the relationship between the artist, his/her medium and how this reciprocation continually unfolds.

Faculty Biography

Kerri Cushman is an Associate Professor who joined Longwood University's Art Department in 2005. She holds an MFA in Interdisciplinary Book & Paper Arts from Columbia College Chicago, IL. Known for her sculptural artist books, her work has been shown in over 100 exhibitions both in the United States and internationally including Egypt, France, United Kingdom, Scotland, and Switzerland.

Artist Statement – Amy Jackson, Adrienne Heinbaugh, Melissa Dorton

Last semester during the course of a newly offered Editions class we had the privilege of designing, crafting, and printing the invitations for the October 2009 Friends of Dard Hunter International Organization of Hand Papermakers Annual Meeting in Atlanta, Georgia. Over the course of five months we brought this project to completion, with an end result of over 500 postcards made with handmade paper, letterpress printing, and multicolor linocut prints. In addition, 250 handmade paper folders were designed, created, letterpress printed, and distributed to all participants at the conference. The process began with little to no information about Dard Hunter, his organization, or the daunting task ahead. The class researched the life of the historic papermaker and the question at hand was “Who was Dard Hunter?” and “What would Dard do?” It became evident that Dard Hunter would have had his hand in every step of the process. That was the philosophy under which the Dard Cards were created.

Being a skilled and groundbreaking American papermaker, Dard Hunter would have most definitely have pulled his own paper for the cards. Adrienne Heinbaugh and Melissa Dorton focused on creating a durable paper that would survive the mail, be pleasing to the eye, be receptive to the printing processes it would endure, and fit into the aesthetics of the period and style characterized Dard Hunter’s work. The 500 cards were made in a variety of colors, and were double-couched allowing each side to be a different color. The double-couching also allowed for extra strength, as did the abaca (banana leaf) fiber added to recycled cotton fabric. After experimentation it was found that a 75% cotton to 25% abaca pulp ratio was the ultimate formula for the cards.

After the paper was made it was cut down and readied for the printing process. Using a Chandler and Price clamshell press the cards were hand letter-pressed with a variety of different inks. Amy Jackson, using the typesetting skills attained while working at Cat Tail Run Hand Bookbindery, designed and set the type for the informative side of the postcard. Only three different hand set fonts were used, for they were appropriate for the time period and bore a resemblance to the original fonts created by Dard Hunter.



Figure 9: "Dare to Dard" Amy Jackson, Adrienne Heinbaugh, Melissa Dorton

The final step was to print the front design on the cards. Adrienne drew an Art Nouveau inspired floral design. Melissa cut the two needed linoleum blocks for each color in the design. The linoleum blocks were then set in the clamshell press and inked in several colors that complemented the handmade paper. Adrienne, Melissa, and Amy printed the designs on all 500 cards, which is a total of 2000 passes through the press. Over the course of five months 50 plus hours were spent making paper and printing respectively. The Dard Cards' were mailed throughout the United States to all the members of organization.

The Executive Board was so impressed, that we were asked to create a traditional two-pocket folder to house all the materials distributed by the organization at the October 2009 conference. Over summer we continued researching and investigating fibers that could be used to fabricate the strongest paper (using recycled fabric) that printed well. All in all, this research consisted of testing the strength of paper, using variations of pigments to achieve mottled coloring, and experimentation with rubber-based inks.

The process of creating paper for the folders required cutting up mounds of cotton clothing and running the fiber through a two pound papermaking beater. Over 75 gallons of pulp were prepared and formed into sheets. Letterpress printing was achieved though skillful placement of polymer plates made from digitized font originally designed by Dard Hunter. The entire folder was printed using a Vandercook No. 4 flatbed cylinder printing press. The folders were designed to hold a business card and riveted at the sides.

We attended the International Organization of Hand Papermakers Annual Meeting in Atlanta, Georgia, reaping the fruits of our labor in a professional setting, as well as gleaning information about the organization and the process of hand papermaking. We presented our work and research, "Dare 2 Dard" to an international audience at the Student and Emerging Artist Showcase session at the October conference..

