



# Laridae

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## SELF SUFFICIENCY

Lauren Catarinae

(Featured on the cover and above)

### ABSTRACT

The story of *Self Sufficiency* is inspired by stories of compassion told through the remains of ancient humans. For example, whether one was born disabled, or was disabled later in life, there were many instances where they were treated with care and respected even when it made survival of the community more challenging (Gorman, 2012). This is an interesting contrast to the “dumb caveman” trope often seen in popular media. *Self Sufficiency* means to subvert this trope by displaying compassion in a stone age family.

In this scene, a father teaches his three sons how to read animal tracks. One of the triplets had been born with a mutation that made his colors more akin to a leopard seal than a polar bear. Because the species is bulky and less streamlined for long chases, they rely on ambush to hunt. The dark-furred son can't blend in the snow, and so cannot apply stealth to his hunting strategy. Especially while still a child, he has a higher risk of being picked off by a predator as well. All this means his parents need to find new ways of teaching him to get his own food in the winter, since the lessons they were taught can't apply to him. He'll later find a strategy in the sea where such coloration will give him an advantage. In the meantime, his parents made him a camouflage poncho so he could blend into the environment. There are many extra hurdles to surpass, but his parents won't leave him out of the lesson.

A large factor in this piece and its story is speculative biology, a branch of creature design where the study of animals, extinct and living, is applied to the creation of fictional animals with the intent to make them feel real and believable. The species' similarities to bears are attributed to convergent evolution in a cold environment. The way I designed them takes features from many animals but puts them together cohesively. The head and neck resemble a seal's, and their teeth a basilosaurus'. Their summer coats are similar to an arctic fox's, polar bears influence the fur color, ears, and foot structure, the tail resembles a white-tailed deer, and the basic humanoid shape holds everything together. These traits make for an intimidating design but there's a kindness to its personality.

I use Krita for all my digital work, with color palettes of up to 5 colors in a single illustration, though I usually try to use fewer. This rule applies to my character designs as well, so their simpler colors can easily be placed in different environments without having to juggle too many details. When applying characters to illustrations I find I have to show parts of their personalities, even when it's subtle. My illustrations almost always show the characters being in the middle of something where each does something different. Here, the topmost brother is sitting eagerly; his tail is even wagging because he is excited for the lesson. His spikier fur, accented by sparse spots, gives him a chaotic look. The middle brother is withdrawn, nervous about being on his first lesson out in the deep forest, and his fur has smoother shapes. The dark-furred brother is ready to stand when needed, though it's difficult to see from this angle. His hood is down to show he is more at ease in his father's care. The shapes of his fur are also the same as his father's, who keeps his spear handy, and his ears are pointed back to listen for any danger. Storytelling is at the center of my work, which strengthens and is strengthened by creature and character design. Character and creature design aren't that different from one another, and the possibilities are endless and fascinating.

### ACKNOWLEDGMENTS

The artist thanks Jinchul Kim for his encouragement and guidance in technique and illustration.

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Gorman, J. (2012, Dec 18). Ancient bones that tell a story of compassion: [science desk]. *New York Times* Retrieved from <https://proxy-su.researchport.umd.edu/login?url=https://www.proquest.com/newspapers/ancient-bones-that-tell-story-compassion/docview/1239440315/se-2>

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## Letter from the Editor-in-Chief



The advancement of *Laridae* in recent years has been unmatched, and I am delighted to have been a part of this journey. From beginning my journey as an editor of the Science Section to the managing editor and finishing my journey as editor-in-chief, this experience is one that I am forever thankful for.

From expanding my idea of research to helping other students find their voice in research, this experience has been truly gratifying. *Laridae* is one of a kind, publishing academic works from remarkable undergraduate students across every discipline. This publication provides a unique opportunity to the Salisbury University community, providing students an entrance into academia.

The hard work and dedication of students, faculty, and editors is to thank the journal and the progress made in the past five editions. With that, I invite you all to challenge yourself to explore the fifth edition of *Laridae*, featuring 17 articles and three creative works, representing our undergraduate student's desire for knowledge and exploration.

Whether analyzing public restrooms in Downtown Salisbury or discussing the symptoms of CTE in athletes, this edition of *Laridae* has an article for everyone. I am excited to show you the best of what Salisbury University offers.

Please enjoy our fifth edition of *Laridae*, push yourself beyond your initial understanding, challenge preconceived notions, and dare to learn.

**ELIZABETH WASH**

*Editor-In-Chief*

## Letter from the Future Editors-in-Chief

Being a part of *Laridae* has been a rewarding and extraordinary experience, and we are honored to have influenced its journey. We both began as section editors the summer before our sophomore year, Lian for the Interdisciplinary Section and Jane for the Science Section. For this edition, we acted as managing editors and leads for our respective sections. Going forward to the sixth edition of *Laridae*, we will be working together as co-editors-in-chief.

For this edition of *Laridae*, we received 32 initial submissions and accepted 17 manuscripts and three creative works that serve as a diverse representation of the research and creative projects completed at Salisbury University.

The opportunity to engage in undergraduate research at Salisbury is a unique and significant experience that allows students to delve more deeply into their specific interests within their fields of study. The ability to publish this work is especially remarkable, and *Laridae* provides students with this opportunity to share their individual projects and works.

*Laridae's* continued success is only possible through the support from the Office of Undergraduate Research and Creative Activity (OURCA), specifically OURCA's director Dr. Rhyannon Bemis, our wonderful student section editors, the faculty mentors and reviewers, and the many authors who submitted their work. Their continual work in preparing the journal for publication throughout the summer is fundamental, and showcasing the undergraduate research and creative works completed at Salisbury would not be possible otherwise.

Recent editions of *Laridae* have showcased a large proportion of research regarding the COVID-19 pandemic. While COVID-19 is by no means over, the fifth edition of *Laridae* reflects a newfound diversification of research and creative works subjects that we are beyond excited to share with you all.

◆◆◆ Future Co-Editors-in-Chief ◆◆◆



JANE SIMONCIC

LIAN PEACH

# Polynomial Projection Models for New COVID-19 Cases in the Months of May-August 2020

Henna Parmar

## ABSTRACT

At the beginning of March 2020, many government bodies were faced with the decision of whether to mandate lockdowns in response to the COVID-19 global pandemic. The concept of the lockdown was to reduce the number of daily cases and stretch them out over a more extended period, known as “flattening the curve” (Gavin, 2020). This study aims to make projections for the new COVID-19 cases in the months of May, June, July, and August of 2020 and compare the models to the actual data from these months. This study evaluates the overall effectiveness of these various models.

The data for positive COVID-19 cases were extracted from “Our World in Data” (Ritchie et al., 2020). These cases were used from March 1, 2020, to the preceding months to create polynomial regression models of degrees two, three, and four. The model for each month was compared to the actual data for the months of May, June, July, and August. Results suggest that the second-degree polynomial regression models were most effective at predicting the number of COVID-19 cases over time.

## INTRODUCTION

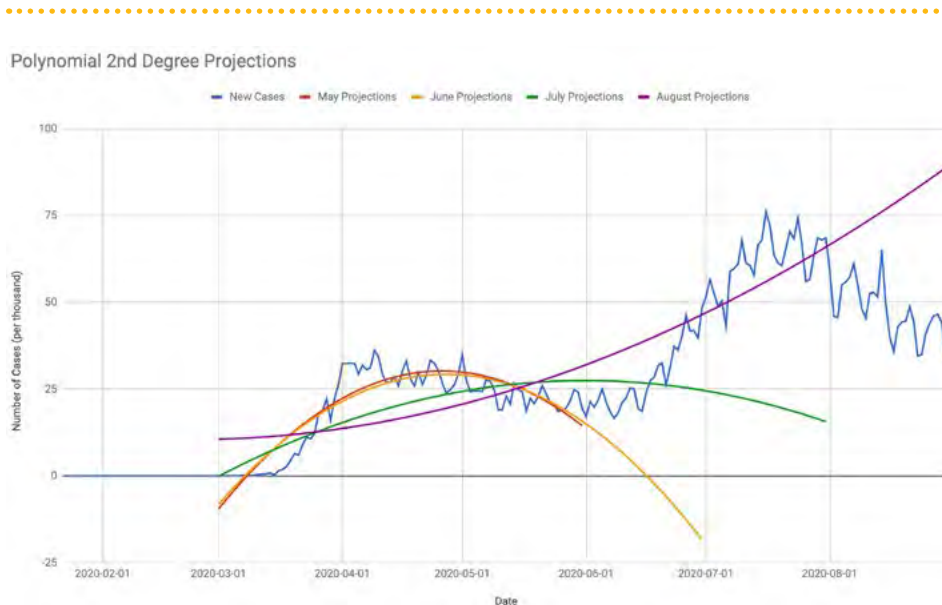
On December 1, 2019, the first case of SAR-CoV-2 (commonly referred to as COVID-19) was reported. COVID-19 was spread around the world and instigated a pandemic through respiratory droplets released from an infected person and infected many other people (Center for Disease Control and Prevention). With the introduction of this new virus, many hospitals in the world did not have the resources equipped to manage the influx of pandemic patients. If measures were taken to slow down the spread of the virus and stretch cases out over a more extended period, hospitals would have been able to keep up with the caseload and lower the number of deaths. As a result, in March 2020 many nations encouraged lockdowns (Center for Disease Control and Prevention). A lockdown is a

provisional situation mandated by governmental bodies during an epidemic or pandemic that urges people to remain home and limit public contact with others (Bollinger et al. 2022).

The data used to make these models were retrieved from “Our World in Data” (Merriam-Webster). Analysis of the data was done using Google Sheets, TI-84 Calculator, and Social Science Statistics (Smith & Moore, 2004). This project aims to create a polynomial regression model for the number of COVID-19 cases and compare predicted values to the actual data during and after the lockdown period in the United States. By using multiple points of comparison (correlation coefficient, coefficient of determination, and P-value), the usefulness of each model was found.

## STATISTICAL ANALYSIS

The number of days since March 1, 2020, functioned as the explanatory variable, and the number of COVID-19 cases were input into the regression models. This started with March 1-April 30, 2020, data, so that projections for the number of cases in May 2020 could be made and then those numbers were compared to the actual May data numbers. Afterwards, data from March-May was considered, and projections for the number of new COVID-19 cases in June were made to be compared to predicted values to the actual June data. Projections and comparisons for July and August of 2020 were completed following this pattern as well.



**FIGURE 1. Second Degree Polynomial Regression Models for May, June, July, and August.** This graph shows the date on the x-axis indicating the date of the first day of each month displayed. The y-axis shows the number of cases per thousand reported in increments of 25. This graph shows the number of new cases (shown in blue) between January 1, 2020, through August 31, 2020. In red, this graph shows the projected number of cases from March 1, 2020, through May 31, 2020. In yellow, this graph displays the projected number of cases from March 1, 2020, through June 30, 2020. In green, this graph displays the projected number of cases from March 1, 2020, through July 31, 2020. In purple, this graph displays the projected number of cases from March 1, 2020, through August 31, 2020.

**TABLE 1.** Second Degree Polynomial Regression Analysis of May (March 1 - April 30).

Equation	$y = -12.7258x^2 + 1446.8323x - 10955.2138$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	-10955.2138	2142.6068	-5.113	0
B1	1446.8323	159.4592	9.0734	0
B2	-12.7258	2.4928	-5.1049	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.8411	0.9156	0	5396.2086 on 58 degrees of freedom	
Analysis Against Predicted Values (March 1 - May 31)				
t-value	P-value	R value	R <sup>2</sup>	
-0.16964	0.8655	0.898	0.8064	

**TABLE 1** shown above has the regression analysis for March 1-April 30, 2020, and a comparison of values for the number of COVID-19 cases predicted for May against observed May data. First, the quadratic regression model based on two months of data is as shown below:

$$y = 12.73x^2 + 1446.83x - 10955.21$$

All regression coefficients and the overall model has P-values of zero. The correlation

coefficient is  $R = 0.9156$ , which indicates a strong relationship between explanatory and response variables. Coefficient of determination  $R^2 = 0.8411$  means that about 84% of new cases could be explained by the number of days since the first observation. March 1, 2020, was the date used because by that time, the number of COVID-19 cases in the U.S. were large and allowed for meaningful statistical analysis.

The data predicted for May 2020 was

compared with observed cases. The alternative hypothesis ( $H_a$ ) is that there is a significant difference between predicted and observed data. The hypothesis test resulted in a  $P\text{-value} = 0.8655$ , meaning that there may be no significant difference in the number of predicted and observed cases in May 2020. This conclusion is supported by a strong, positive correlation coefficient  $R = 0.898$ .

**TABLE 2.** Second Degree Polynomial Regression Analysis of June (March 1 - May 31).

Equation	$y = -11.5730x^2 + 1339.4122x - 9535.7658$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	-9535.7658	1599.6779	-5.9611	0
B1	1339.4122	79.3945	16.8703	0
B2	-11.5730	0.8272	-13.9912	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.8083	0.8991	0	5003.7412 on 89 degrees of freedom	
Analysis Against Predicted Values (March 1 - June 30)				
t-value	P-value	R value	R <sup>2</sup>	
4.3922	0	0.1679	0.0282	

**TABLE 3.** Second Degree Polynomial Regression Analysis of July (March 1 - June 30).

Equation	$y = -3.2693x^2 + 606.9967x - 754.9114$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	754.9114	224.2209	0.3364	0.7372
B1	606.9967	84.2308	7.2063	0
B2	-3.2693	0.6634	-4.928	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.503	0.7092	0	8127.6585 on 119 degrees of freedom	
Analysis Against Predicted Values (March 1 - July 31)				
t-value	P-value	R value	R <sup>2</sup>	
5.7086	0	0.3643	0.1327	

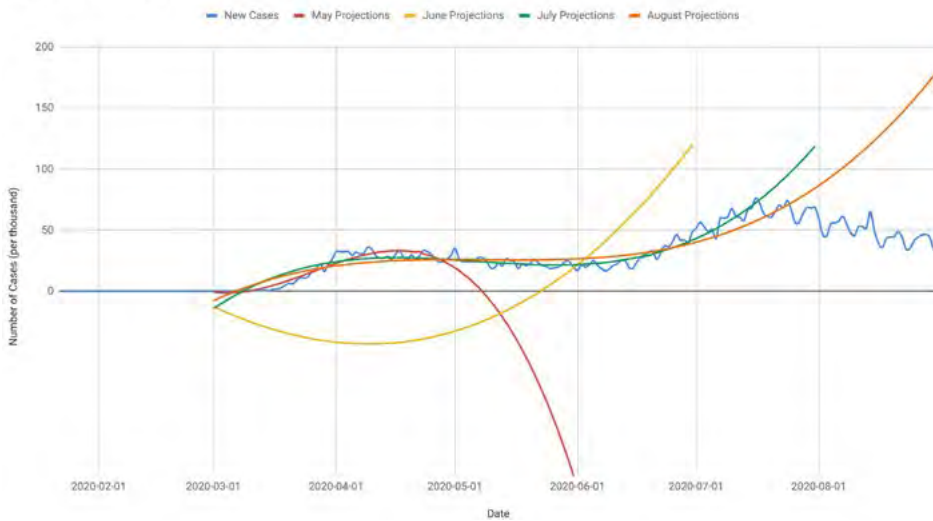
**TABLE 4.** Second Degree Polynomial Regression Analysis of August (March 1 - July 31).

Equation	$y = 2.1801x^2 + 28.3474x + 10488.0793$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	10488.0793	2552.1433	4.1095	0.0001
B1	28.3474	76.5136	0.3705	0.7115
B2	2.1801	0.4813	4.5299	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.7208	0.8490	0	10385.5036 on 150 degrees of freedom	
Analysis Against Predicted Values (March 1 - August 31)				
t-value	P-value	R value	R <sup>2</sup>	
-2.2999	0.2202	0.7441	0.5537	

**TABLES 2-4** summarize quadratic regression analyses and tests comparing predicted and observed data for the months of June through August 2020. Overall, models were significant (the P-value of regression models is zero for all three months) although some coefficients are insignificant. For example, the last term in the quadratic regression model for July has a P-value of 0.7372. The coefficients of determinations,  $R^2$  are 0.8083 for June, 0.503 for July, and 0.7208 for August. Hypothesis tests comparing predicted and observed values resulted in P-values of zero for June and July. This means that predicted values are significantly different from what was later observed in those months. This conclusion is confirmed by weak correlation coefficients (0.1679 for June and 0.3643 for July). The quadratic regression for August is reasonable ( $P\text{-value}=0$ ,  $R=0.8490$ ) as well as the comparison of predicted and observed cases ( $P\text{-value}=0.2202$ ,  $R=0.7441$ ). In summary, quadratic regressions provided dependable models for the months of May and August, but unreliable models for June and July.

**FIGURE 2.**

Polynomial Third Degree Projections



**FIGURE 2. Third Degree Polynomial Regression Models for May, June, July, and August.** This graph shows the date on the x-axis indicating the date of the first day of each month displayed. The y-axis shows the number of cases per thousand reported in increments of 50. This graph shows the number of new cases (shown in blue) between January 1, 2020, through August 31, 2020. In red, this graph shows the projected number of cases from March 1, 2020, through May 31, 2020. In yellow, this graph displays the projected number of cases from March 1, 2020, through June 30, 2020. In green, this graph displays the projected number of cases from March 1, 2020, through July 31, 2020. In orange, this graph displays the projected number of cases from March 1, 2020, through August 31, 2020.

**TABLE 5.** Third Degree Polynomial Regression Analysis of May (March 1 - April 30).

Equation	$y = -0.8571x^3 - 66.9855x^2 - 546.1214x - 242.0163$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	-242.0163	2127.2183	-0.1138	0.9098
B1	-546.1214	294.7382	-1.8529	0.0691
B2	66.9855	10.9981	6.0906	0
B3	-0.8571	0.1167	-7.347	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.9184	0.9583	0	3901.0591 on 57 degrees of freedom	
Analysis Against Predicted Values (March 1 - May 31)				
t-value	P-value	R value	R <sup>2</sup>	

As seen from **TABLE 5**, the third-degree polynomial model to predict the number of COVID-19 cases in May provides reasonable results. Although the overall P-value of the regression model is zero, the P-values of the last two regression coefficients are greater than 0.05 which makes them insignificant. When assessing the hypothesis of whether the predicted numbers of May cases were significantly different from the observed number of cases, there was a P-value of zero. This concludes that there is a difference between projected and observed numbers of cases in May and is supported with low coefficients of correlation (0.1144) and determination (0.0131). The two leading coefficients of the regression equation for the third-degree polynomial model in June is insignificant (see **TABLE 6** on next page). The comparison of predicted and observed data also resulted in the low coefficient of correlation (0.3445) and determination (0.1187).

**TABLE 6.** Third Degree Polynomial Regression Analysis of June (March 1 - May 31).

Equation	$y = 0.0375x^3 + 16.8045x^2 - 1535.0805x - 11093.0306$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	-11093.0306	2173.2853	-5.1043	0
B1	1535.0805	201.287	7.6263	0
B2	-16.8045	5.0147	-3.3511	0.0012
B3	0.0375	0.0355	1.0577	0.2931
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.8107	0.9004	0	5000.4056 on 88 degrees of freedom	
Analysis Against Predicted Values (March 1 - June 30)				
t-value	P-value	R value	R <sup>2</sup>	
6.0159	0	0.3445	0.1187	

**TABLE 7.** Third Degree Polynomial Regression Analysis of July (March 1 - June 30).

Equation	$y = 0.1810x^3 - 36.6690x^2 + 2256.98x - 16501.6206$			
Coefficient	Estimate	Standard Error	t-statistic	p-value
B0	-16501.6206	1932.3231	-8.5398	0
B1	2256.98	135.4978	16.657	0
B2	-36.6690	2.5542	-14.3566	0
B3	0.1810	0.0137	13.259	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.8004	0.8947	0	5172 on 118 degrees of freedom	
Analysis Against Predicted Values (March 1 - June 30)				
t-value	p-value	R value	R <sup>2</sup>	
-1.0326	0.3026	0.9109	0.8297	

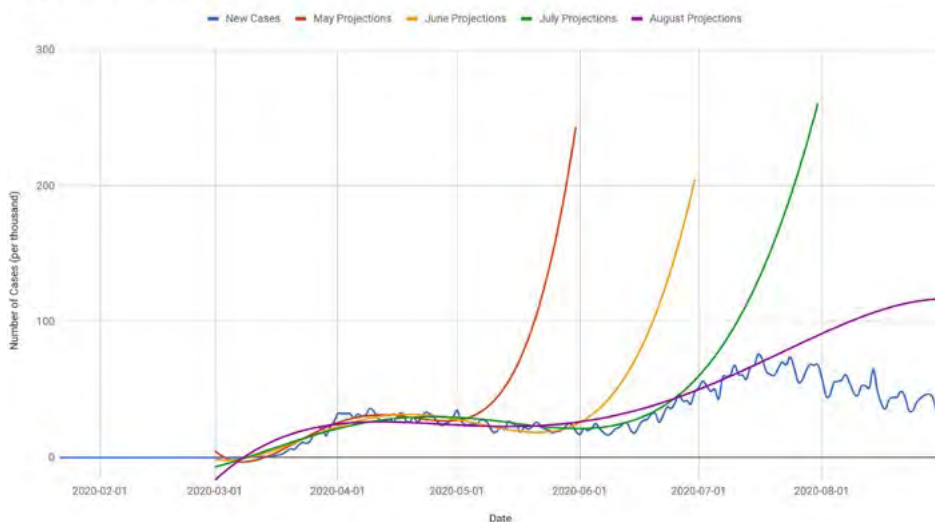
Out of the four third-degree polynomial models, the model for July is the most appropriate (see **TABLE 7**). All regression coefficients and overall model are significant because all P-values are equal to zero. The comparison of predicted and observed values resulted in a P-value of 0.3026 meaning that there may be no significant difference between projected and observed cases. The coefficient of correlation (0.9109) and the coefficient of determination (0.8297) support this conclusion.

**TABLE 8.** Third Degree Polynomial Regression Analysis of August (March 1 - July 31).

Equation	$y = 0.1067x^3 - 22.4643x^2 + 1551.3941x - 9375.3259$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	-9375.3259	2459.8407	-3.8114	0
B1	1551.3941	137.8802	11.2518	0
B2	-22.4643	2.0768	-10.8167	0
B3	0.1067	0.0089	12.0325	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.8565	0.9255	0	7420.9704 on 149 degrees of freedom	
Analysis Against Predicted Values (March 1 - July 31)				
t-value	P-value	R value	R <sup>2</sup>	
-4.0286	0	0.5994	0.3593	

The third-degree polynomial model for August (TABLE 8) has significant coefficients and a P-value of zero for the model overall. However, the comparison of predicted and observed cases contradicts the model. There may be a significant difference between projected and observed numbers of COVID-19 cases in August as confirmed by the weak correlation coefficient (0.5994) and coefficient of determination (0.3593).

Polynomial 4th Degree Projections



**FIGURE 3. Fourth Degree Polynomial Regression Models for May, June, July, and August.** This graph shows the date on the x-axis indicating the date of the first day of each month displayed. The y-axis shows the number of cases per thousand reported in increments of 25. This graph shows the number of new cases (shown in blue) between January 1, 2020, through August 31, 2020. In red, this graph shows the projected number of cases from March 1, 2020, through May 31, 2020. In yellow, this graph displays the projected number of cases from March 1, 2020, through June 30, 2020. In green, this graph displays the projected number of cases from March 1, 2020, through July 31, 2020. In purple, this graph displays the projected number of cases from March 1, 2020, through August 31, 2020.

**TABLE 9.** Fourth Degree Polynomial Regression Analysis of May (March 1 - April 30).

Equation	$y = 0.0358x^4 - 5.2727x^3 + 242.1221x^2 - 2956.8114x + 7613.1123$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	7613.1123	2540.5328	2.9967	0.0041
B1	-2956.8114	556.3205	-5.3149	0
B2	242.1221	35.8525	6.7345	0
B3	-5.2727	0.8671	-6.0807	0
B4	0.0358	0.0069	5.1553	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.9322	0.9655	0	3588.65 on 56 degrees of freedom	
Analysis Against Predicted Values (March 1 - May 31)				
t-value	P-value	R value	R <sup>2</sup>	
-4.1209	0	0.2862	0.0819	

Fourth degree polynomial regression model for May 2020 has all significant coefficients (all P-values below 0.05) and high coefficients of correlation (0.9655) and determination (0.9322). However, the corresponding correlation and determination coefficients when comparing actual data and predicted values are exceptionally low with 0.2862 as the correlation coefficient and 0.0819 as the determination coefficient.

**TABLE 10.** Fourth Degree Polynomial Regression Analysis of June (March 1 - May 31).

Equation	$y = 0.0094x^3 - 1.7047x^2 + 86.8436x - 608.1246x + 647.6576$			
Coefficient	Estimate	Standard Error	t-statistic	P-value
B0	-647.6576	2231.3447	-0.2903	0.7723
B1	-608.1246	328.9762	-1.8485	0.0679
B2	86.8436	14.3329	6.059	0
B3	-1.7047	0.2314	-7.3655	0
B4	0.0094	0.0012	7.6248	0
R <sup>2</sup>	R value	P value	Residual Standard Error	
0.8797	0.9379	0	4008.8337 on 87 degrees of freedom	
Analysis Against Predicted Values (March 1 - June 30)				
t-value	P-value	R value	R <sup>2</sup>	
-3.8420	0.0002	0.6582	0.4332	

The fourth-degree model for June is insignificant for the last two coefficients of the regression model. Despite this deficiency, coefficients of correlation and determination were high with 0.9379 as the value for the correlation coefficient and 0.8797 as the value for the determination coefficient. On the other hand, when evaluating the hypotheses for whether values predicted by the model are significantly different from observed June data, the P-value is less than 0.05 and have low coefficients of correlation (0.6582) and determination (0.4332).

**TABLE 11.** Fourth Degree Polynomial Regression Analysis of July (March 1 - June 30).

Equation	$y = 0.0028x^4 - 0.4978x^3 + 16.9387x^2 + 782.665x - 6972.4656$				
Coefficient	Estimate	Standard Error	t-statistic	P-value	
B0	-6972.4656	2057.2972	-3.3891	0.001	
B1	782.665	228.6755	3.4226	0.009	
B2	16.9387	7.5217	2.252	0.0262	
B3	-0.4978	0.0918	-5.4192	0	
B4	0.0028	0.0004	7.4614	0	
R <sup>2</sup>	R value	P value	Residual Standard Error		
0.7249	0.8514	0	4331.9264 on 117 degrees of freedom		
Analysis Against Predicted Values (March 1 - July 31)					
t-value	P-value	R value	R <sup>2</sup>		
-3.5584	0.00043	0.8514	0.7249		

**TABLE 12.** Fourth Degree Polynomial Regression Analysis of August (March 1 - July 31).

Equation	$y = -0.0012x^4 + 0.4833x^3 - 59.9052x^2 + 2838.815x - 19450.315$				
Coefficient	Estimate	Standard Error	t-statistic	P-value	
B0	-19450.315	2840.371	-6.8478	0	
B1	2838.815	252.9466	11.223	0	
B2	-59.9052	6.6389	-9.0233	0	
B3	0.4833	0.0647	7.4899	0	
B4	-0.0012	0.0002	-5.8848	0	
R <sup>2</sup>	R value	P value	Residual Standard Error		
0.7667	0.5878	0	6750.5288 on 148 degrees of freedom		
Analysis Against Predicted Values (March 1 - August 31)					
t-value	P-value	R value	R <sup>2</sup>		
4.3269	0	0.7667	0.5878		

In summary, for the months of July and August, fourth-degree polynomial models produce contradictory results. However, overall models and all regression coefficients are significant. The correlation and determination coefficients are all over 0.8 meaning there is a strong statistical relationship. The hypothesis tests result in P-value less than 0.05 insinuating that there is enough statistical evidence for the predicted and observed data differences and this is all supported by moderate coefficients of correlation and determination.

**TABLE 13.** Comparing Regression Models for May-August 2020.

	Quadratic	Cubic	Quartic	Best
May	Great, Great	Good, Poor	Great, Poor	Quadratic model
June	Great, Poor	Poor, Poor	Good, Poor	Quadratic model
July	Good, Poor	Great, Great	Great, Poor	Cubic model
August	Good, Great	Great, Poor	Great, Poor	Quadratic model

## DISCUSSION

The statistical analyses above do not give a univocal answer to this question: "Which model is the most appropriate?". All regression models are significant with certain coefficients having P-values greater than 0.05. When comparing predicted and observed COVID-19 cases with different models for all the months, some models show reasonable results and others fail to do so due to their low correlation and determination coefficient values. **Table 13** summarizes the results and shows that for May, June, and August, the quadratic models provide the best results. Among the quadratic models, the May data has the best fit. When comparing all cubic models, we see that July data is the only month for which the cubic model is suitable. All fourth-degree polynomial regression models had some sort of deficiency.

### SIGN ON THE HIGHEST DEGREE

For the second-degree regression models' highest degree coefficient, the sign is negative for May through July, which shows that the number of cases decreased with time. The quadratic model for August has a negative leading coefficient showing how the number of cases will predict an increase unlike the other three quadratic models. For the third-degree regression models, the coefficient for the highest degree is negative for the month of May and positive for June, July, and August.

Finally, for the fourth-degree regression models, May, June, and July all have positive signs for the coefficient of the highest degree meaning that with time, positive COVID-19 tests were to increase, but this was not feasible. Therefore, at the very least, the number of positive COVID-19 cases was bounded by the total population. The sign changes to be negative for the August regression model's coefficient and this is a reasonable switch since the model incorporates most data from March through July 2020.

## LIMITATIONS

This project used COVID-19 data between March 1 and August 31 for the year 2020 and the pandemic continued into 2021 and 2022. Many researchers predict that with time COVID-19 will turn into a seasonal disease, like the common flu. Data limited to six months cannot reveal all the seasonal patterns or general trends, and the nature of a virus like COVID-19 allows for easy mutations. Since the first cases in December 2019, over fifty mutations have been documented (Bollinger et al., 2022). The data used for this project does not distinguish between different types of virus variants. Another crucial factor in the number of positive cases of this viral infection in any given population is vaccination. The availability of COVID-19 vaccines and the percentage of the vaccinated population have a significant impact on infection rates. The first batch of vaccines were available to the U.S. population in December 2020. However, this would not affect the beginning of 2020 data and corresponding models. The future spread of the virus is something researchers should not discard due to those who are vaccinated and/or have different variants of the virus.

## FUTURE WORK

Some next steps to take would include estimating and testing SIR and SIRD components. The SIR models work with three variables: susceptible, infected, and recovered and the SIRD model works with four variables: susceptible, infected, recovered, and died. The relation of the variables in the SIR model is shown below:

$$N = S(t) + I(t) + R(t)$$

where N is the size of the total population, S(t) is the number of susceptible individuals, I(t) is the number of infected individuals, and R(t) is the number of recovered individuals in the population. The derivatives of these equations are also notable as they indicate the rates of change and overall size of each group.

To evaluate the SIR and SIRD components, comparing the models to the data collected during the time period of those predictions would be ideal. This can include calculating the P-value using a 95% confidence interval. If the P-value is less than or equal to 0.05 (5%), it can be concluded that the number of observed cases (those infected) is significantly different from the number of predicted infected persons. A good predictive SIR model should not be significantly different from the observed number of susceptible, infected, and recovered cases.

## CONCLUSION

For three of the four months (May, June, and August) the quadratic model showed to be the most accurate at predicting the trends of COVID-19 in the United States. This could have been due to a variety of reasons, such as the quadratic model being the simplest of all three models (quadratic, cubic, and quartic). Quadratic models have less parameters and simpler equations compared to cubic and quartic models. With fewer parameters, simpler models – in this case the quadratic model – is less sensitive to short-term trends and fluctuations, and less prone to overfitting. Overfitting is when a model fits the noise in the data rather than examining the underlying patterns. In this case, the quadratic model was less likely to overfit and instead map out a more accurate trend line.

COVID-19 did not occur in a controlled environment or a closed system. The space in which COVID-19 occurred was an open system with an infinite number of variables that is too many to quantify, much less calculate into a model. Even if the more basic models do not precisely replicate all the intricate details of a system, these models can capture the essential patterns for understanding a property's behavior. They are more robust against the intricate interactions and sensitive dependencies following each variable.

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# Nursing Homes During COVID-19: How Better Working Conditions for CNAs Can Improve the Well-Being of Residents

Daniella Weinstein

## ABSTRACT

The COVID-19 wave that swept through nursing homes in March of 2020 brought to light preexisting issues regarding working conditions for direct care staff, specifically certified nursing assistants (CNAs). The hierarchy between CNAs and higher-level certified staff creates and contributes to discrimination of the “lower” job position of the CNA which has negatively impacted their confidence and ability to provide the utmost quality of care. The pandemic exacerbated the feelings of neglect, overwhelm, and uncertainty as high turnover rates and understaffing increased the number of responsibilities that CNAs are tasked with. As CNAs have the most direct contact with residents in nursing homes, their overall well-being impacts the mental and physical health of residents. Therefore, when CNAs struggled with their work conditions after the pandemic, the quality of care was further hindered, establishing a domino effect. Research has demonstrated that social functioning in residents left them more susceptible to an increase in depression, emotional anxiety, as well as a growth in cognitive impairment and dementia. This paper argues that to rebuild the quality of care in nursing homes, the domino effect of the pandemic must be reversed. Furthermore, this project found that through administration intervention as well as better CNA training and pay, quality of care for residents can be improved.

**Keywords:** CNAs, nursing homes, residents, COVID-19, well-being, pandemic

Nursing homes since the beginning of their creation have been heavily flawed regarding how they systematically manage the working conditions of direct care staff. Reports for years have outlined issues with job level discrimination, lack of minimum staffing requirements, and an overall disregard for the low levels of satisfaction of both staff and residents (Travers et al., 2020; Franzosa et al., 2022; Pfefferle and Weinberg, 2017; Krein et al, 2022; Denny-Brown et al., 2020). These conditions have been further highlighted by the pandemic, which has worsened staff environments, especially the conditions of lower job positions such as certified nursing assistants (CNAs). According to Levere et al. (2021), the introduction of the pandemic in nursing homes has negatively impacted the quality of care given to residents (p. 949). Such a decline in quality of care has left residents susceptible to the consequences of the pandemic in regard to their mental and physical well-being. Although the social isolation and loneliness in nursing homes have been addressed and considered for residents’ mental health, the problem cannot be fully resolved as the impact of COVID-19 on CNAs continues to be disregarded leaving them overwhelmed, conflicted, and unable to provide the best quality of care for residents.

## THE ROLE OF CNAS IN NURSING HOMES

As stated by Pfefferle and Weinberg (2009), certified nursing assistants are present in nursing homes to provide direct care to residents, while also gaining experience in the healthcare environment (p. 2). Since nursing homes are

about caring for those who cannot do daily tasks independently, such an environment gives CNAs plenty of tools to learn about what it is like to be a caregiver to the sick and vulnerable. This experience is essential for CNAs as they have not yet been introduced to much of the healthcare industry. The Code of Federal Regulations (2019) requires CNAs to have 75 hours of training, 16 hours of training overseen by a professional, as well as 16 more hours that must be completed in various settings, but not in an active nursing home with residents (p.73). While the requirements for CNAs include over 100 hours of training, their knowledge and experience in the direct workforce is minimal, as they are not even allowed to work with residents or patients until after getting their certificate. Therefore, it is in the hands of the “upper level” positions in nursing homes, such as licensed practical nurses (LPNs) and registered nurses (RNs) to further teach CNAs about being a caregiver to residents.

As a result of the need to learn, CNAs are generally responsible for hands-on care in nursing homes. According to Denny-Brown et al. (2020), CNAs provide around 80-90% of the direct care for residents, which includes fulfilling the basic needs of residents, such as their need to eat, get dressed, or shower (p. 2). CNAs are not only given these jobs to learn more about how to be a caregiver, but they also fulfill the duties that LPNs and RNs may not have the time to do, as they are delegated other forms of work. Thus, CNAs have earned the recognition from administrators and other nursing home staff as “the heart and hands of health care” (Pfefferle & Weinberg, 2009 p.2). They are the people

that will be on the floor of the homes frequently checking on residents to ensure their satisfaction and health.

However, CNAs also make mistakes due to their lack of experience in the healthcare industry. They may forget to check on a resident, or they might forget to do a specific task. This is why they work under the supervision of other staff that can provide additional help. According to Pfefferle and Weinberg (2009), nursing homes have a system of “explicit messages” which functions to encourage and criticize CNAs on their performance, whether that be advising them to talk to the loved ones of residents more or gratifying them for being an affectionate caregiver but not getting too emotionally devoted to a resident (p. 2). CNAs require a lot of hands-on experience and help from RNs and LPNs in order to perform to the best of their abilities. This not only supports CNAs and makes them feel more confident in their abilities as a caregiver, but it also ensures the highest quality of care for residents.

## SOCIAL HIERARCHY, LOW PAY, AND HIGH TURNOVER RATES

Although CNAs are in nursing homes to learn and to personalize care for residents, they are continuously fighting the battle of discrimination, low pay, and turnover rates, which may affect their ability to efficiently give care to residents. According to Travers et al.’s (2020) study of social-based discrimination between staff, CNAs have reported being emotionally impacted by their work, as they experience maltreatment, trauma, abandonment, and a

lack of confidence in being able to give the best quality of care to residents (p. 5). Although CNAs require some form of support from their coworkers to thrive in their work environment, the issue of neglect and abuse may hinder them from being able to perform to the best of their abilities. Statements from CNAs in the work of Franzosa et al. (2022) identify some of the effects this social hierarchy has had on their working conditions, as they describe how they are told to not speak out about anything that does not impact the health of residents (p. 909). This means that any form of abuse or mistreatment brought upon CNAs in their working environment is further enabled by the unwritten rules of the nursing homes. Rather than having a safe space where they can speak out against unjust actions and behaviors, CNAs are instead silenced and told to continue doing their job without any proper support.

In addition, with this neglect comes the overall lack of support in helping CNAs learn. If the RNs and LPNs are mistreating the CNAs, there is little chance that they will be open to giving advice and helpful criticism to the CNAs when they need it. Consequently, according to Pfefferle and Weinberg (2017), CNAs typically feel frustrated that they are labeled as essential bodies in the care of residents but are dismissed and devalued for their job position (p. 4). This in turn can influence the care of residents, as CNAs are their hands-on caregivers, and may feel uncertain about being able to perform their job without encouragement and advice.

In addition to the social hierarchy established in nursing homes, CNAs are by far given the lowest amount of pay for their work. For example, in 2021, RNs received an average hourly pay of \$34.24 per hour (p. 5). However, lower job positions such as CNAs were paid less than half the amount of what RNs made, making an average of \$15.34 an hour (U.S. Bureau of Labor Statistics, 2021, p.5). While it is logical to give more qualified positions a higher wage, the significant difference in pay allows RNs and LPNs to have more power over CNAs. This feeds into the abuse experienced by CNAs, and ultimately makes these less qualified workers feel as if their form of work is not nearly as important or respected overall (Travers et al., 2020, p. 13). In addition, CNAs are given a large amount of work for a small amount of pay. They are paid just a little over minimum wage to be a primary caregiver to residents daily. As stated by Travers et al. (2020), each CNA cares for over 15 residents in one 8-hour shift, which includes guaranteeing that all the residents' daily needs are met (p. 4). The jobs of CNAs may not be intricate or medically complicated, but to care for

the basic needs of many residents at once can be exhausting and very overwhelming. Therefore, the lack of reward in forms of both payment and respect is concerning to the wellbeing of CNAs in their work environment.

The pattern of power control and low pay for CNAs has led to high turnover rates, furthering the understaffing problems that nursing homes already face. The annual turnover rate for CNAs is 51.5 percent, meaning that less than half of CNAs retain their jobs in nursing homes each year (Denny-Brown et al., 2020, p. 2). These numbers are not surprising, given the number of difficulties CNAs experience at their work daily. In addition, the high turnover rates create more problems for the many CNAs who decide to stay at the nursing homes. The CNAs that stay at nursing homes are tasked with more responsibility, possibly more than they can handle. A CNA stated that "I actually work any floor that is needed because right now we are very understaffed... I feel like my residents aren't getting the proper care they need, honestly" (Krein et al, 2022, p. 1180). Evidently, CNAs are experiencing the negative implications of understaffing, feeling as though they cannot provide the requisite level of care. With such an amount of pressure put on them, in addition to discrimination from their coworkers with higher degrees, CNAs are further overwhelmed as turnover rates continue to be an issue. Not only is this an issue for the well-being of CNAs, but it also puts the quality of care for residents at nursing homes at risk.

### **COVID-19 AND THE QUALITY OF CARE**

CNAs at nursing homes have historically had problems with discrimination, lack of pay, and low wages problems. However, these problematic working conditions have only worsened as of recently, as the widespread outbreak and transmission of COVID-19 placed an additional load of work on caregivers who need to protect vulnerable people. Due to the spread of the virus in nursing homes during 2020, nursing homes issued an immediate lockdown in an attempt to preserve the well-being of residents and staff. According to Mo and Shi (2020), this lockdown included the implementation of a no-visitor policy, a cessation of social activities that would usually occur in nursing homes, and social distancing even when doing direct forms of care (p. 255). This meant that CNAs were no longer able to be as close and connected with their residents, as they now had to be even more concerned with their health and vulnerability.

While it was important to ensure infection prevention and control with the implementation of regulations at nursing homes, the decrease of

social connection for residents had consequences on their well-being. Since CNAs could no longer provide as much hands-on care, and due to the lack of visitors and social events, residents experienced a decrease in social functioning. According to Levere et al. (2021), there were many identifiable effects of COVID19 restrictions on the mental well-being of residents. These included an increase in unhappiness, a reduction in weight, and a sign of decrease in cognitive abilities, which could suggest dementia or Alzheimer's (p. 950). While social restrictions may not seem to be a big factor in the overall well-being of residents when compared to the threat of COVID-19, it is important to note that residents rely on close contact and social interactions to maintain a healthy physical and mental state in the nursing homes.

### **EXISTING SOLUTIONS ADDRESSING THE SOCIAL ISOLATION AND LONELINESS OF RESIDENTS**

The social ineptness of residents during the COVID-19 pandemic has been considered by scholars, and several solutions have been proposed. While it may seem that the peak of the pandemic has already passed, social restrictions and regulations in nursing homes have not yet been discontinued, as there is still a threat of COVID-19 transmission. According to the work of Kunasekaran et al. (2022), as the COVID-19 pandemic is continuing, there is no real way to determine whether another outbreak will occur in nursing homes (p. 7). To ensure the safety of nursing home residents, infection prevention should also be considered in regard to the social functioning of residents.

An example of a form of care that could address both issues is online connecting. Online connecting would not only enable social distancing but would also allow for individuals to connect with residents in the nursing homes. Ferdous (2021) argued that communication via technology could allow students or other members of the community to reach out to residents who may need those social connections (p. 9). This engages residents and prevents them from feeling socially isolated. It can also help students who want to get involved with the seniors of their community. Not only can technological communication be used between students and residents, but also with loved ones who may not be able to visit. According to Anderson (2020), the no visitation protocol of nursing homes made it impossible for some to even say goodbye to their loved ones before they passed (p. 37). This is not only heartbreaking to the members of the family, but it could also be a very bad reflection on nursing homes, as

they are inhibiting residents from being able to receive their final goodbyes from their families and friends. As COVID-19 is still an issue in these facilities, loved ones should be able to talk to the residents in some form, which could include communication online.

In addition, Ferdous (2021) proposed therapy and personalized care as a way to manage the stress residents may face from the consequences of COVID-19 (p. 9). Therapy not only would help residents ease the effects of COVID-19 on their mental well-being but would also act as a social outlet for those in isolation. COVID-19 has not been a short-lived event, and outbreaks cannot be ruled out in the future. With that in mind, establishing a form of outreach for residents could prove helpful not only in the present, but also in the face of other outbreaks later. Ferdous suggests multiple kinds of therapy, such as animal assisted therapy, therapeutic touch, and telemedicine (p. 9). All these services would adhere to CDC guidelines while ensuring an improvement in providing quality care for residents. Animal assisted care would include personal pets which are non-demanding like fish or hermit crabs.

Therapeutic touch would be provided by caregivers in simple ways such as washing a resident's hands or brushing their hair. If there was a need for care from a licensed therapist, telemedicine is a great way to find outreach to those services. Furthermore, person-centered care can be as easy as having a folder regarding each resident that can be used by CNAs to address individual wants and needs. This is further supported by Mo and Shi (2020), who stated that emotional anxiety is a major outcome of social isolation and could be reduced with the help of emotional assistance (p. 255). Emotional assistance through therapy and the development of coping strategies is an exemplary form of personalized care. Since CNAs and other direct care staff are incapable of resolving every resident's emotional needs despite providing personalized care, it is vital to have other forms of therapeutic assistance that could improve the quality of care for residents without adding to the already significant workload.

Lastly, Madrigal et al. (2021) specifies that nursing homes could provide staff with tests that evaluate which care plans work best for residents based on long-term outcomes, maximizing the benefit care can have to their well-being (p. 1996). A care plan measure looks at the individual preferences of residents in terms of what they want to see in order to improve their social functioning, while an outcome-based measure identifies how those changes over time affect the state of residents and their well-being (Madrigal et al., 2021 p. 1996). This is a direct

solution, as it tasks those primary caregivers with the responsibility of learning what residents want in their care and how to provide it to them. It could also make residents feel heard in the nursing homes, rather than dismissed due to the chaos of the pandemic and its restrictions.

### **LIMITATIONS OF EXISTING SOLUTIONS**

While it is helpful to have a wide range of solutions addressing the improvement of care for residents, these existing solutions miss a major component related to benefitting the quality of care. In order to even consider implementing these solutions, there are some factors that must be addressed. Mo and Shi (2020) highlighted the main limitation to improving the mental and physical well-being of residents during the COVID-19 pandemic, stating that they recommended conducting further research that looks at helping staff in nursing homes who may also be suffering with the consequences of the pandemic, as their emotional state proportionally affects their performance at nursing homes in regard to the quality of care they provide (p. 256). Without considering how direct care staff are coping with the effects of COVID-19 on their work life, the quality of resident well-being cannot be fully addressed. As discussed previously, CNAs hold the most prevalent job position at nursing homes. They handle the direct care of residents, including their daily needs. Hence, as stated by Ecker et al. (2021), when the pandemic spread and restrictions were enforced, CNAs had to implement social distancing, infection control precautions, and other procedures to ensure the best care for residents (p. 1556). These changes to the working conditions in nursing homes affected CNAs and their mental health. CNAs were already facing challenges such as discrimination, understaffing, and a heavy workload, and the pandemic only added to the stress to their working conditions.

Snyder et al. (2021) supports this idea, claiming that workers were worried about getting COVID-19, felt unsure about their abilities to navigate the pandemic while also providing care for residents, and were also overwhelmed by the new responsibilities added on to their daily schedules (p. 6). All these factors can in turn inhibit the performance of direct care staff such as CNAs, as they do not feel prepared, and are negatively affected by the new conditions in nursing homes. A CNA stated that "nobody really wanted to cooperate," while another CNA claimed that "if we have enough staff, we could give the level of care [dying residents] really need," which both demonstrate just how detrimental the lack of staff is on not only resident care, but also on the working conditions

of CNAs (Franzosa et al., 2022, p. 908). CNAs are the primary caregivers to the residents in nursing homes, and as seen by these statements, they truly care about how residents are treated during the COVID-19 pandemic. They want to help and provide the best quality of care for these residents but are restricted by the lack of teamwork due to factors such as discrimination and understaffing. Therefore, it is not possible to consider solutions for improving resident well-being without acknowledging the fact that CNAs are struggling to provide efficient care.

One existing solution that could not be implemented without addressing the needs of CNAs for better working conditions is online connecting. Anderson (2020) highlights how CNAs would need to find time to assist residents with technology for such a solution to work (p.37). The lack of staff in conjunction with demanding responsibilities makes it very difficult for CNAs to ensure that every resident is getting access to online communication. As stated previously, CNAs have up to 15 residents to care for each shift, and each resident has basic needs that must be satisfied. While it would be beneficial for residents to speak to others online, some are too physically weak or mentally unable to independently schedule and manage a call (Anderson, 2020, p. 37). This means that CNAs would have to be present for the duration of the call and would possibly have to direct the majority of the conversation. Considering the CNAs lack of experience, giving such a responsibility to them could lead to more stress and uncertainty and would hinder their ability to perform their job. In addition, therapeutic assistance such as telemedicine and personalized care requires the effort of CNAs, which would inherently add responsibility. If both solutions were implemented in nursing homes, the CNAs workload would just be increased, preventing these solutions from truly benefiting the quality of care.

Another existing solution that requires time and energy is the idea of surveys and measurements to gauge how residents are feeling about their care. As stated in the work of Madrigal et al. (2021), the conduction of these assessments would be in the hands of direct care staff (p. 1995). This means that CNAs would have to find the time to individually speak to each resident, conduct the assessments, and then use the results to change care. As CNAs already feel overwhelmed and unsure in their work environment, additional criticism and recommendations might just stress them out further. Unfortunately, with the conditions of nursing homes, individualized, tailored care is not as accessible as merely conducting measurements to focus care on each resident.

## **SUGGESTED IMPROVEMENTS TO WORKING CONDITIONS**

In order to improve the working conditions of CNAs, the voices of these workers must be considered. It has been evident that CNAs suffer from the power control of other staff, leading to uncertainty and the feeling of being overwhelmed. In addition, the issue of understaffing and low wages further hinders the quality of working conditions of CNAs. To resolve these issues, policies should be enforced to improve the working conditions of CNAs.

When looking at the power difference of LPNs and RNs to CNAs in nursing homes, solutions can be implemented to ease the control this may have on "lower level" positions. According to Pfefferle and Weinberg (2017), workers have power because of their level of experience, degree, and the difference in pay (p. 4). While it may be the responsibility of LPNs and RNs to help CNAs gain knowledge and experience, their abuse of these "lower" positions prevents CNAs from growing and thriving in their work community. With this being said, there are multiple ways to tackle the issue of discrimination and abuse in nursing homes. One solution would be to have interventions in nursing homes where these issues may arise, which would communicate to workers such as LPNs and RNs the importance of helping CNAs rather than mistreating them due to their lack of experience or a degree. According to Iowa Better Jobs Better Care Coalition (2004), only 50% of administrators have been able to find time to communicate with CNAs, even though a multitude of administrators find it important to speak with all staff (p. 10). Establishing simple forms of communication like this could give CNAs a voice, and therefore bring awareness to RNs and LPNs who might be unaware of the effects that their behavior has on CNAs.

Another solution is related to the training requirements for CNAs. If CNAs are feeling uncertain of their abilities to care for residents, it may be beneficial to require more hours of training, including an increase in supervised training hours in a clinical setting so that CNAs

can get more hands-on experience before being put into nursing homes. According to Travers et al. (2021), as LPNs, RNs, and other licensed staff have their own load of work and rarely find time to help teach CNAs, CNAs are typically left uncertain that they can conduct their job efficiently (p. 5). More clinical training hours would allow CNAs to not rely on the training of LPNs and RNs who might not be available. Giving CNAs more training could also prove efficient for the quality of care, as they would know better how to care for residents. Their confidence in their work would show in the way residents are treated, which demonstrates the importance of considering staff well-being in conjunction with resident health.

CNAs should also have more benefits which could improve their well-being. As stated by Franzosa et al. (2022), CNAs argue that they are not only very overwhelmed by the pandemic and its implications on their working conditions but are also extremely overworked and do not have many breaks, especially since their income is so slim and the need to work is dire (p. 908). Therefore, in order to make CNAs feel like they can take a break while working at nursing homes, vacation time should be considered. The implementation of this solution is complicated, as understaffing limits the ability to take vacations. It is important, however, to provide some form of breaks despite staffing levels, as the quality of care will only be hindered if CNAs are forced to work despite their exhaustion. Additionally, according to Levere et al. (2020), staffing levels could be improved if wages were increased, as this is one of the underlying causes for understaffing in nursing homes (p. 951). Hence, to tackle the issue of understaffing, solutions such as higher pay and vacation time should be evaluated.

While the budgets of nursing homes may not coincide with the increase of wages, looking into improving the amount Medicaid gives to nursing homes could open doors for such a solution. According to McGarry and Grabowski (2022) when comparing Medicaid with Medicare, Medicare can be defined as federal funds that

provide payments for short term delivery care costs while Medicaid comes from state funds and generally gives below what is needed for long-term residents (p. 159). This means that, although Medicare is purposed to provide for individuals 65 or older, Medicaid is the primary provider for long term residents in nursing homes. As claimed by McGarry and Grabowski (2022), compared to private payments, Medicaid only provides 70% of what private payments give to nursing homes on a daily basis (p. 141). Therefore, when looking at residential care in these permanent homes, Medicaid payments could be increased by the federal government in order to ensure better care. More money towards nursing homes could allow for higher wages, which would likely help retain workers who need a better income. CNAs work many hours to provide care to residents, and it would be unfair to not consider the fact that they need sufficient income and vacation time in order to perform well at their jobs. The increase of Medicaid payments by the federal government is a viable way to make these solutions more attainable.

## **CONCLUSION**

The effects of the COVID-19 pandemic on nursing homes not only enhanced social isolation and loneliness of residents, but also highlighted the ongoing issues in the working conditions of CNAs. The power hierarchy in the working environment puts CNAs in a situation where they are unheard, uncertain in their job, and overwhelmed by the responsibilities given to them. As the direct care providers for residents, their well-being is proportional to the health of residents. Therefore, in order to combat the anxiety, depression, and cognitive impairment of residents as a result of the social restrictions, CNA satisfaction must also be considered. Addressing work discrimination via administration intervention and more training, in conjunction with better pay and benefits, will reverse the domino effect between CNA wellbeing and resident quality of care.

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# Headstrong: Analyzing the Correlations Between Sub-Concussive Head Injury and Balance, Depression, and Cognition in Collision and Contact Sports

Catherine Milligan, Aman Shahzad

## ABSTRACT

Athletes are susceptible to head injuries that could lead to alterations in cognitive function. Of particular concern for many professional athletes is the risk of developing Chronic Traumatic Encephalopathy (CTE). CTE is a neurodegenerative brain condition in which patients show cognitive impairment and emotional dysregulation as a result of repeated head trauma. The National Football League (NFL), for example, has acknowledged that playing football can and does lead to brain damage. Recent evidence, however, suggests that it is not just professionals that are at risk. Repeated sub-concussive events (head trauma that does not cause observable concussions) at any level of sport play are harmful to the brain because of the damage it causes to white matter. An athlete's previous sport history, position, and activity level contributes to the exposure to head trauma. It can be assumed that white matter damage begins to accumulate early in an athlete's career, which has the potential to later develop into CTE. To test this hypothesis, we recruited college students with a history of playing collision or contact sports. We tested their cognitive function and compared it to control participants who had no history of playing sports.