Student Biography

Amy Jackson is a junior in the Art Department at Longwood University studying Printmaking and Book Arts. Her interests include bookbinding, conservation, and

investigating paper as a sculptural medium. She spends her summers interning at Cattail Run handbook bindery in Winchester, VA. She has been saving books since 2007. All three are proud to be new members of the Friends of Dard Hunter International Organization of Hand Papermakers. Adrienne Heinbaugh (BFA Crafts, 2009) and Melissa Dorton (BFA Printmaking & Book Arts, 2009) are alumni of the Longwood University Art Department. They are in the process of establishing their own papermaking studio, Good Natured Paper.

Faculty Biography

Kerri Cushman is an Associate Professor who joined Longwood University's Art Department in 2005. She holds an MFA in Interdisciplinary Book & Paper Arts from Columbia College Chicago, IL. Known for her sculptural artist books, her work has been shown in over 100 exhibitions both in the United States and internationally including Egypt, France, United Kingdom, Scotland, and Switzerland.



Figure 10: "Untitled" Hopson

Artist Statement – Hopson

This series is about revealing.

I photograph the backs of houses because that is where people hide things. By displaying the backs of houses, I've revealed the private as public.

I am white trash.

My mother is black and my father is white. Here, a person of mixed blood is called white trash. This piece of information played a major role in my process when picking which houses to photograph.

I am the product of an affair. The private act that produced me has complicated my life. I've pushed this issue to the back of my mind because I didn't want to reveal it to myself. By using photography to display people's realities I've come to terms with my own.



Figure 11: "Untitled" Hopson



Figure 12: "Untitled" Hopson

Revealing is liberation.

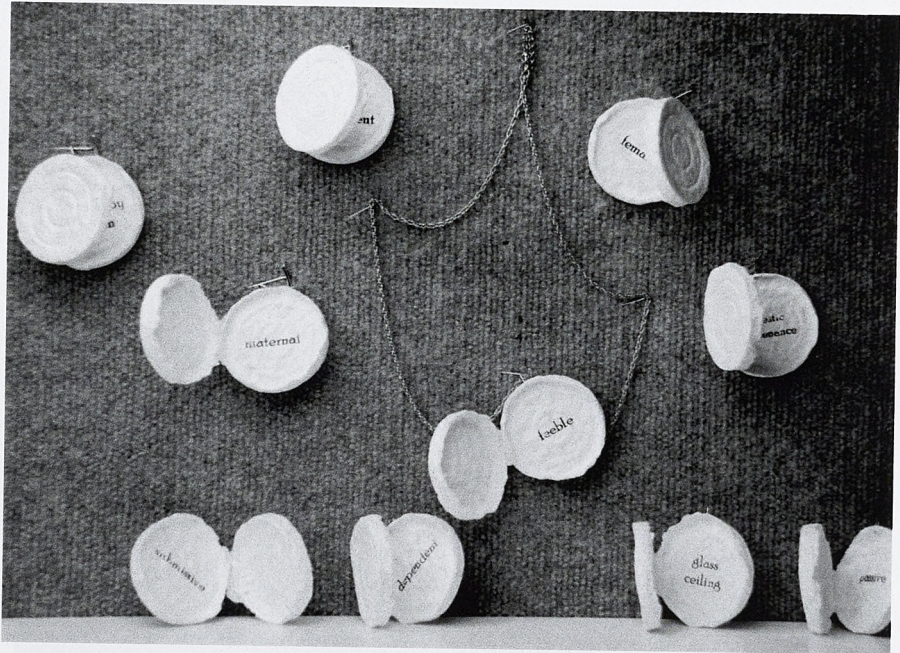


Figure 13: "Locketts" Morgan Howard

Artist Statement – Morgan Howard

Even today, there is little equality between the sexes. Women make less money than men, are still the subject of crude jokes, and are still seen as feeble individuals. As women, we dress up to feel attractive and desirable to the opposite sex. However, the jewelry we wear to heighten our femininity may be working against us. We wear locketts to keep something near to our hearts. It may be a photograph or a note; a gift of sentimental value.