**Keywords:** head injuries, chronic traumatic encephalopathy, sub-concussive events, white matter damage, cognitive function

## INTRODUCTION

Dr. Bennet Omalu was the first to discover CTE in retired professional football player, Mike Webster. Before his premature death, Mike Webster experienced deficits in his executive functioning. Webster suffered from short term memory loss, behavioral disturbances, and difficulty focusing and paying attention. Upon further investigating during the autopsy, Dr. Omalu found amyloid plaques, sparse neurofibrillary tangles, and t-positive neurotic threads in neocortical areas—all elements produced in the pathogenesis of Alzheimer's disease (Omalu et al., 2005). CTE was not well researched and was new to the medical field. Following Dr. Omalu's discovery, Dr. Ann McKee became director of the Boston University CTE Center and extensively researched the effects of sub-concussive head impacts and its possible development into CTE. McKee's research indicated that a buildup of tauopathy in the brain is the result of repeated head injury and sub-concussive head impacts (McKee, 2009). Tauopathy is a neurodegenerative disorder characterized by the accumulation of abnormal tau proteins, similar to that of Alzheimer's disease (McKee 2023). However, after further investigation, Omalu and McKee found that CTE was a pathologically distinct disease of its own. According to Boston University CTE Center, over 99% of the former NFL players autopsied brains have been diagnosed with CTE (Boston University, 2023).

Initially, it was presumed that CTE was the result of the many concussions experienced in a professional athlete's career. CTE risk is not only associated with the number of concussions that an athlete experiences, but also the type of

sport, how long they have been playing, as well as the age at which they began participating in the sport (Alosco et al., 2018; Mez et al, 2020). Sports can be classified based on the level of contact required. Collision sports (e.g., football, lacrosse, boxing) require athletes to purposefully collide with each other using great force. In contact sports (e.g., basketball, soccer) athletes will routinely collide with each other, but with less force and frequency. Limited-contact sport athletes (e.g., tennis, cross country, diving) rarely make contact with each other, but serious injuries may occur sporadically under certain circumstances (Rice 2008). The repetitive force collision athletes use makes them susceptible to sub-concussive head injuries.

Although extensive CTE research has been performed post-mortem relating to its neuropathology, the cognitive and behavioral changes of early CTE stages are still not fully understood. This study aims to better understand early changes in developing young adult brains who have sustained repeated head injuries from collision and contact sports through the use of symptom surveys, a balance test, and multiple cognitive tests. The hypothesis is that students between the ages of 18-23 who have participated in contact and collision sports have slight but significant differences in performance compared to their limited-contact and non-sport playing peers.

## METHODS

Participants were recruited on a voluntary basis from the Salisbury University campus as well as from the Salisbury community through flyers, e-mail, and in-class announcements. Psychology students that participated in the study were given

extra credit as an incentive for their contribution. Psychology students were recruited from Introduction to Psychology classes (PSYC101). The participants' age range was between 18-23 years, with 20-year-olds being the highest average in each group. Based on the sports played by the participants they were sorted into one of three separate groups: at least 3 years of collision or contact sports (CLCN), at least 3 years of little-to-no contact sports (LCON), and those who play no sports (CTRL). Students were recruited and assessed for balance, cognition, and other head injury symptoms.

## BALANCE ERROR SCORING SYSTEM (BESS)

Individuals who have sustained long term, repetitive head injuries commonly show impairments in balance (Row 2019). The Balance Error Scoring System (BESS) is a measure of balance for athletes who have sustained concussions. It can be used as a tool in assisting physicians in making return-to-play decisions after an individual sustains a head injury (Furman 2013). The BESS protocol requires an individual to stand for 20 seconds in six stance positions. The test is administered on a firm surface and a foam pad. The first stance, the double leg stance, requires the participant to stand straight with both feet aligned side by side. The second stance is the single leg stance in which the participant must stand on their non-dominant leg with the contralateral limb held in approximately 20° of hip flexion, 45° of knee flexion and neutral position in the frontal plane. The final stance, the tandem stance, has the participant stand with their dominant foot placed in front of their non-dominant foot with the heel of the anterior foot touching the toe of the posterior foot. The participant completes the three stances on the

firm floor first, and then on the foam pad. During the stance, the participant must close their eyes and place their hands on their iliac crest (hip). Scores are measured based on the number of errors a participant makes. Errors are defined as the following: moving hands off the iliac crest, opening the eyes, stumbling or falling, abducting the hip, lifting the foot or heel off the surface, and remaining out of the proper stance for more than 5 seconds. The maximum total number of errors for each stance is 10, with 60 total errors being the maximum for the entire test. The errors recorded by the administrator demonstrate the participants inability to maintain proper postural control (Dubas 2021).

#### **CENTER FOR EPIDEMIOLOGIC STUDIES DEPRESSION SCALE (CES-D)**

The CES-D is a self-report measure of depression symptoms and severity over the previous week (McCauley 2006). Individuals are asked to rate their symptoms from the past week on a scale of 0 to 3, where 0 indicates rarely and 3 indicates most of the time. The symptoms on the CES-D range from feelings of loneliness, restlessness, fear, poor appetite, etc. The scores are calculated by adding the 20 rate of depression questions for an overall total score. The total scores range from 0-60, with 60 indicating the highest symptomology.

#### **RIVERMEAD POST- CONCUSSION SYMPTOMS QUESTIONNAIRE (RPSQ)**

The RPSQ is a self-report concussion scale that measures how severe an individual experiences symptoms after a concussion (de Guis 2010). Individuals are asked to rate 18 symptoms that range from 0 to 4, where 0 indicates "not experienced at all" and 4 indicates "a severe problem". A total score is calculated by adding up the ratings from the 18 questions. The total scores range from 0-72, with 72 attributed to the likelihood of a concussion present. It is presumed that the individuals participating in the study will have not recently been diagnosed with a concussion. Therefore, the RPSQ will apply to any incident of head injury experienced by the participant during their time as an athlete. Participants that have not sustained a diagnosed concussion will still complete the survey to account for misdiagnosis and will indicate if they have not had a concussion at the bottom of the survey page. RPSQ has been established as a useful neuropsychological tool after mild head injury (Heitger et al., 2006). Although higher RPSQ scores are significantly associated with greater CTE pathology, this study also aims to predict any limitations in the questionnaire (De Guise et al., 2016). Previous studies showed that participants that had sustained minor head injury

scored higher on RPSQ for as long as 3 months after the accident (Heitger et al., 2006).

#### **NATIONAL INSTITUTES OF HEALTH (NIH) TOOLBOX - COGNITION BATTERY**

The NIH toolbox is a standardized set of instruments designed to measure cognitive, emotional, motor, and sensory function developed under the leadership of Dr. Richard Gershon (Zelazo et al., 2013). These measures have been psychometrically validated on a nationally representative sample and organized into batteries. The cognition battery was used for this study and presented and scored through the NIH app software. The cognition battery consists of seven tests presented in the following order: Picture Vocabulary, Flanker Inhibitory Test, List Sorting Working Memory, Dimensional Change Card Sort, Pattern Comparison, Picture Sequence, and Oral Reading Recognition. The NIH toolbox battery was administered using an iPad tablet.

The Picture Vocabulary Test (PVT) is an assessment of receptive vocabulary. Participants are shown four images on the screen as a vocabulary word is audibly spoken through the iPad. They must select the image that they believe best represents the definition of the vocabulary word. The Oral Reading Recognition Test (ORRT) assesses expressive language and written word pronunciation. Single words or letters are presented on the screen and the participant must pronounce the word back to the administrator. The administrator is responsible for correctly identifying if the response was correct or not. The scores of the language tests are based on the item response theory (IRT) and comparable measures of vocabulary ability (Hoffman 2012).

The Flanker Inhibitory Control and Attention Test (FIT) measures visuospatial inhibitory attention. In this test, the participant is shown a row of arrows. They may select either the left arrow button or the right arrow. The arrow in the middle of the row may be in unison with the others, or it is facing the opposite direction. The participant must always select the button of the direction that the middle arrow is pointing. This requires the participant to inhibit their attention towards the other arrows. The scores of the test are based on accuracy and reaction time.

List Sorting Working Memory task (LSWM) measures working memory. Working memory pertains to the ability to maintain and hold information in the conscious temporarily (Jaffe 2021). The first part of this task consists of showing the participant a sequence of food or animals and then a blank screen. The participants are required to repeat the sequence in order from smallest to largest once the blank screen

appears. In the second part of the task, the food and animals are combined into a sequence. The participant must list the food in size order from smallest to largest, and then animals in size order smallest to largest. The administrator scores the participant based on accuracy. Scores of the test are based on the number of correctly identified sequences in both trials.

The Dimensional Change Card Sort Test (DCCS) assesses executive function in terms of cognitive flexibility and attention. In this task, there is a display of two different stimuli on the screen. The stimuli are different colors and different shapes. Before the test stimulus is shown, the word "shape" or "color" appears on the screen. The participant must select the matching shape or color of the test stimuli based on the word presented. Scoring is based on accuracy and reaction time.

The Pattern Comparison Processing Speed Test (PCPS) measures the participants processing speed. The participant is presented with two images side-by-side on the screen. They are asked to depict whether the pictures are the same using a "Yes" and "No" button. The scores are based on the total number of correct responses within a 90 second time period. The Picture Sequence Memory Test (PSM) is a measure of episodic memory. Episodic memory is the conscious recollection of personal experiences (Mahr 2017). The participant is shown sequential pictures related to an activity, such as "playing in the park", along with an audio file narrating each picture. After hearing the entire sequence, the pictures are randomized in the center of the screen and the participant must slide them into the correct order. Scores are based on the total number of correct placements across each trial.

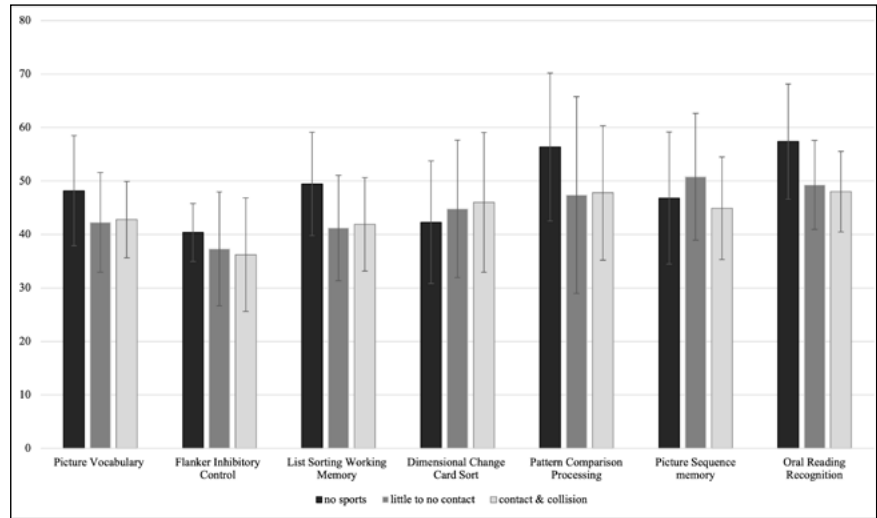
#### **PROCEDURE**

This study was conducted in compliance with the Institutional Review Board (IRB) standards for ethical research. Participants were recruited from the Salisbury University community as well as Introductory Psychology classes. Upon arrival, participants were given a consent form that ensured that they understood the elements of the experiment. Participants were made aware that they could forfeit their participation at any time without being penalized.

Participants were then asked to complete the NIH toolbox cognitive battery. A research assistant administered the test and remained present in the testing room to provide instruction and clarification if needed. The toolbox took roughly 30 minutes to complete, depending on the participants and their reaction time. Once the participants completed the NIH toolbox, they were asked to remove their shoes and complete the BESS test. After the balance test, participants

Variable	Contact & Collision	Limited to no contact	No sports
Female (n):	10 (66.7%)	9 (32.1%)	9 (32.1%)
Male (n):	5 (33.3%)	1 (11.1%)	2 (22.2%)
Race:			
Caucasian	10 (66.7%)	7 (70%)	6 (54.5%)
African American	3 (20%)	2 (20%)	3 (27.3%)
Asian	1 (6.7%)	---	2 (18%)
Other	1 (6.7%)	1 (10%)	---
Average age:	19.75	20.6	19.91
Average alcohol consumption per week:	5.13	3	3
History of leg fractures (n):	6	5	3
History of concussions (n):	2	2	2
Organized sport:	Cheer: 2 Soccer: 9 Lacrosse: 9 Basketball: 4 Football: 3	Softball: 3 Baseball: 2 Diving: 1 Swimming: 2 Tennis: 6 Equestrian: 1 Volleyball: 1 Track & Field: 5	

**TABLE 1:** A description of demographic questionnaire responses from the 36 subjects. Subject responses were broken down based on the experimental and control groups.



**FIGURE 1:** Fully corrected T scores of each NIH toolbox cognition battery task were averaged for the three sport groups. The CTRL group is represented by the black color; the LCON by a gray; and the CLCN by the lightest hue. Slight differences are present between the groups for all the tasks.

were asked to complete a demographic questionnaire, along with the RPSQ and CESD surveys. Participants were reminded that their identity would remain anonymous, and they were told to answer as honestly as possible to obtain accurate data. Once the tasks and questionnaires were completed, the participants were given a debriefing form. Information related to the study and the importance of the research was listed on the form as well as resources to be utilized if participants were not satisfied with the study's outcome.

## RESULTS

A total of 37 participants were recruited from Introductory Psychology classes at Salisbury University over the course of two semesters. Subject 37 was excluded from the data because they were 2.5 times the age average and a prominent outlier. **Table 1** displays the demographic information collected pertaining to the three groups. Of the remaining 36 participants, 15 of them played collision and contact sports (CLCN), 10 participants played little to no contact sports (LCON), and 11 participants did not participate in team sports (CTRL). NIH Toolbox results and survey data were analyzed in Microsoft Excel by calculating the mean and standard deviation of the total scores from each participant in the three groups. Statistical significance was computed using the Statistical Package for Social Sciences (SPSS) software. The effect size and p-value were calculated using a One-Way ANOVA test.

### NIH TOOLBOX

The NIH Toolbox contains a built-in measure in the program that calculates fully corrected

T-scores. The fully corrected T-score is calculated by computing the raw score, the total number of correct responses or time taken to complete the task, and correcting them based on factors such as age, gender, education level, and parent education level. **Figure 1** depicts the averages of the fully corrected T-score data for each executive function task. Fully corrected T-scores were used as they reflect a standardized measure of performance.

Assumption of normality was observed to be satisfied for all dependent measures except PVT and ORRT (Schmider, et al. 2010). Additionally, we verified that the assumption of homogeneity of variance was satisfied according to Levene's *F* test for PVT ( $F(2,33)=1.05, p=.36$ ), FIT ( $F(2,33)=0.88, p=.42$ ), LWSM ( $F(2,33)=0.32, p=.73$ ), DCCS ( $F(2,33)=0.22, p=.81$ ), PCPS ( $F(2,33)=0.76, p=.84$ ), PSM ( $F(2,33)=0.76, p=.48$ ), and ORRT ( $F(2,33)=1.39, p=.26$

Each dependent measure was submitted to a Between Groups One Way ANOVA (CLCN vs LCON vs CTRL). As can be seen in **Figure 1**, a significant main effect of group was found for LWSM ( $F(2,1)=4.97, p<.05, \eta^2=.23$ ). Bonferroni-corrected post hoc t-tests (family-wise error rate set at .05) indicated that the CTRL group ( $M=51.64, SD=8.72$ ) was significantly different from CLCN ( $M=40.93, SD=8.76$ ) and LCON ( $M=41.6, SD=10.2$ ). A significant main effect was also found for ORRT ( $F(2,1)=5.96, p<.0, \eta^2=.27$ ). Bonferroni-corrected post hoc t-tests (family-wise error rate set at .05) indicated that the CLCN ( $M=46.53, SD=6.5$ ) attained significantly lower scores than the CTRL group ( $M=58, SD=10$ ) but their scores were not significantly different from those of the LCON group ( $M=51.6, SD=8.96$ ). Further, the CTRL group exhibited marginally

and significantly higher scores than the LCON group ( $p=.09$ ). This data should be interpreted with caution, however, given that the test for normality rejected the null hypothesis.

We observed a significant main effect for FIT ( $F(2,1)=2.99, p=.06, \eta^2=.15$ ) and PCPS ( $F(2,1)=2.66, p=.08, \eta^2=.14$ ). For FIT, Bonferroni-corrected post hoc t-tests (family-wise error rate set at .05) indicated that the CLCN group ( $M=41.07, SD=7.97$ ) performed significantly worse than the CTRL group ( $M=48.55, SD=9.76$ ) and marginally significantly worse than the LCON group ( $M=43.6, SD=9.36$ ). There was no significant difference, however, between the CTRL and LCON groups ( $p=.88$ ). For PCPS, Bonferroni-corrected post hoc t-tests (family-wise error rate set at .05) indicated the CLCN group ( $M=50.64, SD=15.46$ ) performed significantly worse than the CTRL ( $M=58.73, SD=12.12$ ) group ( $p<.05$ ). However, the LCON group ( $M=50.2, SD=17.04$ ) did not significantly differ from either the CLCN group ( $p=.40$ ) or CTRL group ( $p=.20$ ). Finally, no significant differences were found for PVT ( $F(2,1)=2.25, p=.12, \eta^2=.12$ ), PSM ( $F(2,1)=0.37, p=.69, \eta^2=.02$ ), DCCS ( $F(2,1)=0.21, p=.81, \eta^2=.01$ ).

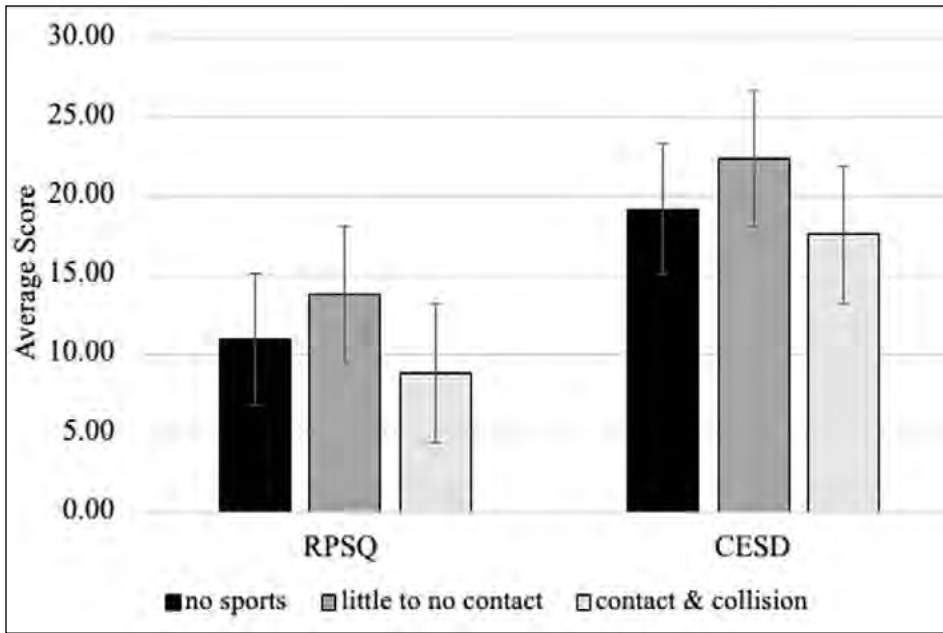
### QUESTIONNAIRES

No significant main effect of group was found for the RPSQ ( $F(2,1)=0.566, p=.57, \eta^2=.01$ ) or CESD ( $F(2,1)=1.5, p=.24, \eta^2=.08$ ).

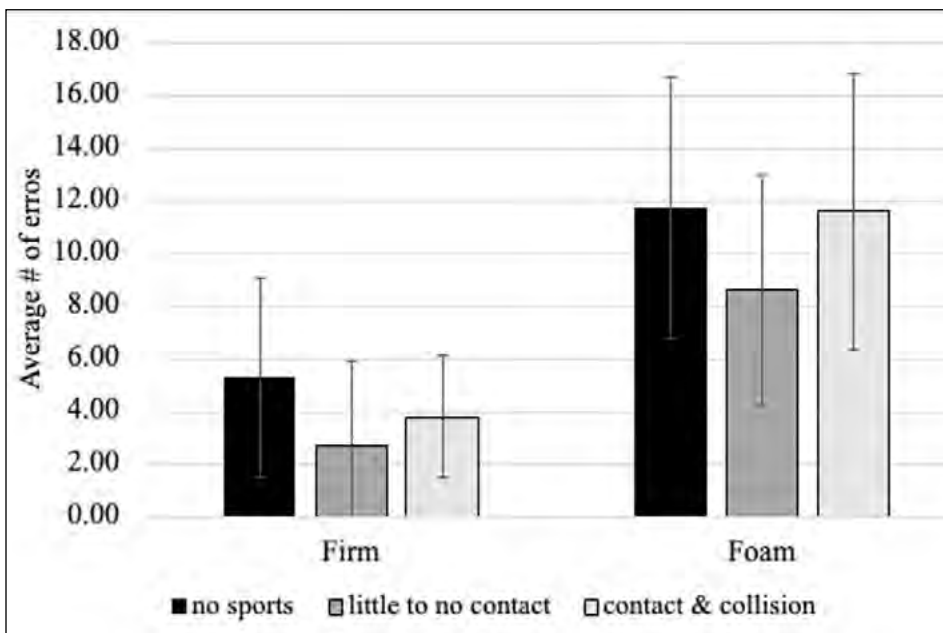
**Figure 2** depicts the averages of the RPSQ and CESD results for each group.

### BESS TEST

A significant main effect of the group was observed for the Firm Surface test ( $F(2,1), p<.05, \eta^2=.17$ ). Bonferroni-corrected post hoc t-tests



**Figure 2:** Regarding the RPSQ, the higher the average score, the higher the likelihood of head injury being present. For the CESD, the higher the score, the higher the symptomology of depression. The CTRL group is represented by the black color; the LCON by a gray; and the CLCN by the lightest hue.



**Figure 3:** The higher the bars, the higher average number of errors made on the BESS test. The CTRL group is represented by the black color; the LCON by a gray; and the CLCN by the lightest hue.

(family-wise error rate set at .05) indicated that the CTRL group ( $M=5.73$ ,  $SD=3.69$ ) had significantly more errors than the LCON group ( $M=2.2$ ,  $SD=2.49$ ). The CLCN group ( $M=3.8$ ,  $SD=2.93$ ), however, did not perform significantly different from either of the groups. No significant main effect of group was found for the Foam Surface test ( $F(2,1)=1.48$ ,  $p=.24$ ,  $\eta^2=.08$ ). **Figure 3** displays the average number of errors for each group on the firm and foam surface.

## DISCUSSION

These findings partially support the main hypothesis. The main hypothesis was that the no sports group would cognitively outperform the collision and contact group. Most of the NIH toolbox result trends directly support this hypothesis. The Picture Vocabulary test, Flanker Inhibition test, List Sort Working Memory test, Pattern Comparison Processing Speed test, and Oral Reading Recognition test all show

trends displaying the CTRL group performing better than both the CLCN and LCON groups. While not every test showed significance, it can be inferred from our observed power for each of these that with a larger sample, the tests would have become statistically significant for all seven NIH tasks. In the Picture Sequence Memory task, the no sports group performed better than the contact and collision group, but worse than the little to no contact group. This shows that the participants in the little to no contact group performed better in terms of recalling from episodic memory. Athletes in contact and collision sports experience cognitive dysfunction, particularly in episodic memory, because of repeated head injuries (Katz 2021). The Dimensional Change Card Sort test results show that the contact and collision group scored higher than both the no sports group and little to no contact group. The results of the DCCS are not statistically significant, but they imply that the contact and collision group maintained greater attention and had an accurate, faster reaction time. This could be due to the heightened concentration required by athletes when competing in sports.

The results from the CESD results are consistent with research pertaining to participation in team sports leading to increased happiness, discipline, and stress relief (Marsh, 2003). Being a part of a team sport can raise confidence and self-esteem in athletes. While many of the participants scored low in terms of depressive symptoms, this does not directly suggest that symptoms do not surface in the future. CTE symptoms, like mood dysregulation, may present early in an athlete's life. However, they are typically shown to progress later in life through the course of the disease (Patel 2023).

The RPSQ results, concussion and head injury history, did not show statistical significance. A possible explanation for this is survey error. Subjects were made aware that their names would not be attached to any questionnaire answers and results. However, research has shown that anonymously answering questionnaires does not guarantee a higher disclosure rate to sensitive topics, including health and medical history (Maureen 2014). The RPSQ asked questions regarding physical and mental vulnerabilities, which subjects may have not been willing to answer honestly. The questionnaire sheet also displayed the words "concussion symptoms". Participants that have not previously been diagnosed with a concussion may have believed that they should have answered "0" for each question, meaning they have not felt fatigue, poor concentration, depressive symptoms, etc., within the past 24 hours before testing. The study analyzed

sub-concussive head impacts, not concussions. In terms of future research, it would be beneficial to remove the title or statements regarding a concussion diagnosis to ensure a higher chance of receiving honesty from subjects.

The no sports, CTRL, group had a higher average number of errors on the BESS firm surface compared to the LCON and CLCN groups. A possible explanation for this is regarding the coordination training athletes endure. Previous research supports that athletes who participate in more proficient athletics, like collision and contact sports, show to have improved balance. This is because the rigorous training experience that is practiced aiding in coordination and strength, also improves balance (Hrysomallis 2011). The CTRL and CLCN groups scored similarly on the foam surface. The no sports group averaged M=11.73 errors and the collision and contact group averaged M=11.6 errors. The purpose of the foam pad is to establish an unstable surface that challenges the individuals balance and coordination. The results of the BESS test show that overall, the no sports group struggled to maintain postural stability, while the little to no contact group performed the best in maintaining balance.

## LIMITATIONS AND FUTURE RESEARCH

A priori power analysis based on previous findings indicated that a sample size of at least 42 participants should be proficient to obtain 80% power for One Way Analysis (Ting et al., 2016). Over the course of a year, we were able to recruit a total of 37 subjects, with 36 usable sets of data. Due to the smaller sample of participants, the statistical power did not reach 80% to obtain a proficient significance in all the tasks. It can be inferred, due to the trends in data, that a larger sample of participants would have resulted in more robust data pertaining to the tasks that did not show significance.

The CLCN group was predominately female (66.7%), with only 33.3% of the subjects being male. Most of the research relating to symptoms and diagnoses of CTE is directed towards the male population. There is limited CTE research involving female participants. This is because until recently, only male athletes have been tested and diagnosed with CTE postmortem. However, the first case of CTE in a female Australian football player has been reported after her suicide in 2022 (Williams 2023). It is likely that as more females are tested and diagnosed,

research will become more accurate for the entire population.

The data collected has displayed trends supporting that individuals who have not played sports cognitively perform better in executive function tasks. This supports previous research done on CTE and the correlation between contact and collision sports on cognitive functioning. While the subjects showed cognitive differences between the experimental groups, they are still in a normal range of functioning. Therefore, the data should not be interpreted as the experimental groups being at a cognitive disadvantage. There are still unknown factors relating to CTE research including gender differences, onset of symptoms, pre-mortem diagnoses, etc. Currently, CTE can only be officially diagnosed post-mortem after a thorough brain autopsy. This ultimately makes it difficult to treat and there is yet to be a cure for the neurodegenerative disease. As CTE research progresses, it is necessary to further study cognition and behavioral impairments in young adults in hopes of developing early prevention methods and pre-mortem diagnoses.

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# Parental Distress After NICU Discharge: Resilience Through Music Therapy Intervention

Kate Gerlus

## ABSTRACT

The nature of the neonatal intensive care unit (NICU) can be traumatizing for both admitted infants and their parents. Such distress is often combated in the hospital through music therapy (MT) intervention. However, recent evidence indicates parents of hospitalized infants endure untreated psychological distress even after discharge. The issue of parental distress intensifies as scholars report an interdependent relationship between parental and infant health. This paper analyzes the complications of the NICU environment and how MT intervention has been implemented to support parents and infants in the hospital. In addition, this paper addresses parental distress after discharge and how such conflict can negatively impact infants. Furthermore, with scholarship regarding telehealth MT intervention during the COVID-19 pandemic, this paper argues for the adoption of telehealth virtual services in MT delivery in order to reach families suffering from NICU distress after discharge. Understanding how NICU trauma in the hospital is being addressed through MT will provide insight on how NICU trauma experienced at home can also be addressed through MT utilizing telehealth services.

**Keywords:** NICU, psychological distress, music therapy, infant development, telehealth

## INTRODUCTION

In 2021, 10.5% of births in the United States were born prematurely, resulting in infant admission into the neonatal intensive care unit (NICU) (Centers for Disease Control and Prevention, 2022). Despite its life-saving nature, the NICU is a traumatizing environment for both admitted infants and their parents as it induces psychological distress and suppressed development in parents and infants (Dickinson et al., 2022; Ettenberger et al., 2017; Gooding & Trainor, 2018). Music therapy (MT) intervention in the hospital is a widely supported solution for combating NICU trauma (Ettenberger et al., 2017; Malloch et al., 2012; Palazzi et al., 2021). However, parents of previously hospitalized infants endure untreated psychological distress even after discharge (Brelsford & Doheny, 2022; Dickinson et al., 2022; Grunberg et al., 2020; White et al., 2017). Continued parental distress heightens in severity when considering the interdependent relationship between parental and infant health (Ettenberger et al., 2017; Malloch et al., 2012; Palazzi et al., 2021). If parental distress after discharge remains untreated, parental mental health and infant development will suffer an interactive downward spiral. However, recent telehealth scholarship following the COVID-19 pandemic suggests virtual music therapy as effective in supporting patient mental health (Cephas et al., 2022; Wilhelm & Wilhelm, 2022). While MT intervention is typically delivered in-person, MT providers should adopt virtual services through telehealth delivery to address parental distress after discharge. By understanding and connecting MT and telehealth services, traumatized families can reconcile their new lives

outside of the hospital, allowing both parents and infants to live healthier and longer lives.

## TRAUMATIZED PATIENTS

Admitted infants are physiologically traumatized by the NICU. Palazzi et al. (2021) concluded stress-inducing procedures performed in the NICU hinder infant brain and physiological development (p. 672). In addition, NICU infants suffer increased health risks from stressful and invasive procedures such as complications with heart rate and blood pressure (Palazzi et al., 2021, p. 673). The NICU incorporates lifesaving procedures for infants. While these procedures are necessary for infant survival, they also obstruct the physiological development of infants. Furthermore, invasive procedures negatively influencing infant heart rate and blood pressure illustrate the NICU as a stressful environment for infants. While medical professionals succeed in promoting infant survival, the nature of the NICU can traumatize infants' by impacting their physiological development.

Admitted infants additionally suffer psychological distress while in the NICU. Malloch et al. (2012) reported the NICU as a source of psychological distress and suppressed development in admitted infants due to infant social isolation (p. 387, 388). Infants require nurturing and affection from their caregivers for socio-emotional support and development (Ettenberger et al., 2017, p. 208; Malloch et al. 2012, p. 387; Palazzi et al., 2021, p. 673). However, the NICU setting involves complicated technology and harsh medical interventions that inhibit "parental-infant" bonding (Malloch et al., 2012, p. 387; Palazzi et al., 2021, p.

673). Additionally, infants are often restrained to medical equipment for optimal survival, minimizing opportunities for physical connection (Malloch et al., 2012, p. 387). The nature of the NICU restricts social interaction between parents and infants, resulting in socially and physically deprived infants. Without the necessary contact between parents and infants, infants are unable to properly develop socio-emotionally. While the NICU prioritizes enhancing survival, it interferes with the social and psychological needs of admitted infants.

In addition to the suffering infants experience from the NICU, parents encounter challenges, as well. Gooding and Trainor (2018) reported that parents "... face a variety of emotional and practical challenges ..." such as the use of necessary medical equipment, the frail appearance of their infant, financial complications, and communication with medical professionals (p. 1). The authors concluded that such challenges hinder parental-infant bonding, and result in inadequate sleep, anxiety, depression, and even post-traumatic stress disorders. There are many challenges within the NICU, which have all been shown to affect parental mental health. Facing these challenges throughout their infant's hospitalization without any support may trigger an increase in mental health complications within parents.

An increase in mental health complications can manifest in the form of negative self-consciousness within parents. Barr (2015) reported considerable evidence of additional negative self-conscious emotions such as shame, chronic guilt, and fear of infant death exhibiting in parents after their infant's hospitalization (p. 408, 409). These harsh emotions have a

negative influence on parents' mental health, resulting in psychological distress (Barr, 2015, p. 409). Negative self-consciousness and negative emotions present in parents following their infant's NICU admission indicate the NICU as the source and/or trigger for these feelings. To add, such information illustrates parents associate a negative realm of emotions with the NICU.

Whilst dealing with such intense emotions, parents turn to unhealthy habits as a form of coping. Dickinson et al. (2022) noted 18% of parents reporting harmful levels of alcohol and ⅓ of parents presenting symptoms of low-to-intermediate substance abuse following the first two weeks of their infant's NICU admission (p. 377, 378). A report of unhealthy habits in parents following their infants NICU admission indicates psychological affliction because of such admission. Adversities regarding infant NICU admission may be the driving factor behind parents turning to alcohol and substance abuse. Furthermore, an increase in alcohol and substance abuse in parents after their infants' NICU hospitalization hints at such habits being a coping strategy. Overall, Dickinson et al. (2022), Barr (2015), and Gooding and Trainor (2018) illustrate disastrous effects of the NICU on parents, proving that parental mental health is severely at risk.

### **MUSIC THERAPY AS A SOLUTION**

MT intervention has been implemented in the NICU to combat parental and infant distress (Palazzi et al., 2021, p. 672). These therapeutic musical experiences are administered in the hospital as family focused support known as Family-Centered Care and are used to mentally support patients and ease pain (Cephas et al., 2022; Ettenberger et al., 2017; Malloch et al., 2012; Palazzi et al., 2021). MT aims to trigger infant expression, support infant physiology, and encourage parental-infant bonding (Ettenberger et al., 2017; Gooding & Trainor, 2018; Palazzi et al., 2021). MT in the NICU is presented through various methods such as parental singing, live improvised infant-contingent singing, hands-on instrumental music, or audio recordings (Ettenberger et al., 2017; Malloch et al., 2012; Palazzi et al., 2021). Furthermore, MT expands through soothing intrauterine sounds, classical sounds, lullabies, and even family cultural music (Malloch et al., 2012; Palazzi et al., 2021). Additionally, MT is often incorporated with parental-infant skin-to-skin contact known as kangaroo care to encourage social and physical interaction between parents and infants (Ettenberger et al., 2017; Malloch et al., 2012). To continue, MT works to address parental needs by focusing on parental anxiety, increased family

engagement, increasing normalization and encouraging healthy coping strategies (Gooding & Trainor, 2018). Overall, MT intervention incorporated with kangaroo care serves to encourage parental-infant physical and social interaction. MT intervention is catered to alleviate the physiological and psychological damages the NICU has on admitted infants. In addition, MT intervention encourages the support of parental mental health by minimizing the challenges parents face within the NICU.

MT intervention has psychological benefits for distressed NICU infants. As assessed by the Neurobehavioral Assessment of the Preterm Infant (NAPI), MT successfully improves the neurological and behavioral functions of NICU infants (Malloch et al., 2012). Malloch et al. (2012) collected NAPI scoring of preterm infants pre and post MT intervention (p. 389). These results were compared to the NAPI scoring of healthy infants and of preterm infants not receiving MT intervention. Both preterm groups presented low pre-assessment NAPI scores with no significant difference between one another. However, after receiving MT intervention, the MT group displayed a statistically significant increase in their post-assessment NAPI scores, ultimately reflecting the high NAPI scores of the healthy control group. An increase in NAPI scores indicates MT intervention as a medical practice that positively assists the neurobehavioral development of NICU infants. Given how infants suffer socio-emotional development during the NICU, a significant improvement in infant neurobehavior demonstrates a step towards rebuilding infant socio-emotional development.

MT intervention also benefits infant physiology. Palazzi et al. (2021) reported MT intervention supporting infant physiology by demonstrating positive trends in decreasing infant heart rate and stabilizing oxygen saturation during MT sessions (p. 680). The non-invasive and soothing medical practice of MT intervention worked to relax infants, allowing them to experience such de-stressing physiological symptoms (Palazzi et al., 2021, p. 683, 684). Similarly, Ettenberger et al. (2017) reports MT intervention as supporting infant weight gain through increased caloric intake and decreased caloric expenditure (p. 224). Decreased heart rate, stabilized oxygen saturation, and increased weight in infants verifies MT intervention as a medical practice that relaxes hospitalized infants. Considering infants suffer stress, increased heart rate and increased blood pressure from NICU procedures, MT intervention's ability to reverse these effects indicates MT as beneficial for hospitalized infants. Furthermore, with infants relaxed, they

are more susceptible to parental-infant contact, further encouraging the healing process of the hospitalized infant. Overall, MT intervention works to mentally and physically support distressed NICU infants.

MT intervention simultaneously addresses parental mental health. Ettenberger et al. (2017) reported evidence of MT significantly decreasing parental anxiety as analyzed by the State-Trait Anxiety Inventory (STAI) assessment (p. 219). STAI improvement was demonstrated in both mothers and fathers, with mothers experiencing a statistically significant decrease in anxiety scores (Ettenberger et al., 2017, p. 219). Similarly, Palazzi et al. (2021) reported none of the mothers in their study who received MT intervention presented high STAI scores (p. 678). A decrease and/or stabilization in STAI scores in parents suggests MT intervention as a mentally relaxing practice. The calming nature of MT intervention works to reduce the anxiety, stress, and fears that parents may experience within the NICU. Furthermore, Palazzi et al. (2021), utilizing the Edinburgh Postnatal Depression Scale (EPDS), found a lowered risk of depression in mothers who experienced MT intervention (p. 676, 678). While ten non-MT mothers presented risk of postnatal depression, only five MT mothers presented such risk (Palazzi et al., 2021, p. 678). MT decreasing the risk of postnatal depression in women indicates MT as mentally supportive in mothers as they continue life after pregnancy. MT intervention encourages mothers to prioritize their mental health, which can alleviate some of the challenges parents face within the NICU.

Additionally, parents demonstrated reduced negative self-consciousness because of MT intervention as they felt more involved in their infants' care (Ettenberger et al., 2017, p. 222; Malloch et al., 2012, p. 395; Palazzi et al., 2021, p. 674, 678). Decreased negative self-consciousness after MT intervention verifies MT as mentally uplifting for parents. Furthermore, increased parental participation in the NICU works to support parental-infant bonding within the NICU. As a result, both parents and infants are uplifted by MT intervention.

### **PARENTAL SUFFERING AT HOME**

However, parental trauma from the NICU continues even after discharge, despite the purview of MT in hospitals. Parents experience increased distress after discharge as they must rapidly become caretakers of a "medically complex infant," an infant requiring extensive medical attention, without their usual medical assistance (Grunberg et al., 2020, p. 343, 351). Grunberg et al. (2020) assessed parental stress after discharge using the Parental Stress

Index-Short Form (PSI-SF) (p. 346). The PSI-SF results indicated 20.4% of parents presented high stress levels. A significant percentage of parents presenting high stress levels in the PSI-SF assessment illustrates severe stress in parents after their infants NICU dischargement. Increased stress in parents after their infants NICU dischargement indicates a multitude of unaddressed challenges existing beyond the NICU.

Along with stress, parents experience increased anxiety after their infant's NICU dischargement. White et al. (2017) reported medical professionals imposing increased anxiety on parents through advice given as parents depart from the hospital (p. 111, 112). Additional advice left parents in anxious fear over their ability to properly care for their infant. Consequently, parents lack self-efficiency after discharge because they feel unprepared, inadequate, and incapable of adhering to their new responsibilities. Feelings of unpreparedness, inadequacy, and incapableness exhibiting in parents after discharge further indicates that parents suffer untreated distress at home. In addition, such emotions exhibited in parents demonstrate a need for additional parental support in order to alleviate the uncertainty parents experience regarding their ability to nurture their infant.

While the initial dischargement damages parents, the pain continues in their homelife. Brelsford and Doheny (2022) found evidence of parents experiencing a decline in mental health related to an increase of negative spiritual coping after their infants NICU dischargement (p. 120). Negative spiritual coping is a strained relationship with one's spirit, and such complications can lead to life questioning associated with depression, anxiety, and stress symptoms (Brelsford & Doheny, 2022, p. 120). Additionally, parents experience lack of parental life clarity, guilt, and self-blame through negative spiritual coping after NICU discharge (Brelsford & Doheny, 2022, p. 122, 123). The presence of negative spiritual coping and its relations with worsening mental health illustrates damage in parental quality of life after discharge. Parental quality of life after discharge is necessary to upkeep, as quality of life can begin to impact multiple aspects of life.

Furthermore, parents experience damaged relationships after NICU discharge. Grunberg et al. (2020) assessed couple functioning of discharged NICU parents through the Revised Dyadic Adjustment Scale (RDAS) (p. 346). Grunberg et al. (2020)'s RDAS results indicated 43.36% of parents presenting damaged couples functioning (p. 346). A high percentage of parents presenting damaged couple functioning

indicates tension between parents after their infant's NICU discharge. Such complications can significantly deteriorate parental quality of life, as parents may lose support within their household. In addition, White et al. (2017) reported parents experiencing strained family relationships as they adhere to medical advice (p. 112, 113). Since preterm infants are more susceptible to illness, parents are heavily advised to avoid germ threats by limiting exposure (White et al., 2017, p. 112). Consequently, parents significantly minimize family/friend visits, further resulting in parental isolation and a lack of social support. Additionally, excessive declines of social gatherings strains family/friend relationships by going against their loved one's desires (White et al., 2017, p. 113). Evidence of damaged couple functioning and limited family/friend interaction after NICU discharge demonstrates parents experiencing strained relationships in their homelife. As parents suffer relationship issues between their partners, they lose additional social support from family and friends, too.

In addition to psychological distress and damaged relationships, parents also experience equipment adversity after their infant's NICU dischargement (Grunberg et al., 2020, p. 347; White et al., 2017, p. 110). Discharged parents of NICU infants who were supported by an extracorporeal membrane oxygenation machine (ECMO) in the hospital experience increased family burden in comparison to parents of infants who were not supported by ECMO (Grunberg et al. 2020, p. 349, 351). ECMO is a form of life support for patients with acute heart and/or lung failure (American Lung Association, 2021). Family burden for parents refers to exhaustion experienced separate from caring for their infant, and an absence of parental socialization and self-care (Grunberg et al., 2020, p. 351). Increased family burden resulting from previous ECMO equipment usage demonstrates unaddressed uncertainty regarding an infant's need for equipment at home. Additionally, the correlation between ECMO and family burden may hint at unaddressed trauma from ECMO that parents continue to suffer from at home.

Parents currently utilizing home medical equipment for their infant's survival also experience equipment uncertainty (Grunberg et al., 2020, p. 351; White et al., 2017, p. 110). Grunberg et al. (2020) reported an increased use of medical devices at home associated with increased relationship distress between parents (p. 315). Similarly, White et al. (2017) concluded parents lack confidence in utilizing home medical equipment assigned to their infant because they are in anxious fear of misinterpreting data and feel incapable of properly monitoring their infant with machines

(p. 110). Evidence of negative emotions such as relationship distress, anxious fear, and incompetence present in parents regarding home medical equipment indicates challenges at home resulting from their infant's need for equipment. If such adversities remain unaddressed, mental health complications may increase, further damaging parental quality of life. While MT intervention has benefited parents and infants in the NICU, such benefits do not transfer after discharge.

## **INTERDEPENDENT PAIN**

Parental distress complications heighten in severity when considering the interdependent relationship between parental and infant health. Parents endure distress when observing their infant's distress (Barr, 2015, p. 402; Gooding & Trainor, 2018, p. 1). The physical appearance of their infant such as concerning size, deformities, or attachment to medical equipment triggers stress and anxiety within parents (Gooding & Trainor, 2018, p. 1). Similarly, Barr (2015) reports parents experience increased stress and anxiety when viewing all the medical equipment needed to support their infant's survival, feeling disturbance over their infant's appearance, and issuing self-blame as a result of "[being] empathetically attuned to their newborns adversity..." (p. 402, 403). Such evidence demonstrates a connection between parents and their infants. As parents observe the distress experienced by their infants, parents begin to experience increased stress and anxiety. Such negative emotions exhibiting in parents influenced by their infant's need for intense medical assistance illustrates how infant distress directly correlates with parental distress.

Similarly, parental mental health conversely influences infant health. Infants are extremely sensitive to emotions, often sensing their caregiver's tension (Ettenberger et al., 2017, p. 208, 226). Ettenberger et al. (2017) reported tension within parents as they interact with their hospitalized infant (p. 226). Such physical tension exhibited by parents is then sensed by their infants, resulting in their infant to be stressed, as well (Ettenberger et al., 2017, p. 226). Distressed infants exhibit signs of emotional unrest through irritability, unresponsiveness, and/or suppressed development (Ettenberger et al., 2017, p. 208, 226; Malloch et al., 2012, p. 394). As a result, a barrier is created between parent-infant bonding as distressed infants are not susceptible to parents' attempts to communicate (Ettenberger et al., 2017, p. 208, 226; Malloch et al., 2021, p. 395). Mental health disturbance in parents influences negative responses in their infants. As

a result, parental infant bonding is significantly hindered, further obstructing the developmental process of the infant. Parental mental health complications affecting infant's response to bonding verifies the corresponding influences between parental and infant health.

Additionally, the interdependent relationship between parents and infants affects parental nurturing. Parental mental health status directly impacts their ability to effectively operate as parental figures in their infants' lives (Ettenberger et al., 2017, p. 209; Palazzi et al., 2021, p. 682). Palazzi et al. (2021) found that decreasing maternal stress, anxiety and postnatal depression strengthened mothers' ability to actively participate in infant care (p. 682). Supporting maternal mental health increased feelings of parental competency, allowing mothers to be more engaged when nurturing their infant (Palazzi et al., 2021, p. 682). Improved parenting resulting from mental health support verifies how parental mental health influences a parent's ability to be nurturing to their infant. Similarly, Ettenberger et al. (2017) found improved parental STAI scoring positively correlating with increased parental-infant bonding (p. 218, 222). As parents relaxed, they were able to focus on their infant rather than their increased anxiety and stress levels (Ettenberger et al., 2017, p. 221). Parents becoming better parents as their mental health improves further indicates how parental mental health influences parental nurturing. Furthermore, such evidence indicates that mental health disturbances found in parents after NICU discharge directly impacts their ability to nurture their infants. In order to aid parental health, and by extension, infant health, parents must be provided with services constructed to support their needs beyond the NICU.

### **TELEHEALTH MUSIC THERAPY**

MT intervention expanded through telehealth services may be effective in addressing parental distress after discharge. Scholars conclude MT is effective in addressing parental needs in the NICU by focusing on parental anxiety, increased family engagement, educating patients and by adapting MT services to better suit parental needs (Gooding & Trainor, 2018, p. 5). Positive acknowledgement of parental needs in the hospital can continue through virtual reach via telehealth MT. Similarly, parents praised MT intervention because it supports their mental health, parental-infant bonding, and stimulates their infants (Ettenberger et al., 2017, p. 222, 223). Overall, evidence suggests MT intervention significantly improves parental quality of life. Such results should not be exclusive to the NICU

hospital experience. Positive support of parental health in the hospital can be reflected through virtual MT to combat distress at home.

Following the COVID-19 pandemic, studies have been conducted to evaluate the use of telehealth services on varying patient types (Cephas et al., 2022; Wilhelm & Wilhelm, 2022). The COVID-19 lockdown forced therapists to rely on telehealth virtual services such as Zoom to reach patients at home (Cephas et al., 2022; Wilhelm & Wilhelm, 2022). Complications regarding telehealth MT include audio delay, limited instruments, inconsistent internet, and limited interpersonal connection between client and therapist (Cephas et al., 2022; Wilhelm & Wilhelm, 2022). However, Cephas et al. (2022) and Wilhelm and Wilhelm (2022) both found positive experiences of virtual MT in pain management patients and older adults, respectively. Such positive experiences in other adult patients may allude to benefits for parents of recently discharged NICU infants.

Telehealth MT can help parents develop self-efficacy. Cephas et al. (2022) discussed how complications within the virtual setting required patients to problem solve (p. 221, 222). As patients began utilizing the virtual setting and provided solutions for technological issues, they exhibited increased self-efficacy (Cephas et al., 2022, p. 221). Increased self-efficacy is beneficial for parents of discharged hospitalized infants as they suffer feelings of incompetence and inadequacy (White et al., 2017, p. 108, 109). The experience of gaining confidence through virtual MT may encourage feelings of competence in distressed parents. Increased feelings of competence in parents may alleviate parent's fear of being unable to care for their recently discharged infant.

Additionally, virtual MT may provide parents with an increased sense of comfort and self-expression. Cephas et al. (2022) noted how telehealth MT patients experienced increased comfort and self-expression as they were able to choose their therapeutic setting (p. 219). Patients choose to participate in therapy from outside, a less stressful room, or an entirely different place (Cephas et al., 2022, p. 219). Patients were also able to express their mood and escape negative environments through their choice of virtual backgrounds (Cephas et al., 2022, p. 219). Engaging in therapy from a relaxing setting of their choice, physical or virtual, may allow parents to be more susceptible to relaxation. With increased relaxation, parents can stray away from exhaustion associated with family burden, which can improve their quality of life. Furthermore, Wilhelm and Wilhelm (2022) also found increased comfort in telehealth services (p. 90). Telehealth music therapists reported

increased comfort and safety in their adult clients from being able to participate in therapy from home (Wilhelm & Wilhelm, 2022, p. 90). Parents may also find comfort in participating in therapy from the safety of their home since, according to White et al. (2017), parents constantly worry about the health of their infant (p. 111, 112, 113). With the ability to receive therapeutic support from home, parents may find comfort in the safety their home provides for their infant.

Furthermore, parents can benefit from the increased participation and accessibility provided by telehealth MT. As an extension of increased comfort in telehealth MT, patients had increased participation (Cephas et al., 2022, p. 220, 221). Patients were encouraged to participate in therapy in a way that provides them with the most comfort, whether that be a change in scenery, entering a metaphoric environment, or muting audio/turning off camera if self-conscious about singing or dancing (Cephas et al., 2022, 219, 220). The ability to freely express themselves without judgment increased participation as patients were more willing to partake in therapy (Cephas et al., 2022, p. 220). Similarly, Wilhelm and Wilhelm (2022) reported increased participation through increased accessibility (p. 90). Telehealth MT provided an easily accessible home service with adjustable appointment scheduling (Wilhelm & Wilhelm, 2022, p. 89, 90). Therapists reported an increased number of appointments throughout the week, allowing for more MT sessions (p. 90). Parents may be able to gain better results from telehealth MT because the nature of telehealth MT encourages increased participation. In addition, while busy with caring for their infant, parents may appreciate telehealth MT services as they provide accessible home therapy.

However, medical professionals and clients may regard telehealth MT intervention as an inferior practice, as it does not provide clients with an in-person relationship with their therapist. In-person therapy allows patients to feel connected with their therapist, further enhancing therapeutic practices (Wilhelm & Wilhelm, 2022, p. 88). While virtual MT through telehealth services does not involve in-person therapy, the lack of this characteristic may be crucial in supporting parental mental health after their infant's NICU discharge. As mentioned, parents suffer social isolation to shield their illness prone infant from germ exposure (White et al., 2017, p. 111, 112, 113). Health concerns may steer parents away from beneficial in-person therapy because it involves increased exposure. However, Wilhelm and Wilhelm (2022) reported improved safety as a strength in telehealth MT because patients were able to participate in therapy from home with little concerns over

health issues (p. 90). Therapy provided to parents at home would decrease outside exposure, allowing for parents to receive support without promoting additional psychological strain. Through MT intervention, parents can focus on healing their mental health whilst ensuring the safety of their infant.

## CONCLUSION

While parental and infant distress is being addressed in the hospital, the suffering continuing at home experienced by both

parents and infants remains unaddressed. An issue regarding parental health becomes an immediate issue of infant development, as research suggests an interdependent relationship between the two. Such complications can be addressed with MT intervention if telehealth services are implemented to reach suffering families at home. While MT intervention is typically an in-person service, MT providers must adopt virtual services through telehealth delivery in order to address parental distress after discharge.

Research following the COVID-19 pandemic demonstrates telehealth MT as beneficial in other patients. Positive experiences from virtual music therapy should be extended to parents of discharged NICU infants at home. Additionally, more research is needed to evaluate the effectiveness of telehealth MT and to locate areas for improvement to further support distressed parents. By addressing parental needs at home through telehealth MT, families damaged by the NICU can begin to rebuild and look forward to more fulfilling and nourishing lives.

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# Stemming Solutions to the Depreciation of Botany: Interactions of Plants and Mental Health in Garden Therapy

Katie Guevara

## ABSTRACT

In recent years, plants and greenery have been the focus of a surge in pop-culture interest due to their restorative properties and the ease with which they can be accessed. Ironically, despite this recent growth in popularity of plants and greenery, the field of botany, which encompasses the study, structures, and functions of plants, has maintained its decades of dormancy as an academic and scientific discipline. The persistent lack of interest in botany stems from the shortcomings of it being taught wherein botany is portrayed inaccurately, if at all. This discourages students from pursuing botany in their future careers and further perpetuates disinterest in botany. Such disinterest is dangerous for the posterity of botany as well as fields of study dependent on botanical knowledge. This relates particularly to the growing field of garden therapy, which focuses on utilizing the restorative properties of plants and greenery as a means of intervention. In this paper, analysis of the knowledge botany has provided will be applied to the effects of garden therapy to justify the importance of botany and explain methods of encouraging botany teaching and interest. This includes the reform of botany teaching in schools and implementing botanical knowledge in the form of public green spaces.

**Keywords:** botany, plants and greenery, mental restoration, garden therapy, botanical education

## INTRODUCTION

Despite the recent growth in popularity of plants and greenery, the field of botany as an academic and scientific discipline has maintained its decades of stagnancy. Scholars Hershey (1996), Stroud et al. (2022), and Uno (1994) credit the depreciating interest in botany, which encompasses the study of plants and their structures and functions, to persistent shortcomings in the teachings of botany, such as use of preserved plants during instruction time, preference of zoological teachings over botanical teachings, and prevalence of botanical illiteracy among the public, including professors and teachers. Botany, in light of its depletion, has managed to provide information justifying the pop-culture boom of plants and greenery, including the restorative abilities of plants and greenery achieved merely through interaction (Dzhambov et al., 2020; van den Bogerd et al., 2018). Plants and greenery can also provide restoration upon viewing them (Apaolaza et al., 2019; van den Bogerd et al., 2018; White & Gatersleben, 2011). The healing properties of plants are tremendously beneficial in society as the COVID-19 pandemic enters its endemic stages and raises awareness regarding the importance of mental health. Although botany as a scientific field has been able to make advances, it is not able to thrive due to inadequate botany teaching.

Without botany, fields of research, including that of garden therapy, will diminish: therefore, capitalizing (and continuing to capitalize) upon the healing properties of plants and greenery would be tremendously beneficial for society during the endemic stages of the

COVID-19 pandemic. Garden therapy serves as an extremely feasible method of ensuring positive mental health due to easy access (Adevi & Mårtensson, 2013; Gubbels et al., 2016). To properly capitalize on such a pop-culture interest in plants, teachers of botany should undergo more rigorous, strictly botanical teaching to encourage the posterity of botany, especially for the advancement of garden therapy.

## PLANTS IN POP CULTURE AND PROFESSION

Plants have consistently held a prevalent role within pop culture, especially in relation to gardening (Moehlmann, 1993); however, in recent years, indoor plants—particularly house plants, namely pothos, monstera deliciosa, and snake plants—have gained traction within pop culture on par with and exceeding that of outdoor plants (Burke et al., 2022; Akin, 2021). The rise in popularity of houseplants has often been accredited to their natural restorative properties. Restorative properties of plants include, but are not limited to, the improvement of air quality (Kraus & Šenitková, 2021) and the inherent stress reduction provided through simple interaction with plants: for example, owning a houseplant, engaging with an outdoor garden, or merely viewing greenery in any capacity (Adevi & Mårtensson, 2013; Gubbels et al., 2016). Plant care contribution has also been shown to have positive effects on one's self-esteem (Adevi & Mårtensson, 2013). In 2022, Burke et al. accredited social media for the rise of popularity especially indoor houseplants, citing the trends in 'plant-parenting' and plant-based diets.