Inspired by inequality between the male and female in society, I created locketts as an object representing the stereotypical female image. Inside each locket is a word embodying the female identity some still hold today. These locketts contain something we, as women, do not want perpetuated. We are presented as

sex symbols in the media exemplified by what jewelry and clothes we wear. By wearing jewelry we are unintentionally supporting the submissive and feeble role of women. The locket that sits upon our chests close to our hearts are not holding sentimental value, but are holding years of inequality. This inequality then sits near and dear to our hearts fostering our acceptance of this submissive role.

Student Biography

Morgan Howard- As a student studying Crafts, she values the physical aspect of material manipulation. Focusing on ceramics, her interest lies in hand-building sculptures and pottery. Her work explores the relationship between the artist, his/her medium and how this reciprocation continually unfolds.

Faculty Biography

Kerri Cushman is an Associate Professor who joined Longwood University's Art Department in 2005. She holds an MFA in Interdisciplinary Book & Paper Arts from Columbia College Chicago, IL. Known for her sculptural artist books, her work has been shown in over 100 exhibitions both in the United States and internationally including Egypt, France, United Kingdom, Scotland, and Switzerland.

Artist Statement – Ciarra Stalker

As the eldest of four children, I have always been an example to my siblings. Whether good or bad, I have been a considerable influence on my two younger sisters. Inadvertently, that made me an example to the people they interacted with, thus beginning (or continuing) an endless waterfall of influence. That influence was unconsciously made, but it nonetheless impacted lives. Likewise every individual's influence trickles into a universal phenomenon.

This series is a sociological study through photographs. These photos inquire what motivates young women's choices. I have used the formal qualities of the photographic frame to divide each image such that they convey a sense of tension. In some of the photos, that tension is between individuals and sometimes the images convey a sense of internal conflict-anxiety.

I have photographed females between the ages of 12 and 21. This time span between girl and woman is a very vulnerable period. It is a time of self-discovery and growth. The intricacies of the female psyche are very easy to overlook, and the moments and behaviors captured in these photos give the viewer a glimpse inside that psyche.

The situations these young women put themselves in and the image they portray are both the product of their own actions and ideas. Whether a young woman chooses to be influenced by worthy examples is subjective. However, their choice defines them, and ultimately determines how they are viewed by the outside world. Are women victims in a male dominated society, or are they prey to their own standards of beauty? Are they objectified in today's culture or do they objectify themselves?