Despite such a significant increase in social interest in indoor and outdoor plants

and greenery, interest in the already-lacking field of botany has remained mostly stagnant (Burke et al., 2022). Botany as a scientific-academic discipline revolves around the study of plants and has surged in pop culture interest as people have picked up planting and gardening as a hobby and passion. This should naturally correlate to a milder surge in interest in botany as a profession since many correlate their passions to their career goals, providing senses of "achievement and fulfillment" (Nazar, 2021). However, this has not been the case. The depletion of botany minimizes the potential for the development of new knowledge and research in botanically driven fields, including that of garden therapy. Garden therapy has been in use since the 1930s and was then termed 'horticultural therapy' (Adevi & Mårtensson, 2013). Over the decades, it has proven to be effective at reducing stress—which, both during and post COVID-19, is vital to maintaining mental health and productivity. Unfortunately, the decrease in the interest of botany in both academic and scientific contexts has been a "persistent issue" (Burke et al., 2022), dating back decades.

## BOTANY IN EDUCATIONAL INSTITUTIONS

In the early 1900s, botany was taught alongside biology in schools due to their shared study of living organisms; however, following the detachment of botany from biology in school settings, botany experienced a sharp decline in the overall quality at which it was taught (Hershey, 1996), which played a major role in its decline of interest over time. Examples of the lessening quality at which botany has been

taught include the use of preserved plants as teaching tools (as opposed to current, living plants) and the concept of teaching to the test. Only covering material guaranteed to appear on tests and quizzes and never to be readdressed diminishes student appreciation of botany in an academic context by not accurately representing botany, and instead portraying it in a boring, incorrect light. Botany encompasses "horticulture, agronomy, forestry, plant pathology, weed science, plant physiology, plant morphology, plant genetics, plant ecology, plant taxonomy, etc." (Hershey, 1996). Therefore, it cannot be represented through mere textbook readings and analyses of preserved plants, as much of botany examines the states, functions, and actions of current and living plants.

Plants can take days, weeks, or even months to yield results from any experiments which may be performed within a classroom setting, thus rendering the duration of time needed to develop optimal results incompatible with typical high school student attention span and impractical for many high school class time periods (Uno, 1994). This forces teachers to rely solely on the use of preserved plants for lessons. Hershey (1996) reemphasized the valid concern regarding current teachings of botany and the use of preserved plants, claiming "botany teaching is often uninspiring" due to "too little use of living plants" and "too few hands-on activities." The lack of inspiration and interest in botanical teachings from the instructor's point of view impressed upon students leads to their own lack of interest in the topic. However, Uno (1994) also poses several examples of experiments which may be more feasible for in-class use with respect to time constraints, including studies of pollen germination and other seed-related experiments. Simply put, teachers could teach about plant and botanical concepts in a way that better appeals to students, but often choose not to do so.

The decision to continue the improper teachings of botany despite feasible access to more proper, refined teachings stems from a chicken-and-egg dynamic wherein one action reinforces another which reinforces the first. This results from the tendency of teachers to put more energy into the material which they are more comfortable with teaching (Uno, 1994). Due to not being taught proper botany teachings, teachers do not feel comfortable performing such-or-any-botany teachings to their students, and this further deteriorates student's understanding and interest in botany. The circular, spiraling nature of the miseducation of botany parallels the findings of Hershey (1996) regarding botanical illiteracy, which encompasses the general lack of knowledge many current teachers have. Hershey (1996) additionally

credits botanical illiteracy to the inaccessible nature of botanical literature, especially in terms of pre-college teachers, stating "botany teaching literature is underutilized ... it is scattered in hundreds of books and journals available only in larger university libraries." The widespread disposition of botanical illiteracy adds onto the detrimental lack of general knowledge many college and high school teachers possess regarding botany.

Widespread botanical illiteracy is endangering botany as an academic and scientific discipline; beyond that, however, widespread botanical illiteracy is endangering humanity, as demonstrated by Stroud et al. (2022) stating, "plants will play a key role in achieving many of the United Nations (UN) Sustainable Development Goals (SDGs)." SDG 15 aims to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (UN, 2022). This goal aims to eliminate, halt, and reverse practices created by humans which have proven to be harmful to animals at the expense of plant life and natural biodiversity. Botanical literacy plays the largest role in achieving SDG 15 on a global scale, which exemplifies the real-world dangers and consequences of illiteracy. The adoption of botanical illiteracy often begins in biology class, wherein "biology textbooks utilize a far greater number of animal examples" (Stroud et al., 2022). The prioritization of animals over plants in biological teachings is a massive contribution to botanical illiteracy.

Teachers more commonly possess zoological knowledge, and, as previously discussed, it can be concluded that teachers are more inclined to teach animal-related coursework with more in-depth explanations and provide little detail on plants as producers (Uno, 1994). Two chicken-and-egg dynamics coexist here: the first, which explains how a lack of botany teaching encourages further lack of botany teaching; and the second, which explains how overuse of zoological teaching encourages further overuse of zoological teaching. Within the two chicken-and-egg dynamics, the second reinforces the first. The priority of zoological instruction over botanical instruction in the academic sphere has been termed 'zoochauvinism' (Hershey, 1996). In the scientific sphere, zoochauvinism expresses itself as plants "typically considered as simply part of the habitat of animals" (Hershey, 1996). Furthermore, zoochauvinism is an inherent contradiction, as animals could not exist without the presence of plants which provide food and shelter. Hershey (1996) also blames 'research chauvinism' for a shortage of teachers properly

qualified to teach botany due to the wrongful emphasis on teachers to produce their own work rather than to enhance knowledge. The shortcomings of botanical teachings are reflected within the issues in the educational system and have directly caused the depletion of botanists.

### **USING BOTANY TO COPE WITH COVID-19**

Just as the enablement of botanical illiteracy directly contributes to the decline of botany, the enabled growth and perpetuation of coronavirus illuminated many faults within various societies regarding their healthcare industries and systems (Hiestand, 2021). The United States boasts the most expensive healthcare system in the world (Geyman, 2021) and the onslaught of COVID-19 exposed the dire consequences of systemic financial inequality as demonstrated by the disproportionate wound left by COVID-19 on impoverished communities (Human Rights Watch, 2021) due to their inability to afford the excessive costs of health insurance in the United States. In impoverished communities where most people do not have healthcare coverage, some do not go to the doctor when they are ill, nor do they receive treatment. Since impoverished communities often lie within densely packed cities, illnesses spread much more rampantly than in suburban or rural areas.

Inaccessibility to health insurance in the United States also restricts access to mental health care; and, even as the COVID-19 pandemic enters its endemic stages, the emphasis on nurturing mental health must never diminish. The mental health of adolescents is a point of contention as the CDC reported in 2021 that 42% of students experienced symptoms of depression, including persistent feelings of hopelessness. Scholars Panchal et al. (2023) concluded that the recent spike in both symptoms and diagnoses of anxiety and depression may be due to the isolation caused by COVID-19. This stemmed from job loss, online school, or a death in the household. However, Panchal et al. (2023) elaborated symptoms of depression and anxiety also stemmed from substance use, including that of hard drugs and alcohol to cope with isolation. Coping mechanisms vary greatly from person to person; however, some can be more dangerous than others. Interaction with plants and greenery in a therapeutic context, otherwise known as garden therapy, is a safe and effective method for dealing with stress.

### **HEALING PROPERTIES OF PLANTS**

The healing properties of plants have proven to be a terrific coping mechanism for those struggling in isolation. The most-commonly

discussed healing properties of plants and greenery include natural restorative abilities reaped through simple interaction (Adevi & Mårtensson, 2013; Akin, 2021). The psychologically restorative properties of plants and greenery include feelings of mental restoration and rejuvenation, as well as other associated indicators of general well-being (Adevi & Mårtensson, 2013; Shibata & Suzuki, 2004), including feeling more motivated and well-rested.

White & Gatersleben (2011) defined mental restoration as the recovery from mental exhaustion and stress. Scholars agree that the differing means through which an individual can experience or interact with greenery makes no difference on whether said individual reaps these psychologically restorative properties (Dzhambov et al., 2020; van den Bogerd et al., 2018). Dzhambov (2020) described the experience with plants and greenery as three separate entities: first, viewing greenery from a window; second, owning and maintaining an indoor houseplant; and, lastly, interacting with an outdoor garden. The varying levels of greenery interaction indicate the ease at which any individual can allow themselves the full capacity to reap its affiliated psychological benefits.

Individuals additionally experience a noticeable decrease in symptoms of anxiety and depression due to the mental restoration derived from interaction with plants and greenery (Adevi & Mårtensson, 2013; Gubbels et al., 2016). This can contribute to improvements in one's mood and productivity (Dzhambov et al., 2020; Shibata & Suzuki, 2004; van den Bogerd et al., 2018). Especially in the era of COVID-19, when many jobs allow for remote working, the ability to maintain one's psychological health in a manner which also accounts for necessary productivity is of pinnacle importance. Smith (2002) of the American Psychological Association (APA) stated "mental health conditions are the No. 1 health-related reason for lost productivity." The presence of plants has shown to reduce the negative aspects of mental health, including symptoms of anxiety and depression. Shibata & Suzuki (2004) stated that "viewing nature causes a positive affective state in people," which concurs with the findings of Dzhambov et al. (2020) regarding the differing methods of greenery interaction, primarily when applied to COVID-19 work-from-home practices: "the mental health of young adults during the COVID-19 pandemic was better if greenery was present", and, "both greenery experienced indoors and outdoors were important." Through houseplant ownership and garden interaction, among other easily accessible means, individuals can improve their moods via mental restoration.

## THE AESTHETICS ASSOCIATED WITH PLANTS

The sheer aesthetic appreciation of viewing plants and greenery has also been shown to positively affect the moods of individuals (Apaolaza et al., 2019; White & Gatersleben, 2011). Plants have been placed in medical and residential care facilities to help patients heal simply through these visuals (Apaolaza et al., 2019; Shibata & Suzuki, 2004), and has shown to be a promising practice. Shibata & Suzuki (2004) cited the restorative abilities of plants in relation to stress, including "lowered blood pressure, lowered muscle tension, and skin conductance." They also stated that "mood evaluations were more positive when indoor plants increased." Additionally, their findings coincide with the findings of Kraus & Šenitková (2021), which argue the dominance of the "aesthetic impressions" plants serve in indoor environments.

Beyond the aesthetics of indoor plants and greenery and their benefits, outdoor plants and greenery and their associated aesthetics have also been shown to benefit the populations who experience and interact with said outdoor plants and greenery in the forms of community gardens, walkable green spaces, green walls, and rooftop gardens (van den Bogerd et al., 2018; White & Gatersleben, 2011). The presence of community gardens and shared green spaces has demonstrated increased community interaction caused by bonding over plants (Gubbels et al., 2016), and this indicates the importance of accessible green spaces within any given community. On top of the provision of community, accessible green spaces such as parks, gardens, and forests also provide natural greenness. White & Gatersleben (2011) stated "greenery may be particularly desired within the urban environment since it has restorative properties that appear to combat stressors such as noise and crowding." This reinforces the idea of aesthetic appreciation of greenery as a de-stressor and therefore a key component in achieving mental restoration.

Aesthetic appreciation of greenery plays a significant role in determining preference in a variety of settings – namely academic, housing, and marketing. The findings of van den Bogerd et al. (2018) regarding student preference and performance in a university's environment suggest that students prefer spaces with more greenery and experience better mood and academic performance when within said spaces. These findings parallel those of housing, as discussed by White & Gatersleben (2011), citizens consistently demonstrated the belief that homes with greater quantities of exterior greenery were more beautiful. Apaolaza et

al. (2019) relates this through the lens of the hospitality industry as customers self-reported a higher preference for spaces with more plants and greenery. They also perceive better service and stronger senses of customer loyalty. Following the theme of perception, Gubbels et al. (2016) stated that "increases in perceived greenery were associated with better mental health, i.e., less depressive symptoms." The parallel findings discussed above indicate the power of the aesthetic allure of greenery and how it positively affects people's perceptions of their surroundings, and thereby positively affects people themselves.

## APPLICATION IN GARDEN THERAPY

The positive effects of plants and greenery with mental restoration, aesthetic appeal, and the improvements of mood upon individuals experiencing plants and greenery all interweave to form the field of garden therapy. Garden therapy originated as a remedy for burnout and other stress-related fatigue ailments and developed from the horticultural and occupational therapy practices in the 1930s (Adevi & Mårtensson, 2013). It "aims to stimulate all senses, increase self-esteem, self-awareness, and help participants to create positive habits and routines for daily life" (Adevi & Mårtensson, 2013). So far, garden therapy has proven to be effective and has served as a legitimate form of therapy that has consistently endowed its participants with an overall feeling of mental restoration, as well as a lesser presence of depressive symptoms (Adevi & Mårtensson, 2013; Gubbels et al., 2016), including fatigue, feelings of hopelessness, and struggle with concentration (APA, 2013).

COVID-19, which crumbled the structure of an already-stressful existence, has made the public overall more susceptible to burnout and fatigue and other depressive or anxious symptoms. With the high accessibility of garden therapy, many scholars choose to pursue more information regarding the practice. Garden therapy has been shown to encourage community engagement and physical activity (Gubbels et al., 2016) and contributes toward mental restoration felt by patients of garden therapy. As for the self-esteem aspect, Adevi & Mårtensson (2013) spoke of a participant that said, "it was a really bad feeling not to be needed ... the plants needed me," which demonstrates how plants and greenery fulfill the innate human need to nurture and to feel important, thus validating the position of plants and greenery as a means of therapy.

## A CALL TO ACTION

The field of garden therapy must continue to undergo research to determine the most effective means to execute any findings; hence, the need for more interest in botany. Botany in its academic sphere must undergo rigorous transformation, including a centered round of instruction and reform of botanical in-class experiments, literature, and resources. To encourage botany in its social sphere, urban developers should configure areas with the purpose of existing as a green space, whether in the form of a park, forest, green wall, or rooftop garden. By generating social and academic interest in botany, its scientific sphere will experience a necessary influx of enthusiastic botanists to rebrand a positive chicken-and-egg dynamic of student and teacher interest in botany which will lead to teachers who will care more about the subject and impress that upon their students.

Scholars Hershey (1996) and Uno (1994) agree that the use of preserved plants during in-class experiments are an inaccurate and harmful representation of botany and is a direct contributor to the depreciation of it. The solutions posed by Uno (1994) including pollen-germination and other quick-reaction experiments should be standardized across

the country in high school classes to properly introduce students to botany. By consolidating all current and former botanical research onto a botanically-centered database, which will be reviewed regularly by botanical experts; scholars, teachers, and students alike will have better access to more accurate resources regarding botany. This will significantly lessen the omnipotence of botanical illiteracy.

With increased botanical literacy and interest, more botanists will be available to focus on advancing research on the field of garden therapy. Garden therapy should be implemented alongside other forms of therapy such as music and conversational therapy in an integrative approach. This is due to the ease with which garden therapy can be accessed by the public and the plethora of restorative properties discussed previously. As for generating social interest in botany, urban developers should configure public areas purely designated for green space, such as parks, forests, and provide plaques within those green spaces that provide information about the space itself as well as its mentally restorative properties. Featured among the plaques should be short descriptions of famous historical botanists, such as George Washington Carver and Marie Stopes. The mention of these figures and the availability

of tangible impacts of botany will intrigue the public.

## CONCLUSION

Teachers of botany should undergo more rigorous, strictly botanical teaching to encourage the posterity of botany and development of garden therapy to properly capitalize on the pop-culture interest in plants. Despite the recent growth in pop-culture interest in plants and greenery, botany as an academic and scientific discipline has maintained its dormant state. Scholars Hershey (1996) and Uno (1994) credit botany's depreciation to shortcomings in the teachings of botany in pre-college environments, including the use of preserved plants during instruction time and botanical illiteracy among biology teachers. Botany has managed to provide information explaining interest in plants and greenery, including the natural restorative abilities of plants and greenery achieved through simple interaction (Adevi & Mårtensson, 2013; Akin, 2021). Although botany as a scientific field has been able to make advances, botany is not able to thrive due to the inadequacy of teaching in the subject. Without botany, fields of research, including that of garden therapy, will diminish.

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# Deconstructing Gender Roles of "The Me Decade": An Analysis of How *That '70s Show* Portrays Gender Stereotypes

Sophia Smith

## ABSTRACT

This paper explores the timeless program *That '70s Show*, an all-American sitcom that aired on FOX from 1998 to 2006. The main character, Eric Forman, and his close-knit group of friends navigate the ups and downs of life as the program follows them from high school to young adulthood, including a nostalgic ambience of the 1970s. The program's timeline coincides with significant advances in women's rights, including the growth of the feminist movement, the passing of the Equal Rights Amendment, and an overall defiance toward conventional and outdated standards for women. An era of significant social change, the time period of *That '70s Show* was purposefully chosen for the progressive ideas circulating throughout the country. The program ultimately positions the audience to see the misogyny and gender stereotypes of the 1970s as undesirable, allowing viewers to understand their harmful impact and consider different perspectives on societal expectations. This paper will explore the ways in which the program presents these outdated gender stereotypes as undesirable and encourages the audience to reject them. Three scenes were chosen from specific episodes that display how women began to gravitate toward a feminist ideology in the 1970s while defying gender stereotypes. A close reading of each episode was performed and the chosen scenes from the episodes were subjected to a textual analysis.

## DESCRIPTION OF THE PROGRAM

*That '70s Show* is an American sitcom that aired on FOX from 1998 to 2006. The program follows a group of teenagers as they transition from high school to early adulthood in the fictional town of Point Place, Wisconsin. It integrates the nostalgic ambience of the 1970s as the characters learn, change, and navigate the trials and tribulations of teenagehood. Together, they experience the universal emotions, thoughts, and anxieties that any adolescent can relate to – often concerning their relationships, parents, and their futures – and find themselves in amusing accidents and adventures along the way.

Eric Forman, played by Tophér Grace, is an ordinary high school student who is raised in a nuclear family household. Eric is a nerdy, quick-witted teenager with a sarcastic sense of humor, and often finds himself in tricky situations. Eric's father, Red (Kurtwood Smith), is a Navy combat veteran who holds traditional values regarding gender roles and family dynamics. Red is strict and overbearing, and the two often butt heads due to their differences. Kitty (Debra Jo Rupp), Eric's mother, keeps the peace within the home and enjoys coddling Eric and his friends. Eric's older sister, Laurie (Lisa Robin Kelly, Christina Moore), visits home from college every now and then, and is known for her various romantic relationships. She is more interested in men and partying than preparing for the future, eventually leading to her flunking out of college. Due to her lack of direction or career prospects, Red and Kitty repeatedly pressure her to marry well, reinforcing the notion that women must marry into success and depend on a man in order to live comfortably. Donna Pinciotti, Eric's love interest, played by Laura Prepon, and her

parents Bob (Don Stark) and Midge (Tanya Roberts) have lived next door for years. Donna is portrayed as a smart, easygoing tomgirl with a strong ideological perspective; specifically shown through her identity as a proud, self-proclaimed feminist, often outwardly challenging traditional gender roles and expectations. She and Eric share a close friendship and eventually have a serious on-and-off relationship throughout the show. Her father, Bob, is portrayed as an embarrassingly happy and upbeat parent, known for his lack of self-awareness and cluelessness in serious situations. He is a loving father, but his narrow-mindedness interferes with his ability to understand his daughter, who he often unintentionally embarrasses as a result. His beautiful wife, and the mother of Donna, Midge, is often portrayed as a "dumb blonde." However, she is also a caring mother who goes above what was expected of women during the time period by showing her daughter that she does not have to conform under the societal constraints that were placed on women at the time. Giving Donna valuable advice, fiercely standing up to her husband, and empowering Donna to live a life of her own choosing are just some of the many ways that Midge exemplifies a strong female role model for her daughter. Midge has always been a stay-at-home mom, but begins to feel increasingly unfulfilled as the show progresses. Bob finds it difficult to understand her frustrations with domesticity, which causes issues in their marriage.

## JUSTIFICATION OF THE STUDY

Watching *That '70s Show*, one can identify that the exaggerated misogyny is meant to come across as ignorant and foolish, in an attempt

to denounce the rigid sex roles within America during the 1970s. A concise summary of these established core beliefs from the *Journal of Marriage and the Family* follows: "... The basic philosophy governing the decisioning of the traditional woman is 'if the family does well, I do too.' ... In complementary fashion, the traditional male reasons that 'if I do well, the family does too.' His individual interests are primary – but 'for the sake of the group'" (Scanzoni & Fox, 1980). Men were encouraged to participate and enjoy life in the "public sphere," while women were relegated to the "private sphere" and encouraged to engage in domesticity. As women grew increasingly more vocal and assertive in their dissatisfaction with these limitations, the collective resistance to traditional standards allowed the second-wave feminist movement of the 1960s and 1970s to flourish. According to the Gale's *Women's Studies Archive*, second-wave feminism is described as "a general feeling of solidarity among women who were fighting together for equality and was responsible for many legal and cultural victories that brought about greater equality, building on the work of first wave feminists and suffrage" ("Second Wave Feminism," n.d.). Consequently, the program's time period was carefully chosen to be during this unique era when new social developments and political ideas were spreading throughout the country. The timeline coincides with many significant advances in the field of women's rights, such as the spread of the second-wave feminist movement, the passing of the Equal Rights Amendment in Congress, and a new, progressive definition of societal standards for women. Studying *That '70s Show* is justified because it

realistically sheds light on the advancements and setbacks of the second-wave feminist movement, and gives an inside look into how the socio-political landscape of this transformational time affected both men and women of varying ages. This makes it an interesting subject to research, as it rationally portrays the fluid and dynamic political atmosphere of the 1970s and contextualizes them within the situations of the program. By going into detail about how the show portrays the difference of opinions between men and women on gender roles in society, this study shows how the program encourages the audience to regard misogyny and gender norms as corrupt and discriminatory.

## METHODOLOGY

All seasons were viewed on the Peacock streaming service, and the particular episodes were chosen for textual analysis to highlight how *That '70s Show* encourages viewers to reject the misogyny and gender stereotypes that were prevalent in the era. According to Mittell (2010), textual analysis is a method that includes an in-depth interpretation of a text in order to "understand what it might be saying about identity and how representations fit within broader cultural assumptions and contexts." It goes beyond simply "good" or "bad" assessments and explores what messages the program conveys and how they convey them. The selection of scenes clearly emphasizes how women began to gravitate toward feminist ideologies in the 1970s – when female empowerment and independence became increasingly encouraged – in addition to rejecting their conventional roles as subservient housewives. A textual analysis and thorough examination of each episode was performed, with special attention paid to the dialogue; specifically, how certain characters either promoted or rejected gender stereotypes, progressive ideas, and the development of feminism in the 1970s. A textual analysis of the chosen scenes from the sample episodes is provided in the next section to show the numerous ways *That '70s Show* challenges sexism and gender stereotypes.

## ANALYSIS AND DISCUSSION

The first scene under consideration takes place in the 14th episode of Season 1, titled "Stolen Car" (Brazill et al, 1999). Given that the episode is toward the beginning of the show, one can deduce that the season occurs around 1976, when the second-wave feminist movement was unfolding in America. Before the scene takes place, Midge and Bob are in their kitchen when she reminds him that she is going to a class at their local community college, which she

later identifies as a female empowerment class called "The Woman Warrior: Fighting Female Stereotypes." Bob immediately reacts angrily, calling it stupid. He declares that he is the man of the house and therefore forbids her to go. However, Midge does not back down and goes anyway.

The scene begins with a shot of Bob and Donna later in the day, sitting in their kitchen at the table, both eating plain sandwiches. Bob is visibly agitated. Shaking his head, he exclaims, "I can't believe she went to that class! Married women do not abandon their families." He holds up the sandwich and looks at it with disappointment. "Sure they do, Dad. It's the '70s," Donna replies. "I know what decade it is," Bob responds with a tone of annoyance. "Doesn't change the fact I'm eating a sandwich instead of a hot meal!" He places the sandwich on the table, frowning. "Well, want me to microwave it for you?" Donna quips back. Bob steers the conversation toward his concerns about Midge's behavior. "I just don't understand why she needs this. I've given her a great life!" His face suggests that he is deeply offended by her actions, as if Midge's pursuit of her own interests is somehow harmful to him. Donna's demeanor shifts to seriousness as she tells him in a stern voice, "Dad, that's not the issue! The whole point of the Equal Rights Amendment is so that women don't have to define themselves by a man." Bob sits and ponders for a moment, appearing to be in deep thought, before saying, "Donna, is this about clothes? 'Cause I can buy you clothes." She receives a condescending look from him as he shakes his head, suggesting that his daughter is reflecting the stereotype of a temperamental and emotional woman for voicing ideas that were different from his own. Donna pauses, then looks off into the distance and mutters to herself, "This is pointless," before getting up and leaving the room. As she leaves, Bob calls out "Hey, while you're up, you wanna get daddy a beer? Honey?" After he is completely ignored, the scene closes with Bob sitting at the table, beer-less and alone.

This scene is a significant and accurate example of the gender expectations and discrimination that was typical of the 1970s. A 1980 article in the *Journal of Marriage and the Family* reflects back on the previous decade's gender dynamics and finds that conflict became increasingly common in households where the woman aligned more with an "egalitarian" worldview (Scanlon & Fox, 1980). This scene similarly depicts how Bob and Donna have opposing views on feminism and the gravity of systemic misogyny, which causes conflict and dissatisfaction with all parties involved. Bob is unable to accept the idea of Midge adopting progressive feminist beliefs and bringing them

into the home, nor does he want his daughter to be influenced by these perspectives, due to his strict adherence to his conservative worldview. His traditional principles expect that Midge always obeys his wishes faithfully and without question. When Midge attends the class against his wishes, in addition to the lack of a "hot meal" waiting for him at home, Bob appears baffled and upset, unable to understand Midge's blatant rejection of traditional marital duties. This depicts stereotypical ideas of toxic masculinity, gender norms, and conventional concepts of male supremacy and feminine inferiority. The fact that Midge stands up for herself and attends the class exemplifies how the feminist movement in the 1970s challenged female predisposition to inflate the male ego by obeying them, as well as the societal presumption that men are better than women. In the end, Bob is meant to come off looking unintelligent, bigoted, and ignorant, as the show uses his misogyny as the punchline, making it embarrassing and uncomfortable to watch. By the end of the episode, his stubborn attitude has driven those closest to him away, and he is alone physically and figuratively. This conclusion demonstrates how *That '70s Show* sets the audience up to perceive the sexism and gender stereotypes of the 1970s as undesirable, inspiring the characters to defy these stereotypes and encouraging the viewers to reject them.

The second scene under consideration takes place in the 7th episode of Season 3, titled "Baby Fever" (Brazill et al, 1999). In this episode, a baby that belongs to Kitty's friend is staying at the Forman's home, and Laurie is tasked with taking care of her. Before the scene takes place, Eric's group of friends are hanging out in his parents' basement when Donna enters and proudly announces that her first story has been published in the school paper. Eric looks at it and laughs that her last name has been misspelled as "Donna Pincipotti." Later in the day, Laurie is struggling to change the baby's diaper in the kitchen when Eric and Donna walk in. Donna volunteers to take over and successfully changes the diaper, in response to which Eric is visibly happy and impressed.

The scene selected for analysis takes place after Donna and Eric exit the kitchen and are sitting on the couch in the living room. "Hey, you know, you were really good in there," Eric says. Donna brushes off the compliment and says, "Well, it's not exactly brain surgery." Eric continues to excitedly praise her for changing a diaper, and Donna pauses and makes a confused face. "Eric, you're over the moon because I changed a poopy diaper, but when I got my story in the school paper all you said was, 'Yeah, they called you Donna Pincipotti.'" Eric reassures her

that he was just trying to pay her a compliment. "What was the compliment?" Donna asks. "That you are gonna be so great staying home with our kids," Eric replies. Donna laughs out loud and looks at him in astonishment. "What? Eric, how exactly do you see our future?" she asks. The scene then cuts to Eric's fantasy of Donna as a stay-at-home mom with their children. Eric is seen coming home from work wearing a suit and holding a briefcase. He kisses Donna on the cheek and they both smile at the camera. "That could work," Donna says in a flat tone. "I would just like to adjust one little thing." The scene now cuts to Donna's fantasy in which the roles are reversed, where Eric stays at home with the children and Donna pursues a career. "Okay, the businesswoman idea is good," Eric responds. "But what about this?" A third fantasy sequence now begins in which Eric is at a strip club and Donna is dancing in a risqué businesswoman outfit. "Okay. Uh-huh. Yeah," Donna says sarcastically. "I would just change one thing." The fantasy sequence continues with Donna kicking Eric in the face with her high heel, then smiling happily. The fantasy ends, and Eric winces. "That seems more hurtful than sexy," he says, then laughs. Donna angrily calls him a "jackass" and storms out. "So does that," Eric replies.

The scene not only emphasizes the societal expectations of women to care for the family and the home, but also the struggles that ambitious women faced during the 1970s. Traditionally, women have had few alternatives to cultivating their homemaking skills, maintaining their physical appeal, and preparing for marriage and motherhood (Scanzoni & Fox, 1980). As a young woman who craves more than the traditional duties of domestic life, Donna embodies the blossoming strength and independence fostered by the second-wave feminist movement. As more women felt empowered to seek out their own careers, enter the workforce, and rely on themselves, Donna personifies this feeling of widespread independency and confidence. This scene also reflects on the mass integration of women into the workforce during the 1970s. However, career-driven women were frequently dismissed and overlooked. Harkess (1985) published a study which found that the rise in women in the workforce during the 1970s was also accompanied by a substantial gender pay gap and a large concentration of employed women in low-paying jobs. Eric's failure to take Donna seriously reflects the attitude of the time toward ambitious women who strive to be successful in their professional careers. Additionally, Eric's delight at Donna's simple ability to change a diaper suggests that he expects women to demonstrate competence in

their assigned gender roles, such as childcare, and considers any ability to fulfill traditional roles to be impressive. His response also aligns with Mirra Komarovsky's research in 1976, which explored the traits that young men sought in their future wives and indicated working women and mothers were not highly respected (Harkess, 1985). Eric's reaction emphasizes the other side of the spectrum, reinforcing the rigid gender norms and insisting that a woman's place is at home with the children.

By portraying Eric's remark as patronizing and condescending, which Donna calls him out on, this scene challenges gender stereotypes and shows the negative effects of sexism. Donna confronts Eric about the double standard, pointing out that he wasn't as enthusiastic when she got her story published in the school paper. She then challenges Eric's traditional idea of gender roles by imagining a fantasy where she pursues a profession and Eric stays at home with the children. When Eric dismisses and undermines her scenario with his strip club fantasy, it implies that he does not take her life goals or ambitions seriously. His actions indicate that he fails to consider Donna's career aspirations, and instead he minimizes them with a fantasy that objectifies and belittles her. Eric's behavior in this scene signifies to the viewer that he believes a woman's value is intrinsically tied to her sexual appeal. Donna's reaction to Eric accurately reflects the "collective resistance to sexual harassment" described by Baker (2007) in an article from the *Journal of Women's History*. The early 1970s marked an increase in women speaking out about being objectified and sexually harassed, such as the formation of the Working Women United (WWU) feminist organization and the Alliance Against Sexual Coercion (AASC), which argued that "sexual harassment was a form of violence against women that reflected and reinforced women's subordinate status in society." Donna's angry response is a clear sign of her frustration with Eric's blatant misogyny, presenting her as a strong and independent woman who refuses to conform to traditional expectations. The scene clearly critiques America's unfavorable gender norms of the 1970s and reinforces that women should be free to pursue their goals without being bound by gender stereotypes.

The third scene under consideration takes place in the 10<sup>th</sup> episode of Season 5, titled "The Crunge" (Brazill et al, 1999). In this episode, the group gets back their SAT scores. Donna receives quite a high score of 1230, while Eric only gets an 800. Before the scene takes place, Red is angry with Eric's low score and tells him to concentrate more on his schoolwork and less

on his relationship with Donna, who "gums up the works." Eric recalls taking the test with Donna and being distracted by a fantasy in which he is James Bond, and she is a Bond girl. Eric agrees with his father and later finds out he can retake the SAT. While he is trying to study in the kitchen, Donna's presence distracts him and he slips into another fantasy. He rushes to Red and tells him that he isn't strong enough to resist Donna. When Eric asks Red to ground him and get rid of Donna, he happily agrees and kicks Donna out.

The scene under analysis begins in Eric's room, where he is sitting at his desk, studying for the SAT. Donna barges in and confronts him. "You grounded yourself?" Eric looks at her in astonishment. He starts laughing and replies, "What? Why would I do that?" "Well, apparently, I 'gum up the works,'" she says angrily. Eric realizes that he's been caught. "Oh, good, someone filled you in," he defeatedly says. Donna looks increasingly annoyed, and replies, "Yeah, Red. When he kicked me out of your kitchen. And then he locked the sliding door and stood there laughing and waving." Eric continues to look guilty. Donna asks him why he is "freaking out" about the test. Eric's demeanor switches to confidence and he stands up, pointing his finger in determination. "I'm not. I'm gonna take it again, and I'm gonna nail it. Anything less than a 1240 is unacceptable." Donna nods her head and squints her eyes, suggesting she finally recognizes his true motives. "A 1240? Hmm ... That's ten more points than I got." Eric plays dumb and pretends he didn't know, but Donna sees through his facade. "You're threatened because I got a better score than you," she says. Finally, Eric relents and gives up his act. "I just, I have to do better than you." "Why?" Donna yells out in annoyance. He replies, "Because I'm the man, and the man's the man, and that's just the way it is!" Donna stares at him in disbelief and prompts him to repeat his answer. Eric stares at her blankly, then looks at his door. "Um ... I'm grounded. Dad, Donna's up here!" He calls out. Donna sighs angrily and storms out.

Eric's behavior reflects the misogynistic notion that men have to be better than women in all aspects of life, including education. The only reason he wants to outperform Donna on the test is because he believes that "the man's the man, and that's just the way it is." By portraying Donna as a mature, level-headed, and intelligent woman, this interaction represents the dismissiveness and invalidation that women often endure due to the permeation of sexism in every-day life. Donna's assertive confrontation as well as her mature approach to the situation reflects what scholars Judith Long-Laws and Pepper Schwartz suggested: "... to a greater

degree than ever before teens of the 1970s have modified dating structures to counteract traditional sex-role stereotypes and the potential for exploitation inherent in traditional dating patterns" (Scanzoni & Fox, 1980). Donna's refusal to obey the expectation of female inferiority exemplifies the ways that progressive young women began to reject conventional norms within their relationships. By confidently asserting herself to Eric, she firmly stands on the grounds that she will not tolerate misogyny in their relationship. Her frustration, portrayed as justified and reasonable, indicates that she is tired of men mistreating and patronizing her, while Eric's attempts to explain himself are exhibited as weak and foolish. He is unable to take responsibility for the reasons behind Donna's frustration, resorting to lying, scheming, and eventually dismissing the situation in an attempt to evade accountability for his actions. Contrary to gender biases of the 1970s, the fact that Donna initially outperformed Eric also shows that women can be as, if not more, skilled and educated than males. Overall, Donna appears sensible, balanced, and emotionally

intelligent, while Eric comes off as insecure and intimidated by her success. The stark contrast of the two characters in this situation serves to highlight Donna's strength and maturity, and Eric's lack thereof. The scene reinforces the belief that gender should not be a factor in judging a person's competence or worth.

### CONCLUSION

The strong female leads in *That '70s Show* recurrently challenge the gender stereotypes and intrinsic misogyny of the era, offering viewers a realistic portrayal of the impact that the socio-political landscape had on people of all ages in the 1970s. The opposing viewpoints held by the various characters in the program reflect the struggles faced by women in everyday life to defy the societal convictions placed upon them by a patriarchal society. The show offers a distinctive critique on the standards and responsibilities of men and women during this period. It does not hesitate to expose the misogynistic attitude that was a defining trait of the decade and portrays the harm that comes with beliefs in masculine superiority,

traditional gender standards, and clichéd ideals of gender. By denouncing these concepts, the audience is made aware of the unfairness of the chauvinism and gender bias of the 1970s, which leads the characters to challenge these assumptions and invites viewers to consider other viewpoints regarding cultural or social norms. Ultimately, the depiction of misogyny and sexual discrimination of the 1970s in the program serves not only to illustrate the history of sexism, but also allows the viewer to draw parallels from modern society. Despite the hard work and achievements made by women throughout history, it is evident that pervasive misogyny is still prevalent in contemporary life. In this way, the program emphasizes the enduring nature of this discrimination against women and encourages the audience to reject stereotyping, gender norms, and sexist beliefs in order to work toward a more equitable future for women. While significant progress has been accomplished in the realm of gender equality, it is crucial to recognize and understand that more work lies ahead.

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# Storylines of Success: Weaving Narratives to Close the Gender Gap in STEM Fields

Lian Peach

## ABSTRACT

Women in the STEM fields have always been in the minority and often are marginalized by their coworkers, employers, and the general public. Research shows that while progress has certainly been made, women are still the minority in multiple STEM fields. Currently, women are roughly half of the overall U.S. workforce but only comprise about 27% of STEM careers. Even more alarming is the fact that the physics field, in particular, lacks female representation. This gender gap needs to be addressed because women offer unique ideas and perspectives to the field, leading to discoveries that would otherwise not be found. Scholars agree that there are a lot of inaccurate perceptions about the physics field and why so few women enter this discipline. Scholars also agree that stories hold a lot of power and can address stereotypes and stigmas, which would change society's views and these inaccurate perceptions. The purpose of this research is to show that testimonies are influential and can be utilized specifically in elementary and secondary schools to spread awareness of the signs and dangers of discrimination as well as the gender gap in general. By diminishing discrimination, the self-efficacy of women considering STEM as a career path will rise, increasing the representation of women in the field. It is imperative for the progression and improvement of society that people are educated about women's underrepresentation for equality to occur.

**Keywords:** women, gender gap, gender equality, discrimination, physics, STEM, storytelling, narrative, education

## INTRODUCTION

Women in the physics field face a daunting gender gap that discourages many young women from entering this discipline. According to the most recent U.S. Census Bureau data, the U.S. workforce is almost 50% women, but women make up only 27% of the STEM (Science, Technology, Engineering, and Mathematics) workforce (Martinez & Christnacht, 2021). Scholars have conducted considerable research on the gender gap in STEM and the reasons for this gap, but not many have focused on possible solutions to address these problems (Ecklund et al., 2012; Francis et al., 2017; Freedman et al., 2018). Ecklund et al. (2012) discovered that while the gender gap in some STEM fields is lessening or nonexistent, such as biology, the gender gap for women in physics remains prominent. The gender gap needs to be addressed because diversity in any industry is important to the influx of new experiences and solutions.

Scholarly research on how storytelling can be utilized to educate others about the physics gender gap is almost nonexistent. Cote (2017) noted that personal narratives help to raise awareness of conscious and unconscious bias and stereotyping. Although there are other solutions not based on narrative, stories are an effective and immediate solution to encourage future generations of women to enter the physics field. To achieve gender equality in these fields and raise awareness about gender discrimination, testimonies of women in the field should be implemented in STEM interest programs in elementary and secondary schools.

## THE IMPORTANCE OF REDUCING THE PHYSICS GENDER GAP

The gender gap in STEM has been an ongoing problem ever since women entered the workforce. Many scholars agree that there is a substantial lack of representation for women in the STEM fields, either in the workforce or in STEM courses in secondary or post-secondary education. Both Legewie and DiPrete (2014) and Stearns et al. (2016) stated that although women have now surpassed men in acquiring college degrees, the gender gap in the attainment of STEM degrees and the STEM workforce remains significant in today's world. Even though it is a great triumph that women are entering and graduating from post-secondary education at record rates, the problem persists that women are underrepresented in certain areas of education and the workforce.

Some STEM disciplines are discouragingly underrepresented, while others do not have such an extreme gap. Women are equally or overrepresented in certain disciplines such as biology and premedical degrees, while there is a significant lack of women graduating with physics and engineering degrees (Heilbronner, 2013). In other words, the gender gap has significantly decreased over the years for specific STEM disciplines but remains salient for other fields, such as physics. Ecklund et al. (2012) stated that women should be equally represented in the STEM workforce, as their unique perspective on the world leads to new discoveries and discussions. For example, a woman's perspective is vital when addressing problems women often face, such as how to address awareness about breast

cancer. Following this logic, having a woman's perspective in the physics field can be unique and equally as essential as a man's perspective. Diversity in physics will lead to more new ways of thinking and analyzing, which will only benefit the field.

Multiple organizations explore and focus on the importance of reducing the gender gap in the physics workplace. The American Institute of Physics (AIP) commented that women were involved in the building blocks stages of STEM fields, yet did not receive the same kind of recognition that men did. For example, despite the many women who have contributed to the physics field, only four women have ever received the Nobel Prize in Physics – which began in 1901 – out of a total of 218 recipients (AIP, n.d.). The four recipients were Marie Curie in 1903, Maria Goeppert Mayer in 1963, Donna Strickland in 2018, and Andrea Ghez in 2020 (AIP, n.d.). The history of the lack of women representation in these fields is part of the reason why women in recent generations have been slow to enter such fields themselves. Organizations such as the American Physical Society (APS) and the Association for Women in Science (AWIS) strive to increase accessibility and reduce the gender gap in STEM. Through organizations like these, awareness is raised about the gender gap and gender discrimination to promote more diversity and tolerance in the workplace.

## REASONS THE PHYSICS GENDER GAP EXISTS

The gender gap exists in physics and other STEM fields due to a multitude of reasons, and several studies were conducted to discuss these reasons.

Ecklund et al. (2012), Francis et al. (2017), and Freedman et al. (2018) concluded that men and women seem to differ in why they believe the gap exists, as well as in their perceptions of their own abilities to achieve success in the STEM and physics fields. In other words, men and women, on average, attribute the existence of the gender gap to vastly different reasons, which also helps to explain why gender discrimination continues to exist in these fields. Women are much more likely to credit discrimination for playing a role in the gender gap. On the other hand, men are more likely to attribute a lack of skill or internal factors to the existence of the gender gap. Additionally, discouragement or lack of encouragement for girls to enter STEM careers begins at a very young age. Each of the respective studies comes to similar conclusions despite the method used.

### **CORRESPONDING STUDIES**

The first study analyzed data from the Perceptions of Women in Academic Science and explored how professionals in the STEM fields themselves view the reasons for the gender gap. The authors gathered responses from "more than 14,000 graduate students, postdoctoral fellows, and tenure-track/tenured faculty members ... yield[ing] a response rate of 72.4%", and interviews conducted with "84 biologists and 66 physicists" (Ecklund et al., 2012, pp. 699-700). Ecklund et al. (2012) concluded that women and men agree that a lack of mentoring helps explain the existence of the gender gap and that women cite discrimination as a reason for the gender gap more than men do. Additionally, women from both biology and physics disciplines acknowledged that women might feel more of a connection to their work in biology since biology deals with life and explores many practical, real-life applications (Ecklund et al., 2012). In contrast, physics is typically much more abstract. In other words, it appears that women believe an emotional connection often exists between a female physicist and her work and that it is harder to identify the practicality of the discoveries of physics in the everyday world. While physics is arguably a more abstract subject, it certainly still has real-life application, as it explores why the world works the way it does.

Apart from a lack of interest in physics, women also stray from a physics track due to conscious or subconscious discouragement to enter the field. Ecklund et al. (2012) noted that women might feel ostracized entering a male-dominated field where women role models and mentors are scarce. On the other hand, men seem to believe that most of the discouragement for women to enter STEM fields happens at

a young age, which alludes to inadequacy in addressing discrimination at higher levels of education (Ecklund et al., 2012). Young women benefit from having a female role model and mentor so that any ostracization from gender discrimination can be addressed in a safe space and with someone who understands. Regardless of the gender of a young woman's mentor, both men and women must be educated about the signs and dangers of gender discrimination. An increased presence of women in the STEM fields will result in a more adequately educated society and encourage more women to consider entering those careers.

The second study used data from the Economic and Social Research Council-funded "Young People's Science and Career Aspirations Age 14-19" (ASPIRES 2) project, which tracks children's career goals (Francis et al., 2017). The current study interviews students ages 15-16 and their parents about the student's future aspirations and perceptions of STEM courses, such as physics (Francis et al., 2017). Similar to the previous study, Francis et al. (2017) also concluded that women are more likely to attribute the underrepresentation of women in physics specifically to stereotyping and discrimination. The interviewees of this study noted three main, but conflicting discourses on the physics gender gap: nothing is barring women from entering physics-related careers, gender discrimination in the physics field deters women, and physics is typically presented as a subject pursued by men (Francis et al., 2017).

The mere existence of the first discourse is cause for concern and needs further examination. The interviewees who believe nothing prevents women's access to physics careers claim that willpower and motivation are all women need to succeed in the field (Francis et al., 2017). It is alarming that just under a third of the students interviewed subscribe to the first discourse, as the problem of gender discrimination is undermined, and the experiences of those who have faced discrimination in a male-dominated field are discredited. The existence of the first discourse points to a severe inadequacy in awareness about the gender gap and the effect gender discrimination has on someone's mental health. However, the study also showed that many of the students and their parents stressed discourses on gender discrimination and the perception of physics as a masculine subject. It is promising that most people agree there are barriers to women entering the physics field so that such barriers can be ultimately eradicated.

The third study conducted three separate experiments in which men and women from a university read fictional short stories depicting

a female student experiencing anxiety over their STEM class. Although there was some disagreement between each experiment's results, the overall consensus showed that men believe lack of preparation or skill is why the STEM gender gap exists (Freedman et al., 2018). The experiments also found that men are less likely to believe that stereotypes play any role in the gender gap and gender discrimination (Freedman et al., 2018). Men in the experiments considered the fictional female student's struggles in the story unrealistic and unrepresentative of women's experiences in STEM fields (Freedman et al., 2018). Similar to the previous two studies, it is discouraging that men and women have largely different perceptions of women's access to and comfort in the physics field. Using the stories of women employed in the physics field will help reduce the gap in these perceptions by raising awareness of the ongoing problem of gender discrimination in the workplace. Women's self-efficacy for success in the physics field is considerably depleted when compared to men. Society perpetuates that being successful only takes hard work and motivation, making women upset and anxious if they find themselves struggling to succeed.

### **INACCURATE PERCEPTIONS SURROUNDING PHYSICS**

Women have made significant progress in closing the gender gap in certain STEM fields, such as biology, but they remain a minority in many of the fields, including physics. There is a multitude of false conceptions about the STEM fields that contribute to the existence of the gender gap in this field. Research shows that physics specifically has an ongoing gender gap due to the perception that it is more of a masculine job (Ecklund et al., 2012; Francis et al., 2017). This perception is damaging to young women since this discourages them at a young age from considering physics as a career path, especially if women in physics are not supported in their respective communities.

Ecklund et al. (2012) and Francis et al. (2017) also noted that not having female role models in the field or having certain preconceived dispositions about the difficulty or inflexibility of a STEM field deters women from considering a career in that field. In other words, having female physics teachers or seeing women represented in the physics field in the community can give younger generations of women a sense of belonging and empowerment as well as encourage them to believe that they can also find success in the field. These role models can help to dispute the inaccurate perception that physics

is a masculine job that only men pursue and succeed in. Unfortunately, many misconceptions continue to exist about the physics field itself and why so few women enter the discipline.

Some women assume that there is inflexibility regarding physics jobs and family responsibilities, which turns them away from careers in physics. However, this notion is not entirely true. Ecklund et al. (2012) noted that although those in the physics field do often work long hours, there is seemingly no difference in the number of hours worked by those in the biology field, whose gender gap is much smaller when compared to physics). Therefore, having and providing for a family while working as a physicist is a very realistic and reasonable lifestyle. The idea that physics is a much more rigorous and demanding field is merely a misconception and is not representative of how the field operates. There are both internal and external misinterpretations that people attribute as valid reasons for the existence of the gender gap in physics.

The perception that physics careers clash with familial responsibilities is not the only misconception people have about the field. Many people, primarily men, attribute biological differences to the gender gap in physics. Some of the comments made by a former Harvard president, Dr. Lawrence Summers, at a conference held by the National Bureau of Economic Research, are noted in Goldenberg's (2005) article, *Why Women Are Poor at Science, by Harvard President.* His comments included that women are not promoted to senior roles in STEM due to a "reluctance to work long hours because of childcare responsibilities" (Goldenberg, 2005). He credited biological differences as to why boys outperform girls in high school STEM courses and implied that discrimination is not a principal reason for the gender gap anymore.

His remarks were not well-received by his audience or the public, and Dr. Summers ended up resigning from his rocky presidency the following year. Although this example occurred back in 2005, women in physics today are still told that they are doing a man's job and are blatantly stereotyped and discriminated against from childhood through adulthood. Additionally, it is alarming that these remarks were made by someone of high stature, as they have the capability to influence a great number of people. Women have been tirelessly fighting against workplace discrimination, and sometimes it appears that almost no progress has been made. However, there are multiple ways to address these perceptions and reasons for the gender gap.

## **CURRENT SOLUTIONS BEING EXPLORED**

There are several current solutions that aim to reduce the gender gap. However, they target the lack of representation in STEM rather than focus on bringing about awareness for those who experience gender discrimination in school and the workplace. Legewie and DiPrete (2014) concluded that high schools that support and encourage women to study STEM reduce the gender gap in that community by 25% or more. However, they also noted that a significant gender gap prevails even in these supportive communities (Legewie & DiPrete, 2014). Therefore, in an effort to cultivate a supportive atmosphere, STEM interest programs should be offered in both secondary and elementary schools. Possible STEM interest programs can range from an assembly educating students about STEM careers to programs that aim to allow students to intern at local companies. These programs should focus on the elementary and secondary school levels because this is when most people's perceptions about their futures are developed. If young women grow up believing that they can enter and succeed in a STEM career, and this belief is carried throughout secondary education, more women will begin to enter the STEM fields.

Additionally, seeing women employed in STEM allows girls to have higher self-efficacy, which will lead to more women entering the STEM fields in the future. Both Riegle-Crumb and Moore (2014) and Stearns et al. (2016) noted that there is a connection between a community's representation of women in the STEM workforce and the gender gap in physics classes in high school and college. If more women are entering STEM-related careers in the community, including STEM teaching, then the number of females taking physics classes in that community's high school or pursuing a physics degree in college increases. This influence is due to instilling a newfound sense of ability to succeed in a STEM career or making STEM courses or clubs feel more welcoming to girls. These female STEM teachers can also mentor young women, and learning about any difficulties and discrimination the teachers have faced helps young women feel less isolated and insecure. The current solutions and the results are fantastic, but it is not enough. A new solution focused on story and testimony needs to be introduced, in conjunction with all of the current solutions.

## **STORIES AS A SOLUTION USING CURRENT STUDIES' RESULTS**

Hearing women's perspectives and personal testimonies on the STEM gender gap helps

younger generations become more aware of gender discrimination and stereotyping in the workplace. Education leaders should welcome local women in STEM into elementary and secondary schools. The women will get the chance to tell their stories, talk about the struggles they faced, how they persevered, and encourage girls K-12 to consider STEM. By meeting these women, girls can network with role models and mentors. Hearing these stories also raises awareness of the gender gap, as many people don't believe it's a prevalent issue anymore.

Another solution would be to incorporate stories of women in STEM into the curriculum to combat the underrepresentation in mass media. One way of doing this is by promoting media that demonstrates diversity in a given field, such as the *Ada Twist, Scientist* book and TV series. Freedman et al. (2018) showed through their study that stories can be used to learn how people perceive the gender gap. Knowing the power of stories can help determine the most effective way to raise awareness and educate others about the biases and discrimination that women face in STEM classes and the STEM workplace. In the same way that sports teams analyze their opponent before they play against them, one needs to know their opponent – the misconceptions people believe about physics – to combat discrimination.

Similarly, Ecklund et al. (2012) found that testimonies and experiences of women who were formerly or are currently in the STEM workforce raise awareness about the disadvantages they have faced in the past in pursuing a STEM career as well as the challenges they are facing currently. Stories of personal experiences feed into people's emotional side, bringing attention to the problems that need addressing and should be utilized in conjunction with the STEM interest programs to promote this message of equality to students of all ages. Stories and one's narrative hold a lot of value in understanding others' experiences, fostering a more accepting world.

## **THE POWER STORIES HOLD**

Stories are powerful and can help correct the many misconceptions people have about physics and women working in the field. O'Toole (2018) concluded that discussing personal narratives through narrative ethnography was valuable in exploring the effect and accuracy of institutional storytelling, which often limit what one believes and reject struggles expressed in personal narratives. Narrative ethnography is defined as the qualitative research of the culture and behaviors of a community. Personal narrative refers to one's personal experiences

or the experiences of those being interviewed, while institutional storytelling is the storyline that society tells or, more simply, societal norms. Due to the limiting nature of institutional stories, people frequently feel isolated in the difficulties that arise when facing stereotypical and discriminatory societal ideas.

In the context of this paper, the institutional story is that a STEM career is masculine and better suited for men solely due to their gender. This perception, in turn, can limit what young women believe about physics so that they dismiss it as “not for them” because they do not want to be perceived in a masculine light. Another widely believed institutional story is that women lack the necessary skills to succeed in the physics field. This idea has been so thoroughly infiltrated into our society that many girls grow up hearing and believing that they are less gifted in the STEM areas, and therefore, they believe that they cannot succeed in a STEM career as men can. Even young women who are drawn to the STEM fields from a young age and know they have the ability to succeed in STEM are suppressed by this societal message. If these women begin to struggle at any point, they often are told or begin to believe they are not cut out for a STEM career or that their work and accomplishments will never be as impressive and important as a man's. Overall, these institutional stories are harmful to a women's self-identity and self-worth as shown in the three studies discussed above (Ecklund et al., 2012; Francis et al., 2017; Freedman et al., 2018).

### **DISPUTING SOCIETAL NORMS**

Women should not blindly subscribe to society's institutional stories but instead, break through the stereotyping and define their own personal narratives. Cote (2017) reflected on the significance of learning about stigmas around depression and its impact on her life. Similarly, learning about the stigmas that society places on women in the physics field can help battle the discrimination that comes with such generalizations. Additionally, hearing others' stories about gender stereotyping can help them recognize any discrimination they face in their own life that they have been blind to previously. Many more voices and stories are begging to be heard that have been drowned out by institutional stories' chaotic and deafening sound.

Stories help women fight against the many different stigmas that society has created. Bove and Tryon (2018) concluded that storytelling can educate others, connect the storyteller with their audience, overcome anxiety surrounding sharing experiences, self-reflect, and strengthen

self-worth and identity. Therefore, testimonies from women in the physics field can also have the same benefits. Testimonies educate others about the gender gap and discrimination and how to address both prevalent problems. Women telling their stories can connect with or mentor younger women who have undergone similar experiences and need guidance. Sharing one's experience can motivate others to share their own, and a community of women with similar backgrounds is formed. Additionally, storytelling can help women in STEM reflect on past situations and how they wish they had reacted differently, as well as build up their self-esteem in their accomplishments and the self-worth of those around them through uplifting, motivating stories. The power of storytelling is demonstrated by women, both past and present, who did not let institutional stories get in the way of their success.