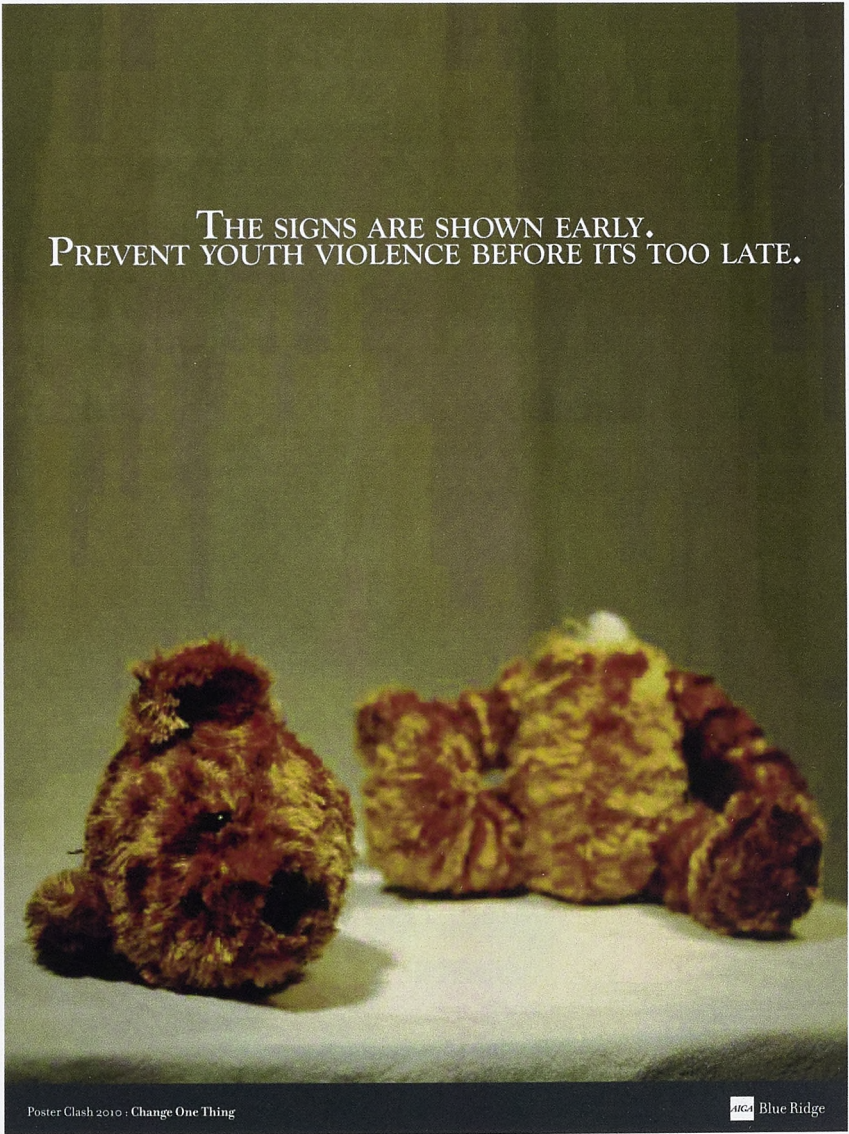


Figure 14: Smith



Independence:
10 Decades
10 Films

AMERICAN FILM INSTITUTE

Figure 15: Filmlogo



Figure 16: David Abbott



Figure 17: Poster Clash



INDEPENDENCE

10 Decades 10 Films

Figure 18: Strachbein



Figure 19: "Untitled" Ciarra Stalker



Figure 20: "Untitled" Ciarra Stalker

7 Music

Selections from a Senior Recital

Joshua R. Davis

Faculty Mentor: Christopher Swanson

Department of Music

The video selections on Incite DVD from the Senior Recital of Joshua R. Davis, tenor. The performance date was Saturday, March 27, 2010, in the Molnar Recital Hall. The performance was assisted by Teri Kidd, piano, and Augusta Arthur, cello.

The program for the recital was as follows:

from *Er rufet seinen Schafen mit Namen*, BWV 175

J. S. Bach (1685-1750)

Wo find' ich dich? ... Es dunket mich, ich she' dich kommen

Poème d'un jour — Gabriel Fauré (1845-1924)

Recontre

Toujours

Adieu

Cantata — John Carter (1937-1989)

Prelude

Rondo

Recitative

Air

Toccata

Student Biography

I completed a Senior Recital in fulfillment of the requirements for the degree of Bachelor of Arts with concentration in Music. I am originally from Lynchburg, VA, and at Longwood University I have sung with the Camerata Singers, the BASIC Gospel Choir, and as a soloist with the university jazz ensemble.

Faculty Biography

Dr. Christopher Swanson is Associate Professor of Music at Longwood University, where he teaches Applied Voice and directs the Opera Workshop. He holds a Doctor of Music Arts degree from the Florida State University.

DVD

INCITE
JOURNAL OF UNDERGRADUATE
SCHOLARSHIP



VOLUME 3
FALL 2010



LONGWOOD UNIVERSITY
COOK-COLE COLLEGE OF ARTS AND SCIENCES

201 High Street
Farmville, VA 23901