### **REAL-WORLD ROLE MODELS**

There are many inspirational stories of women who have made monumental contributions to physics and STEM in general. Three such women were brought to light in the last several years through the movie documentary titled *Hidden Figures*. Wei-Haas (2016) explained that *Hidden Figures* highlights the stories of Katherine Johnson, Dorothy Vaughan, and Mary Jackson, who all were black women who worked at NASA in the 1960s. The movie follows these women through the height of Jim Crow segregation as they use their mathematical genius to help the United States win the space race against the Russians. The book that the movie was based on features this group of black women who were called the West Computers, as they were essentially human computers for NASA during this time. By telling these lost stories of women in STEM, a greater understanding of their experiences and struggles can occur.

Being a successful woman in STEM is possible, as there are prominent, respected women in a multitude of STEM disciplines throughout history and in the present day. Ramakrishnan (2018) noted her personal experiences as a woman in STEM, including encountering sexual harassment and multiple occasions of stereotyping. She also contemplated why her discipline, field biology and wildlife conservation, is still a male-dominated field and addressed the struggles that women in STEM face even today (Ramakrishnan, 2018). Although faced with many setbacks along the way, Dr. Uma Ramakrishnan – a professor at Juniata College – has a passion for field biology that motivated her to continue in her profession. She is a shining example of a woman who overcame the disadvantages and discrimination

women face entering the STEM workplace.

Similarly, there are still many notable women today in the physics field, either as physicists or physics educators. Kirkman (2021) discussed another successful professor in STEM, Dr. Meg Urry, the Yale Center for Astronomy and Astrophysics director at Yale University. She has made impressive additions to the knowledge surrounding black holes and was asked to speak at Towson University to encourage and empower students to conduct scientific research themselves and consider entering scientific careers. Dr. Urry is the “first female, tenure-track physicist to join Yale's faculty”, and she is a leading advocate for women interested in pursuing a STEM career (Kirkman, 2021). Women are certainly making more gains and receiving more recognition for their hard work and discoveries than they were two decades ago. However, the problem of the gender gap and gender discrimination persists. Hearing the personal experiences of women who have been successful in STEM can encourage future generations of young women to enter the physics field.

### **ADDRESSING CONTRADICTIONS**

Some scholars argue that there are other, more effective solutions to reduce the gender gap in physics and raise awareness of the gender discrimination that takes place in the physics field. One such solution is increasing the number of female role models in STEM, either in the physics workplace itself or as physics educators. While increasing the number of female role models or teachers in STEM is an admirable goal, this will take time to achieve. Additionally, it does not address how to encourage more women to enter the physics workforce in the first place. On the other hand, using the personal experiences of women in the field to educate others about the gender gap and gender discrimination is a highly effective and immediate solution. Bove and Tryon (2018) showed the effectiveness of stories on both the storyteller and the audience. Stories can bring awareness to the signs of and problems with gender discrimination and stereotyping to create a more welcoming atmosphere. Hearing other women's experiences also increases self-efficacy in women currently taking physics courses or looking to enter into a physics-related career. Additionally, stories are a much more immediate solution. Testimonies of women in the physics field change entire outlooks on the physics field and therefore, change the trajectory of people's lives. Overall, when compared to other solutions, utilizing stories as a solution to the gender gap is a more effective and immediate resolution.

## CONCLUSION

Stories of the personal experiences of women working in the physics field reduce the gender gap by encouraging future generations of women to enter the physics workforce. Women's self-efficacy in physics and STEM will increase, and society will become more aware of women's accomplishments in these fields. It only takes one person to revolutionize the field of physics completely, and fortunately, more and more of

society is beginning to recognize the importance of women in the physics field, but there is still work to be done. While the gender gap has been previously explored, not much has been done in addressing the problem, and using stories as education should be the next step.

Stories hold enormous power and appeal to the emotional side of people, grabbing the attention of others so that change is brought about. Many women fall victim to discrimination

and stereotyping, and some are unaware of all the microaggressions they have withstood from others. Although some people are lucky enough to never experience discrimination in their schools or workplaces, many others are struggling with the long-term stereotyping they have experienced over the years. Everyone has a story to tell, and it is essential that people are educated about underrepresentation and discrimination so that society will become more accepting and equal for all in time.

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# Combating Cultural Miscommunication: Strategies for an Equitable Elementary Classroom

Amy Kessler

## ABSTRACT

Marginalized students, those linguistically and culturally diverse from the dominant culture, often struggle to reach their full learning potential. Cultural miscommunication, defined as misunderstandings and misconceptions between teachers and students of various cultures, is a common issue within elementary classrooms that can further hinder academic success for marginalized students. While strategies to combat cultural miscommunication in the classroom have been researched the influx of strategies, ideas, and approaches may feel overwhelming to teacher candidates, especially to those who lack experience working in culturally and linguistically diverse classrooms. Therefore, this study sought to make connections across strategies and/or approaches to eliminate cultural miscommunications in an elementary classroom to create a more equitable environment for linguistically and culturally diverse students. Using an interview protocol, participants for this study included ten faculty members from the Department of Early and Elementary Education at a mid-sized Mid-Atlantic university. Interviews were audio-recorded, transcribed, and analyzed. An inductive analysis reveals there are a variety of ways cultural miscommunication can occur in the classroom. However, participants highlighted specific approaches and strategies which teachers can plan for and incorporate to proactively lessen miscommunications. This paper will elaborate on three themes: the importance of teacher reflection, knowing the students, and intentional instructional decisions. While it is difficult to eliminate cultural miscommunications within the classroom entirely, engaging in consistent and intentional reflective practices before, during, and after instruction is an essential step to create a more equitable elementary classroom.

**Keywords:** cultural miscommunication, teacher preparation, equity, equality, reflection

## INTRODUCTION

As a future educator, an important part of my teaching philosophy is to create a classroom environment where each student, regardless of background, has equitable opportunities to succeed. All students deserve to learn in an equitable classroom environment, free from cultural miscommunications; however, most teacher candidates have little experience creating equitable classroom environments. With an abundance of strategies and approaches introduced in teacher preparation programs, teacher candidates must learn how to effectively utilize these strategies to combat the deficit model which infiltrates elementary classrooms. The deficit model – an outlook within the education system which negatively represents marginalized students and their abilities (Delpit, 1988) – pervades the education system today. Research has widely agreed that cultural miscommunication occurs frequently in the classroom between marginalized students and their teachers (Rasheed et al., 2019). Research also highlights ways to meet the needs of linguistically and culturally diverse students (e.g., van Tartwijk, 2009); however, each student is unique and thus requires different instructional attention and decisions. Therefore, my research question is: what approaches or strategies can be planned to eliminate cultural miscommunications in an elementary classroom to create an equitable environment for linguistically and culturally diverse students?

## LITERATURE REVIEW

### CULTURAL MISCOMMUNICATION

The concept of cultural miscommunication within the classroom has been heavily researched (e.g., van Tartwijk, 2009; Mchatton et al., 2013; Rasheed et al., 2019). Rasheed et al. (2019) explains how cultural miscommunication occurs when teachers and students are unfamiliar with one another's culture. This is commonly seen in urban schools where the student population is very diverse (van Tartwijk et al., 2009). A lack of understanding of students' culture can greatly affect their academic success, which is why cultural miscommunication is an obstacle standing in the way of marginalized students trying to reach their full educational potential. Numerous solutions have been proposed to reduce cultural miscommunication within the classroom (Mchatton et al., 2013). Teacher-student matching, the concept of placing students with teachers of the same race or ethnicity, is one way to create a classroom environment that reflects the culture of the marginalized students (Rasheed et al., 2019). However, this can be a difficult task to successfully implement due to the disparity between marginalized teachers and marginalized students in public school systems today (Villegas et al., 2012). Instead, Delpit (1988) suggests that the teacher must use a variety of strategies to meet the needs of all students. To do so, teachers must be able to reduce cultural miscommunication within their

classrooms through academic instruction as well as classroom management techniques.

### TEACHER PREPARATION PROGRAMS

It is important for teacher candidates to enter the field aware that many of the students they teach will differ from themselves (Mchatton et al., 2013). Therefore, teacher preparation programs must educate teacher candidates on ways to address the needs of culturally diverse students. While universities and teacher preparation programs have taken strides to educate teacher candidates on ways to address diversity in their classrooms, Mchatton et al. (2013) proposes an approach that challenges teacher candidates to dive deeper into the developmental levels of themselves and their students, as well as conversations about race and ethnicity. Educating teacher candidates on different cultures and teaching in a diverse setting is a necessary step in closing the opportunity gap, formerly known as an achievement gap, that research has found exists for marginalized students.

### DEFICIT MODEL

In addition to educating teacher candidates about different cultures, candidates must have a general understanding of the deficit model which vastly affects marginalized students in today's education system. Delpit (1988) describes this model as a code of power in which those who hold the power, typically teachers, school districts, and curriculum, control the culture of power created within the school. White

teachers are often unaware they are reproducing White culture and thus the domination of marginalized groups in their classrooms (Delpit, 1988). Teachers should incorporate the cultures of marginalized students into their classroom to help marginalized students understand the value of their culture. The deficit model naturally treats marginalized students as if they are incapable of learning to think critically or with reasoning (Delpit, 1988). Instead of assuming marginalized students are incapable of success, it is important for teachers to understand students' funds of knowledge (van Tartwijk et al., 2009). Knowing traditions, interests, family relationships, and other key components of students' lives allows teachers to craft lessons which highlight student's cultural, personal, and academic assets and are tailored to each student's academic needs. The education system must switch from a deficit model to a model that utilizes students' funds of knowledge to truly provide equitable opportunities for marginalized students to succeed.

### **EQUITABLE TEACHING AND LEARNING**

Teachers have implemented numerous strategies to create an equitable learning environment that benefits each student, regardless of racial and/or ethnic differences. Recent conversations regarding education discuss the difference between an equal and equitable learning experience. Teaching and learning must be equitable to truly meet the needs of all students.

In terms of classroom management skills, research highlights the importance of positive teacher-student relationships (van Tartwijk et al., 2009). As an educator, it is extremely important to form trusting, positive relationships with students outside of simply teaching them the required curriculum. To do so, teachers need to understand the role of authority in different cultures. Delpit (1988) explains how a non-marginalized teacher using indirect communication in their classroom could confuse marginalized students on the directions they need to follow and the authority of the teacher, as this form of communication may differ heavily from the way individuals in positions of authority in their culture communicate. While it is nearly impossible to meet the standards of a good teacher that each culture has set, teachers should aim to have a general understanding of the cultures and authority styles their students from different backgrounds are used to (Delpit, 1988). This knowledge will help the teacher effectively communicate with all students and thus decrease cultural miscommunication.

Beyond classroom management, instruction can reflect numerous cultures despite what the

required curriculum forces teachers to utilize. For example, research has been conducted on ways to incorporate cultural texts into a required text list (Critically Reading the Canon, 2022). While still following a required text list, teachers can teach with critical theories in mind and pair required texts with cultural texts or student interest texts (Critically Reading the Canon, 2022). This is just one way to accommodate marginalized students in ELA instruction.

Each content area presents a unique opportunity for teachers to accommodate marginalized students. For example, utilizing the arts can be helpful. Teachers have advocated for more art integration into the curriculum and research has been conducted on ways to follow a cultural-historical approach in creative education (Connery, 2012). Art is a universal language and should be utilized as such in the classroom. In bilingual, multi-ethnic classrooms, creative assignments and lessons which incorporate art forms, ranging from dance to theatre to drawing, can help students from all backgrounds connect their culture with their learning. When creating art, students are given the freedom to express themselves which often allows them to tie their culture and interests into their work. Integrating art into the classroom is one way for educators to incorporate the cultures of their students into their academic instruction.

## **METHODOLOGY**

### **PARTICIPANTS AND CONTEXT**

This study took place at a mid-sized Mid-Atlantic university. Ten faculty members who teach in the state accredited and nationally recognized teacher preparation programs for early childhood and elementary majors were interviewed. Participants included two males and eight females; representing four races and ethnicities: White, European American, Black Caribbean and Black; and teaching in the content areas of mathematics, science, social studies, or literacy. Faculty members were selected due to my personal experience in the teacher preparation program. Information acquired in a required course on teaching diverse learners, which included the importance of inclusive education, inspired this research.

### **DATA COLLECTION AND ANALYSIS**

An interview protocol was used, and each interview was audio recorded and transcribed. Follow-up questions were asked as needed including information about the demographics of participants. All participants were given a pseudonym. An inductive analysis was used to generate themes. Principles of constant comparison were used, and seven categories

emerged: (1) cultural miscommunication; (2) equity; (3) equality; (4) reflective practices; (5) getting to know the student; (6) family and community involvement; and (7) classroom strategies and approaches. The categories were collapsed, and three themes emerged: teacher reflection, knowing the students, and intentional instructional decisions.

## **FINDINGS**

### **DEFINING KEY TERMS**

At the start of each interview, participants were asked to define and describe the key terms: cultural miscommunication, equity, and equality. Their responses illustrate the complexity of these terms, which can often be difficult to define in a universal way. Using the information and interpretations provided by the participants, a definition was constructed for each term—cultural miscommunication, equity, equality—in an educational context. Participants are referred to by their pseudonym.

### **CULTURAL MISCOMMUNICATION**

Cultural miscommunication can be defined as the misunderstanding of cultures between both teacher and student. Dr. Knight described cultural miscommunication as, "an unspoken expectation broken." Many times, expectations are not clearly communicated leading to misunderstandings and what can easily be viewed in the classroom as disrespect. Teachers often foster misconceptions about students due to a lack of knowledge about the student's culture and life outside of school. With such a variety of cultures in the classroom, it can be difficult to navigate the different values and expectations each culture holds. Being unaware of these cultural expectations and values can lead to misunderstandings. Dr. Burns brought to light how being embedded in so many cultures makes it difficult to remove oneself from them and the miscommunications that naturally occur. To combat these inevitable miscommunications, teachers must be open to learning about cultures different than their own. The strategies and approaches discussed in this paper aim to provide teachers and teacher candidates with ways to recognize, integrate, and accommodate culture in the classroom in a sustaining way.

### **EQUITY**

In an educational context, equity can be defined as meeting student's individual, unique needs. Dr. Fleming described equity as students, "getting exactly what they need, regardless of where they are on their socio trajectories." Every student has unique assets and needs which must be met. Meeting one student's needs will arguably always look different than

meeting another student's needs. To create an equitable classroom, the student must be looked at as an individual who requires different accommodations than those around them.

### EQUALITY

In an educational context, equality can be defined as giving each student the same resources and attention despite individual needs. Individual needs may include learning needs, physical needs, and/or emotional needs. Dr. Mason discussed how equality in the classroom would mean, "all students are going to get the exact same thing no matter their circumstance." Equality in the elementary classroom would be a "one size fits all" (Professor Green) approach. When students come from varying backgrounds, they arrive with varying needs. A student's individual needs cannot truly be honored when an equality approach is utilized. While equality is a concept widely discussed and promoted in society today, equality in the elementary classroom can negatively impact linguistically and culturally diverse students.

thinking critically about one's practice before, during and after instruction.

### TEACHER REFLECTION

While analyzing the data collected, the theme of teacher's self-reflection emerged. Teaching requires consistent, critical reflection to ensure that proper instructional decisions are made. Examining one's own biases can be a difficult and uncomfortable task; however, criticality is essential to the development of an equitable classroom. Teachers must engage in consistent and intentional reflective practices before, during, and after instruction in order to create an equitable elementary classroom.

**Before instruction.** Prior to instruction, teachers must reflect on their students' needs. Having a deep understanding of each student is crucial to ensuring that appropriate instructional decisions are made each day. Potential lessons should be critically examined to ensure they accommodate different needs and are being utilized for academic purposes. In the digital age

or instructional adaptations need to occur to meet the needs of all students. As instruction occurs, the teacher should be, "constantly reevaluating" (Dr. Knight) to ensure cultural miscommunications are not hindering the success of linguistically and culturally diverse students.

**After Instruction.** Reflecting after instruction is important to assess the achievement of learning goals and ensure that future instruction is appropriately planned for. Careful consideration should occur following instruction that focuses on teacher effectiveness, student engagement, and learning outcomes. Teacher effectiveness refers to the teacher's pedagogical practice. Questions to consider include:

- Was instruction free from bias?
- Did my pedagogical practices meet the needs of all students? If not, how could I adapt or differentiate future instruction to meet the unique needs of all students?
- What practices might I use again?
- Did cultural miscommunications hinder the success of my linguistically and culturally diverse students?
- Was instruction relevant and meaningful to all students?

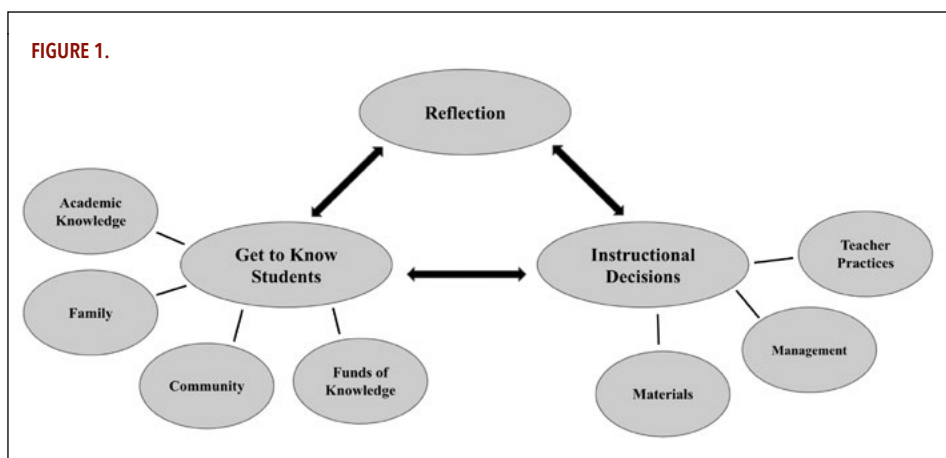
Reflecting on student engagement after instruction is imperative in ensuring that future instruction is appropriately planned for to engage, motivate, and excite students. If students lacked engagement and motivation during a lesson, the teacher needs to consider ways instruction could be altered to increase engagement levels. Instruction that is relevant and meaningful to students is often met with increased engagement. What may have worked for one specific class in previous years, may not work for another class. Each unique group of students will engage in different ways. Reflecting on learning outcomes or objectives also occurs after instruction. This is where the content knowledge students have gathered and demonstrated is assessed and used to determine future instruction.

This research highlights that reflection must go beyond occurring solely after instruction. Engaging in reflective practices before, during, and after instruction ensures that student knowledge is utilized to make appropriate instructional decisions that work to create an equitable classroom environment with decreased cultural miscommunications.

### KNOWING THE STUDENTS

**Academic Knowledge.** To make intentional and appropriate instructional decisions, teachers must have a strong understanding of their students within and beyond the classroom.

Within the classroom, knowledge of each



### STRATEGIES FOR AN EQUITABLE CLASSROOM

Figure 1 highlights the relationship among the findings for creating an equitable classroom. The three broad themes that emerged: reflection, getting to know students, and intentional instructional decisions hold equal weight within this model. The arrows point in both directions to indicate how moving between these three themes is necessary when striving to create an equitable classroom environment. For example, using knowledge of the students and reflection, appropriate instructional decisions can be made. Getting to know students involves knowledge of their academics, family, community, and funds of knowledge. Instructional decisions include pedagogical teacher practices, approaches to classroom management, and careful consideration of classroom materials. Reflection refers to the practice of actively critiquing and

it can often be easy to find an activity or lesson online to use without a second thought.

Dr. Mason stated:

Having that criticality of [an] activity is great. 'I saw it on Teachers Pay Teachers.' 'I saw it on teacher TikTok'...and then actually thinking about it in a critical way. It is so important [to think] about your students and [if] they [will] actually benefit from this or is it just something to fill the time.

Activities should be tailored to individual students and accommodations for linguistic and cultural differences should be planned for in advance.

**During Instruction.** As instruction occurs, reflection should continue to occur.

Reflecting on the students' understanding of content knowledge must occur throughout instruction to determine if additional scaffolding

individual student's assets and needs is essential to their success. Dr. Knight stated:

One of the things to be really mindful of is that different kids engage in different ways and that looks different. So being able to figure out when a kid is either motivated or engaged or completely shut off, and how else they stand out as different [is important].

Getting to know students and forming a positive relationship sets a firm foundation for academic success. A strong relationship between teacher and student also allows the classroom community to thrive. Getting to know students' interests, strengths, and weaknesses within the classroom helps uncover similarities and connections that strengthen the teacher-student relationship.

### **Knowledge Beyond the Classroom.**

Getting to know students outside of the classroom is equally as important. Knowledge of a student's culture and home life should be incorporated into the classroom. Dr. Day recommends, "seeing who [the students] interact with outside of school and how they interact." Understanding students' lives beyond the classroom not only strengthens relationships but can help determine why students act in a certain way. It is important to allow students to bring their lives into the classroom. Students' different worlds should be able to intertwine with one another's and be celebrated within the classroom. Knowledge of the student beyond the classroom also helps identify interests and assets. Once teachers know what motivates and excites their students, they can plan engaging instruction. To truly create an equitable classroom, students' unique needs must be met. Knowing the students' academic capabilities as well as their life outside of the classroom is essential to developing an equitable classroom environment.

### **Family and Community Involvement.**

Analysis of the data showed a continued focus on family and community involvement. As teachers get to know their students, they will also interact with families and the surrounding community. The relationship teachers develop with student's families is incredibly important to the student's success in school. To develop strong relationships with families, the findings reveal a few different components which must be considered. When speaking with families, it can be easy to assume the student's guardian is a parent. However, as Dr. Knight highlighted, when communicating with families, using terms such as "guardians" or "significant adults" can help those students in what society often deems as nontraditional families feel seen and included. Remaining consistent with this language and address is

critical to successful communication.

As you communicate with guardians and significant adults, conversations about life at home and expectations should occur. Mrs. Foster suggests having an "upfront conversation with the [guardian] in the beginning [about] what their expectations are." Conversations about expectations for their child as well as expectations for the teacher are a productive way to establish a strong relationship and team mindset. When expectations are clearly communicated, opportunities for miscommunication within the classroom decrease.

Frequent positive communication is an essential component of strong teacher-guardian relationships. Dr. Fleming shared an experience in which he called home for a positive report about a student and was shocked when the guardian did not react with enthusiasm. The guardian assumed that a phone call from the teacher meant bad news. Dr. Fleming stated, "when I never talked about bad news, [the guardian] had no idea how to handle that." Ensuring that positive, productive learning experiences are shared with guardians frequently is an essential way to build trust and respect. Phone calls, texts, or emails to guardians, or significant adults, can significantly impact all parties involved. In the digital age, communication through other applications such as ClassDojo and Google Voice are easy ways to involve guardians on a consistent basis.

In addition to family communication, community involvement can help decrease cultural miscommunications. Understanding and being involved with the community where students spend much of their time is necessary to ensure instruction connects to the student's personal life. In addition, showing guardians and significant adults that the teacher values the community they are involved in helps to remove the hierarchy of power that often prevents guardians from being actively involved in their child's education.

### **INTENTIONAL INSTRUCTIONAL DECISIONS**

Participants provided a variety of different strategies and approaches that can be utilized in the classroom to create an equitable environment and decrease cultural miscommunications. The abundance of strategies provided by participants have been organized into three categories: considering classroom materials, approaching management, and teacher practices.

**Considering Classroom Materials.** When striving to create an equitable classroom environment, conscious thought must be put into the materials present in the classroom. Data analysis revealed the consistency of three types of materials suggested across participant responses:

children's literature, inclusive print, and basic needs.

Children's literature should be intentionally chosen to mirror and represent the students in the class. Teachers should put extensive thought into the personal library they acquire and the books they have in the classroom. Dr. Knight encourages teacher candidates to ensure they have a classroom library they are familiar with and that represents a multitude of cultures. Children deserve to see themselves, their families, and their communities represented in the literature they consume. Not only should children's literature act as mirrors for students, but literature should also help them learn about tough topics. Dr. Mason shared that children's literature can be used, "to facilitate ... really tough conversations."

Children's literature goes hand in hand with the print environment created in the classroom. The print, or text, within the classroom should show diversity and once again represent the students. An inclusive print environment includes wall hangings and decorations. Classroom decorations should connect to students' interests, cultures, and lifestyles. Dr. Knight spoke extensively about the importance of classroom decorations and the idea of combusting stereotypes, saying:

Have pictures of black female scientists, pictures of dads at home with kids, pictures of all these things that vary from the original notion. Then, be thoughtful about what kind of languages are coming into the classroom and how you can exhibit representation, because it does really matter when a kid comes in and sees themselves, their family, or their style being there.

With an inclusive print environment and appropriate children's literature, linguistically and culturally diverse students begin to see themselves represented in their education despite curriculum that often fails to accommodate and represent them.

In addition to a classroom environment which represents students, planning to accommodate basic needs should be taken into consideration. Many students have basic needs that are unmet. These needs may include food, hygiene products, and classroom materials such as pencils, paper, or crayons. For many children, teachers are the individuals they can rely on to help meet their basic needs. Providing materials for students who have unsatisfied basic needs is essential. When basic needs are unmet, academic success can suffer.

**Approaching Management.** A teacher's approach to management differs depending on the unique group of students present in the

classroom each year. Using knowledge of the students allows teachers to explore classroom management approaches that fit those particular students. When considering a classroom management strategy, participants suggested understanding the student motivations. Knowing what students want or are interested in can help plan an effective management strategy that will engage students. Professor Green discussed how, "extrinsic motivation is really good to build intrinsic motivation for your students." Building from student motivations can change the focus within the classroom to proactive rather than reactive.

A teacher's approach to classroom management should also help build a strong classroom community. Having students connect with one another and form a family within the classroom walls is necessary for a strong, functioning classroom. Dr. Martin spoke about how students, "need to rely on each other." Dr. Day shared a similar perspective, in which she emphasized how having students connect with one another throughout the entirety of the school year is essential to maintaining a functioning classroom. She suggested engaging in team building exercises, morning meetings, and a social contract that is upheld the entire year. These activities build a strong sense of community between students and aid in the formation of positive relationships.

Choosing an approach to management that is culturally responsive is also paramount to the success of linguistically and culturally diverse students. A culturally responsive practice was suggested by numerous participants. To be culturally responsive, the cultures of each student should be brought into the classroom in a multitude of ways. Beyond academic inclusion, cultures should be embedded into the management tactics used within the classroom. Knowing how each culture values education and views authority can make choosing an approach to management much easier. Not only does this bring students' cultures into the classroom but it can also create an environment that students have familiar experiences in. When choosing an approach to management, understanding each student on an academic, personal, and cultural level is necessary.

**Teacher Practices.** Teachers must engage in practices that foster an equitable classroom environment, such as using knowledge of the students and consistent reflective practices. Participants recommended a variety of teaching practices which include consistency, predictability, flexibility, differentiation, a growth mindset, and the Ubuntu philosophy of human interdependence. Each of these practices holds

important value and has proved successful for many participants.

As a teacher, being consistent is vital. Consistency means showing up for your students and the school community each day. Dr. Knight discussed how, "consistency is something that is rare outside of school" for some students. For those students who lack consistency, the presence of a teacher and the routines of a school day are imperative for a sense of balance within their lives. Along with consistency comes being predictable and flexible. Due to consistency, students should be able to predict that when they have a need, their teacher will try to accommodate it. Flexibility refers to the adaptations teachers make daily to accommodate the ever-changing needs of their students.

The unique needs of individual students call for teachers to differentiate instruction.

Differentiation refers to adapting instruction to address "the individualized needs of the children in [the] class as opposed to treating them like they're just one group of similar students" (Dr. Burns). Dr. Burns went on to discuss the importance of differentiation saying:

One of the most important things is to differentiate lessons and to make sure that your lesson isn't just designed to meet the children in the middle but that it's designed in such a way that it can meet the children at the top, the middle, and at the bottom. And so, thinking about things like making it hands-on, making it meaningful, making it engaging.

Academically, meeting the needs of all children comes down to the differentiation of instruction. Providing equal accommodations in the classroom will not satisfy the needs of all students. Instead, providing equitable accommodations will ensure that the needs of all students are met.

The mindset teachers bring into the classroom has a direct effect on their pedagogy and their students. With access to different social media platforms and negative experiences within the school community, it can be easy to fall into the fixed, negative mindset that pervades the education system today. Separating the evident injustices existing within the education system from the mindset and energy brought directly into the classroom each day for the students is extremely important to student success. Children mimic and pick up on the way adults around them act. If students see their teacher falling into the negative, fixed mindset around education, they are bound to develop that mindset themselves. Remaining positive and open minded is essential to the ideas students develop around the importance of

education. There is no denying the ways in which the education system has failed and continues to fail students and teachers. Teachers must hold strong to their reason for teaching despite the systemic injustices that plague the public education system.

Humans are naturally interdependent, rely on one another, and crave connection. Dr. Powell spoke about this interdependence and how a philosophy known as the Ubuntu philosophy connects to education. The Ubuntu philosophy means that I am because you are. It highlights how humans depend on one another. Within the classroom, students naturally yearn for connection with each other. Providing opportunities for students to build relationships with each other and the teacher is necessary. Pedagogical practices should frequently incorporate collaboration and experiences that foster community and connection.

## CONCLUSIONS AND IMPLICATIONS

While participants of this study presented effective strategies to combat cultural miscommunication in the elementary classroom, the findings indicate that fully eliminating cultural miscommunication is nearly impossible. As individuals who are embedded in numerous different cultures, it is impossible to separate oneself from, "the lenses through which we see the world" (Dr. Burns). Cultural miscommunication can be combatted or lessened using a combination of the strategies and approaches presented above; however, the elimination of cultural miscommunications, as mentioned in the research question for this study, is unattainable. Wherever culture exists, miscommunications will exist. However, the effort put into acknowledging and combatting cultural miscommunications continues to make progress towards a classroom free of miscommunications. Learning to understand and work with cultural differences can help diminish miscommunications that hinder success in the elementary classroom.

Many of the findings in this study show connections to already identified high leverage practices teachers are encouraged to use throughout their pedagogy. High leverage practices within teaching have been researched extensively. The University of Michigan, *Teaching Works* states:

High-leverage practices are the fundamentals of teaching. These practices are used constantly and are critical to helping students learn important content. The high-leverage practices are also central to supporting students' social and emotional development. These high-leverage practices are used across

subject areas, grade levels, and contexts. They are “high-leverage” not only because they matter to student learning but because they are basic for advancing skill in teaching.

Participants in this study identified numerous approaches and strategies that connect to and resemble the high leverage practices identified by Teaching Works. For example, theme two, getting to know students, was revealed by participant responses and directly aligns with the high leverage practices of: learning about students, communicating with families, and building respectful relationships. The high leverage practice of establishing and maintaining community and implementing organizational routines align with participant responses regarding the intentional approach to classroom management. Another high leverage practice identified by Teaching Works is the practice of analyzing instruction for the purpose of improving it. This directly aligns with theme one, teacher reflection, as detailed in this study. Taking time to analyze and reflect on all aspects of instruction ensures that future instruction can be appropriately planned for.

The high leverage practices explored and explained by Teaching Works along with the three themes outlined by this research provide teachers with a variety of practices that can be utilized to create an equitable classroom environment. When teachers actively work towards creating an equitable classroom

environment, cultural miscommunications that can hinder the success of linguistically and culturally diverse students have the opportunity to significantly decrease.

Future research can gain a better understanding of the complexity of culture. Humans are so embedded in their own culture; it is nearly impossible to remove oneself from this to eliminate the miscommunications that occur. Where there is culture, there is bound to be misunderstandings and miscommunications. How does the complexity of culture foster miscommunications in the classroom? Future research is needed to explore how curriculum can be modified to represent all students in meaningful and relevant ways. A culturally responsive practice goes beyond celebrating multi-cultural week or reading one text a month that connects to a student’s culture. Changes must be made at the curriculum level to ensure that linguistically and culturally diverse students are being taught a curriculum that represents themselves in meaningful and relevant ways. Future research must also explore linguistically and culturally diverse students and family’s beliefs of a meaningful and relevant education.

This research highlighted the importance of teacher reflection. Teacher preparation programs can benefit from implementing experiences for teacher candidates to reflect on their practice before, during, and after instruction and/or teaching opportunities. Reflective experiences

are typically present in teacher preparation programs; however, the reflections tend to come after instruction or teaching occurred. While this is necessary, experiences which allow teacher candidates to reflect on their practice before and during instruction will enhance the self-reflection skills of these teacher candidates and thus better prepare them to actively reflect on their practice throughout their careers. Within education, reflective practices go beyond analyzing student work or engagement levels. Reflection is a crucial practice that teachers must utilize to ensure they are providing the most accommodating, relevant instruction to all students, regardless of cultural or linguistic background.

Another implication for teacher preparation programs yielded by this research is the consistency of terminology across content courses. In my personal experience, pedagogical terminology tends to differ across teacher preparation courses. An example of this is the concept of “accommodating students’ needs.” Throughout different courses, planning support for students with different needs has been referred to as “adaptations,” “accommodations,” and “differentiation,” for example. Collaborating as a department to create a set of pedagogical terms that remains consistent across varying courses will benefit teacher candidates. Hearing the same terms in each course will instill the importance of the concept and decrease any confusion that may arise from numerous terms that represent the same pedagogical concept.

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# Policy and LGBTQ+ Youth in the K-12 Public Education System: An Interdisciplinary Analysis Using the Minority Stress Model

Ryan L. Devine

## ABSTRACT

LGBTQ+ youth are disproportionately impacted by social barriers within the United States (U.S.) public education system. Current statewide policies introduced such as Florida's "Parental Rights in Education Act" (H.B.1557, 2022), colloquially referred to as the "Don't Say Gay" bill have left members of the LGBTQ+ community confused about the boundaries under which they can freely express their identities within public education institutions. Additionally, anti-LGBTQ+ policies and agendas by major political figures have caused an increase in anti-LGBTQ+ hate, violence, and rhetoric among U.S. citizens (Berg-Brousseau, 2022). This rise in anti-LGBTQ+ policy and hate contribute to a psychological phenomenon called minority stress. The minority stress model proposes that sexual minority health disparities can be explained by stressors induced by a hostile, homophobic/transphobic culture which often results in a lifetime of discrimination and victimization (Meyer, 2003). For LGBTQ+ youth specifically, issues such as bullying, lack of support at home, social isolation, lack of competence among educators and administrators, and an increase in anti-LGBTQ+ policies have been factors contributing to high rates of mental illness, suicide, school retention, incarceration, homelessness, and overall deficiency in sense of belonging in the school system and community at large. This analysis will investigate trends in anti-LGBTQ+ policy writing in K-12 public institutions, its influence on LGBTQ+ youth, protective factors, and policy recommendations using the minority stress model as a guide.

**Keywords:** anti-LGBTQ+ policy; K-12 public education; LGBTQ+ youth; minority stress model; intersectionality theory

## POLICY TRENDS

Anti-LGBTQ+ policies are being introduced and passed at record-breaking rates. Doubling the number of proposed policies in 2022, 2023 is expected to introduce more anti-LGBTQ+ legislation in U.S. history with almost 500 bills currently in session. This rise in policy introduction reflects a wave of LGBTQ+ visibility which has caused resistance from conservative-leaning groups (Human Rights Campaign, 2021). There are a variety of anti-LGBTQ+ policies being introduced including some that limit accurate government identification for transgender and gender-diverse individuals, weaken non-discrimination laws, restrict free speech and expression, bar access to affirming healthcare, and prohibit usage of various public facilities.

Education policy is one of the most prominent forms of anti-LGBTQ+ policy. These policies include but are not limited to banning LGBTQ+ topics, outing students' gender identity and sexual orientation to parents, and prohibiting preferred pronouns. Anti-LGBTQ+ education policies impact the educational experiences that LGBTQ+ students have throughout their time in the K-12 education system. For example, Florida's "Parental Rights in Education Act" (H.B.1557, 2022), colloquially referred to as the "Don't Say Gay" bill, which is currently being replicated and introduced in other states across the U.S., bans LGBTQ+-related books and content in the school curriculum and outs students who express their sexual orientation or gender identity. Additionally,

in New Jersey, legislative representatives are attempting to provide vouchers for parents to remove their child from the public education system and place them into a private school, covering 75% of their tuition if their moral or religious values do not align with the curriculum offered in public school such as curriculum including LGBTQ+ topics (S585, 2022).

These anti-LGBTQ+ education bills are part of a larger conservative movement against inclusive and equitable education. In addition to anti-LGBTQ+ policy, Black LGBTQ+ youth face serious detriments as anti-critical race theory policies are simultaneously being proposed and implemented within schools. Such policies attempt to ban discussion of Black history, affirmative action, and other forms of support for Black students. For example, in addition to their "Don't Say Gay" bill, Florida representatives are also actively attempting to block the pilot AP (Advanced Placement) African American Studies course from being introduced in Florida public schools (Mazzei & Hartocollis, 2023). The minority stress model suggests that these proposed policies are identified as stressors that contribute to the negative well-being of Black LGBTQ+ youth as a fear of one's rights being revoked induces stress (The Trevor Project, 2022). The combination of legislative attacks on equitable LGBTQ+ and Black history education can potentially make educational environments toxic for Black LGBTQ+ youth.

When putting policy into perspective, it is imperative to note who has power when it comes to the implementation and enforcement of

these policies. Considering age, only individuals eligible to vote and/or hold office and those who are parents or guardians are able to implement policies directed toward LGBTQ+ youth. This issue grants questioning on the extent to which LGBTQ+ youth within the public education system have autonomy and political agency. As seen across the U.S., parents and legislators have had a "the parent knows what is best" approach to deciding which practices are harmful to children in school settings. This approach speaks to juvenile ageism, which manifests how social systems ignore the interests of children, impacting their development (Westman, 1991). There are many reasons why this parenting method is harmful. One example is implicit bias, which is an unconscious and unintentional bias that influences decision-making processes. In contexts of dynamics between parents and children, parents carry heteronormative and cisnormative biases that facilitate this "parent knows what is best" mindset, meaning parents make decisions with an unconscious preference and assumption that their child is heterosexual or cisgender (Kulvalanka et al., 2019). Another reason is that most parents are unsupportive of their LGBTQ+ children (The Trevor Project, 2022), which is reflective of many adults' perceptions of LGBTQ+ youth. The Trevor Project, an organization dedicated to serving the needs of LGBTQ+ youth, reported that most households show low to moderate support toward their LGBTQ+ identifying child (The Trevor Project, 2022). If legal agents are not highly supportive of their LGBTQ+ identifying child, then the

insufficiency in support translates to the amount of parental influence for anti-LGBTQ+ policies and a lack of advocacy for LGBTQ+ youth who cannot participate in voting. Since many LGBTQ+ youth do not have parents as legal advocates, their autonomy and voices are stripped away during this decision-making process, and parents can impact their child's experiences in school in a harmful manner. When applying this to the minority stress model, parents are expected to be supportive factors who provide affirming spaces to mitigate the stressors that their children face. However, this data shows that parents are actually contributors to minority stress for many LGBTQ+ youth.

### **EXPERIENCES OF LGBTQ+ YOUTH**

In 2022, a study conducted by the K-12 LGBTQ+ student advocacy organization GLSEN showed that 81.8% of LGBTQ+ students felt unsafe in school because of their actual or perceived personal characteristics. This lack of safety is a result of the treatment that LGBTQ+ students face as the study revealed that 97% of LGBTQ+ students heard the word "gay" being used in a negative connotation, and 89.9% heard homophobic remarks such as the term "faggot" and "dyke" (Kosciw et al., 2022; Russell et al., 2021). Further, LGBTQ+ students were still twice as likely to face disciplinary infractions in comparison to their heterosexual or cisgender counterparts, despite the violence against them (Kosciw et al., 2022). Violence targeting LGBTQ+ students occur in a variety of school settings causing fear of utilizing spaces within schools that lack supervision or sources of intervention, with four out of ten LGBTQ+ students avoiding bathrooms, locker rooms, and gym classes (Kosciw et al., 2022). Studies have found that this avoidance of bathroom usage has caused serious health detriments. When LGBTQ+ students restrict their bathroom use because of fear, they place themselves at a higher risk of developing urinary tract or bowel issues from holding it in (Hardacker et al., 2019). Furthermore, LGBTQ+ youth were also found to restrict dietary intake to prevent the need to use the bathroom. This intentional limitation of food is dangerous as suppression of necessary nutrients places deficits in health, mood, and learning capacities (Burrows et al., 2017).

Additionally, heteronormativity puts LGBTQ+ students in a position to feel pushed out of the education system, with an overall lack of support from peers, staff, and administrators. Book bans across school districts cause LGBTQ+ students to be underrepresented in the curriculum and create barriers to accessing resources that are affirming and reflective of these students'

experiences. LGBTQ+ Alliances also must constantly advocate for their positionality as a needed extracurricular in school systems. Many school board representatives, members of the public, and parents argue for the abolishment of these programs with weaponizing statements that claim such programs groom children, meaning LGBTQ+ adults or adults who introduce LGBTQ+ topics are indoctrinating children to become LGBTQ+. These connections have been prominently found through social media, as the term "grooming" rose 400% the evening that Florida's "Don't Say Gay" bill was introduced (Berg-Brousseau, 2022). This accusation of a form of child abuse contributes to harmful stigmas and stereotypes about the LGBTQ+ community.

Furthermore, there is a lack of representation of LGBTQ+ educators as well as culturally competent educators who can properly address the needs of LGBTQ+ students. The cause of this issue partially stems from an unwillingness of teachers to foster an LGBTQ+-inclusive educational environment. In GLSEN's most recent school climate study, a total of "58.0% of students reported hearing homophobic remarks from their teachers or other school staff, and 72.0% of students reported hearing negative remarks about gender expression from teachers or other school staff" (Kosciw et al., 2022). Additionally, one-tenth of LGBTQ+ students reported that school staff intervened most of the time or always when overhearing homophobic remarks at school, and less than one-tenth of LGBTQ+ students reported that school staff intervened most of the time or always when overhearing stigmatizing remarks about gender expression (Kosciw et al., 2022). With many teachers showing hesitance to express overall support for LGBTQ+ students, there are also educators who expressed support but were hesitant due to state and local guidelines being enforced. Studies have shown that 74% of educators were reluctant to introduce LGBTQ+ topics in the curriculum due to barriers placed by administrators and policymakers (Russell et al., 2021).

When considering the experiences of LGBTQ+ youth, it is crucial to also consider the experiences of LGBTQ+ youth who carry additional stigmatized identities such as the experiences of Black LGBTQ+ youth. Intersectionality theory explains the differential impacts that Black LGBTQ+ youth experience across the education system (Crenshaw, 1991). While the entire LGBTQ+ community is experiencing violence and oppression at higher rates within schools compared to their cisgender, heterosexual counterparts, Black LGBTQ+ youth are facing these hostilities at more substantial

rates than White LGBTQ+ youth (Kosciw et al., 2022). This is due to the compounded, unique experience of racialized homophobia or racialized transphobia that differ from the experiences of White LGBTQ+ youth. LGBTQ+-inclusive spaces are typically dominated by White LGBTQ+ youth and are not always racially inclusive. In contrast, racially inclusive spaces are not always LGBTQ+ inclusive, isolating Black LGBTQ+ students from these affirming spaces (Connell, 2016). This double-down phenomenon poses many negative health consequences due to the stigma and prejudice that Black-LGBTQ+ face from the intersection of their LGBTQ+ status and race.

### **OUTCOMES USING THE MINORITY STRESS MODEL**

By reviewing the framework of policy trends, combined with the experiences of LGBTQ+ youth, it can be shown that these instances contribute to minority stress, which as mentioned before, are negative health outcomes due to compounded stigma and discrimination (Meyer, 2003). The consistent stressor of the rights of LGBTQ+ youth being revoked, combined with a feeling of helplessness due to a lack of personal advocates, contribute to negative health and well-being (The Trevor Project, 2022). The many adverse experiences that LGBTQ+ youth experience in schools daily due to stigma that they face also impact physical and mental well-being. Deficiencies in resources dedicated to LGBTQ+ students in need, in conjunction to a lack of cultural competence among staff, violence toward LGBTQ+ students, and a scarcity of perspectives of positive movements among the LGBTQ+ community in the curriculum negatively impact LGBTQ+ students (Catania, 2020; Kosciw et al., 2022).

Due to this lack of sense of safety and belonging, LGBTQ+ youth are found to skip school at much higher rates which correlates to lower grade point averages (GPA) than their cisgender heterosexual counterparts. Lower GPAs and more extreme disciplinary infractions from absenteeism and tardiness contribute to reluctance to pursue post-secondary education (Kosciw et al., 2022). Low GPA or high absenteeism rates are a product of minority stress and anti-LGBTQ+ stigma that non-LGBTQ+ students do not face. For instance, in a study conducted by the Human Rights Campaign, LGBTQ+ students and non-LGBTQ+ students were asked about the most important problem facing their lives at the time. Of all LGBTQ+ students, 26% reported it was non-accepting families, 21% reported school problems, and 18% reported a fear of being out or open. In

contrast, of all non-LGBTQ+ students, 25% reported classes/grades/exams, 14% reported college/career readiness, and 11% reported financial pressures related to college or jobs (Human Rights Campaign, 2012).

Given these adverse school experiences, it is no surprise that several studies report an alarming number of LGBTQ+ youth at risk of or experiencing anxiety, depression, and/or suicidal ideation (Maiolatesi et al., 2022; Poteat et al., 2016). The endurance of these conditions combined with a lack of resources and support further exacerbate these mental health disorders and contribute to an overall lack of interest in school and a decrease in trust between LGBTQ+ youth and their respective school systems. Thus, there is an evident trend in LGBTQ+ youth facing a larger likelihood of dropout than their non-LGBTQ+ counterparts (GLSEN, 2016; Kosciw et al., 2022). LGBTQ+ youth who find themselves dropping out of school, feeling unsatisfied with their occupation, or not pursuing a post-secondary education experience a greater risk of homelessness, incarceration, or institutionalization (GLSEN, 2016; Morton et al., 2018; Kosciw et al., 2022). As they age, LGBTQ+ youth will endure the stigma attached to their sexual orientation or gender identity on top of their employment status, housing status, criminal status, and even race as mentioned in instances for Black LGBTQ+ youth. This nature of events is a direct causation of the stigma and discrimination that LGBTQ+ youth face throughout their childhood and carry through adulthood.

### PROTECTIVE FACTORS

One aspect of the minority stress model is identifying protective factors. When speaking of groups who face stigma, protective factors are characterized by supportive figures or environments that offset the levels of minority stress that LGBTQ+ youth endure (Ceatha et al., 2021). These protective factors boost coping mechanisms for instances in which discrimination and stigmatization occur. One protective factor that ought to exist in schools is figures such as supportive educators, staff, and peers. Current data supports that LGBTQ+ youth identify their schools as a protective factor from their stigmatized identity in comparison to their homes (The Trevor Project, 2022). However, with the current climate that exists in public schools, there is still a great deal of work that must be done to make school environments more affirming and inclusive.

One protective factor that has increased the well-being of LGBTQ+ youth in schools is the implementation of "safe spaces" (Katz et

al., 2016). Safe spaces can be created when a student, staff member, educator, or collective organization undergoes training on creating LGBTQ+-affirming environments, certifying their classroom or space as a safe space for LGBTQ+ youth upon an oath of commitment. Once training is complete, participants are given a sticker to place on the doorways of their designated spaces to prove completion, which has been shown to promote inclusive perceptions and safety in educational environments (Katz et al., 2016). Safe spaces can also administer tactics to intervene when anti-LGBTQ+ remarks are made toward a student. Reports have shown that 58.4% of staff intervened when hearing anti-LGBTQ+ remarks toward a student, and 45.4% of students intervened when hearing anti-LGBTQ+ remarks (Kosciw et al., 2022). If more staff members and students participated in training on making schools a more LGBTQ+-affirming space, then there would be an increase in the number of LGBTQ+ individuals reporting that staff members and peers intervened in a time when violence was enacted toward them (Russell et al., 2021).

Another protective factor is GSAs, also known as gay-straight alliances or LGBTQ+ alliances. GSAs provide a space for LGBTQ+ youth to be their authentic selves away from typical school environments that are dominated by toxic heteronormativity and cisnormativity. Additionally, GSAs are required to have a staff advisor since they are a school-based program. Advisors are typically allies or members of the LGBTQ+ community, serving as mentors and role models for LGBTQ+ youth. Existing data shows that schools with GSAs are reported to have greater levels of school safety as well as overall well-being of LGBTQ+ youth (Ioverno et al., 2016). Since there is a presence of high support, there is a greater sense of well-being and safety which decreases high rates of absenteeism (Toomey et al., 2011).

Furthermore, an LGBTQ+-inclusive curriculum taught by supportive teachers is found to be a protective factor for LGBTQ+ youth. When LGBTQ+ youth are exposed to course content that affirms their identities, their overall academic performance increases, their well-being improves, and their general feeling of support and acceptance rises (Johns et al., 2019). This curriculum comes in three ways: sexuality education, critical social justice education, and queer representative education (Bittker, 2022; Meadows, 2018). When these topics are taught, not only are mental health risks decreased, but physical and sexual health risks are additionally decreased. Students, specifically LGBTQ+ youth, who are taught comprehensive sexuality education are less likely to engage in

sexually risky behaviors and have a decreased likelihood of developing an STD/STI. In terms of mental health, students who are taught LGBTQ+ topics from various disciplines feel safer and more supported in schools, decreasing the risks of mental health disorders, substance abuse, and suicidal ideation (Bittker, 2022; Meadows, 2018).

### POLICY RECOMMENDATIONS

It is crucial to enact changes that build safety, inclusivity, and boost protective factors for LGBTQ+ youth in K-12 school settings. The minority stress model suggests that these discriminatory policies and environments contribute to adverse outcomes and disproportionately impact the quality of education that LGBTQ+ youth receive, negatively altering their career trajectories. Therefore, policymakers carry a responsibility to improve the welfare of LGBTQ+ youth through the implementation of supportive policies. There are three levels in which policies can be advocated for, implemented, and supported: the state or federal government level, school district level, and parental level.

### STATE/FEDERAL POLICY RECOMMENDATIONS

State governments can implement policies that ensure schools are making efforts to improve the well-being of LGBTQ+ youth. By enforcing a bare minimum education standard required to be taught, all schools will provide affirmative curriculum. Seventy-one percent of students in the U.S. reported that their schools did not incorporate LGBTQ+ topics within their curriculum, and only 7.4% of students reported that they were taught LGBTQ+-inclusive sex education (Kosciw et al., 2022). In placing emphasis on the fact that these forms of curriculum are lifesaving and are protective factors for LGBTQ+ youth, state governments ought to enforce policies that include this bare minimum standard level of education.

The curriculum must be taught by educators and staff who have cultural competence training that caters to providing a safe space for LGBTQ+ youth. States ought to enforce a level of training required to gain specialized certification within their jurisdictions. Studies have presented that educators who receive diversity training have been more thoughtful of how to incorporate diversity topics in their curriculum, which in turn has promoted the well-being of not only the students but also the educators (Booker et al., 2016).

On a federal level, legislative representatives can take LGBTQ+-inclusive policies that may have passed in their own states or districts and promote implementation on a federal level. In doing so, states with a single Republican party

delegation that seek to affirm LGBTQ+ youth can be advocated for when someone is not there to do represent them (Ostermeier, 2021). Additionally, state LGBTQ+-affirming policies can be replicated the same way that anti-LGBTQ+ policies are currently being replicated across states so that if specific policies cannot be approved on a federal level, they can at least be adopted through other states.

The federal government also plays a role in advancing the rights afforded to children. Revisiting juvenile ageism, LGBTQ+ youth in the K-12 education systems are left unheard due to their lack of legal recognition and are oftentimes not taken seriously due to their age. In fact, the U.S. is the only developed country that has not signed onto the UNICEF "Convention on the Rights of the Child" which is a commitment toward recognizing the lack of stake children have in their own well-being and how to address that inequality. These rights range from recognizing forms of autonomy youth may have from a parental figure who may abuse their power to recognizing the need for schools to accommodate learning environments for students of all backgrounds (UNICEF, 2023).

### **SCHOOL DISTRICT POLICY RECOMMENDATIONS**

In considering the importance of what states can do to improve the educational experiences of LGBTQ+ youth, it is also crucial for school districts to reflect on their role. Since policies vary based on which state a school is in, or even which district it is in, an individual, annual climate assessment should be conducted to holistically evaluate the needs of LGBTQ+ youth on a school-by-school basis (GLSEN, 2018). This assessment will allow educators and administrators to evaluate how effective they are at working with LGBTQ+ youth, which will guide policies for areas that need improvement.

Schools carry a responsibility to protect LGBTQ+ youth. Like the zero-tolerance campaign against bullying, schools should also implement intervention policies for when anti-LGBTQ+ remarks are made or violence occurs, as LGBTQ+ youth are bullied at disproportionately higher rates than their cisgender, heterosexual counterparts (Kosciw et al., 2022). School districts have an obligation to decrease these statistics as bullying contributes to various adverse mental health outcomes (Day et al., 2019). One effective method is school districts publishing transparent reports on bullying and harassment within their districts, making specific notations of anti-LGBTQ+ motives for bullying. This can assist in identifying the prevalence of bullying toward LGBTQ+ youth and where bullying takes place. It has been noted that bullying toward LGBTQ+ youth prominently occur in bathrooms and

locker rooms (Kosciw et al., 2022). Institutions could remodel bathrooms, locker rooms, and changing areas to incorporate private, single-stall units. These adjustments facilitate increased accessibility and safety for LGBTQ+ students using these spaces while also decreasing the likelihood of bullying and harassment toward LGBTQ+ youth (Francis et al., 2022).

In addition to providing single-use bathrooms, schools can increase the number of trained staff in these spaces to properly monitor and intervene in instances of bullying and harassment (Shattuck et al., 2021). Staff training can take place by mandating professional development training on proper intervention tactics when anti-LGBTQ+ acts take place. Additionally, schools can mandate safe space training among students and staff, spreading more awareness on how to be an ally to LGBTQ+ youth, which has been found to be a protective factor in decreasing victimization and negative health outcomes (Russell et al., 2021). Within this advocacy for safe space training, school boards and staff can advocate for the creation or preservation of a GSA in their school. GSAs can work toward fostering an inclusive space for LGBTQ+ youth while also serving as an organization that can advocate for students' needs to administrators. This will empower LGBTQ+ students in their advocacy skills, boost self-esteem, and increase overall mental health and well-being (Chan et al., 2022).

### **PARENTAL RECOMMENDATIONS**

Parents and guardians are a huge influence for LGBTQ+ policy, most notably through the involvement of parents and guardians in advocating for their children. While parents have voted for elected officials who pass and implement anti-LGBTQ+ policies, parents also have the agency to advocate for elected officials who implement affirming, life-saving policies within their schools on a district-to-state level. There are many benefits to parental involvement in school policy change. The first benefit is the leverage that parents have in fostering change within schools. The political and bureaucratic structures of school systems allow for a paternalistic dynamic that promotes superiority over children in decision-making processes, oftentimes leaving the needs of students unheard (Westman, 1991). Parents ought to beneficially use their power toward the greater good by being a direct reflection of what their child's needs are, rather than following a "parent knows what is best" approach. Since parents are taxpayers in their local school districts and vote to elect their local school boards, parents can elect school board members who are willing to assist in

serving LGBTQ+ youth. Additionally, parents can advocate for more transparent reporting on how well the school is working with LGBTQ+ youth through the school climate reports previously proposed, making results viewable for the public.

The benefit to parents being involved in school-based activities and listening to their children is the potential to facilitate deeper connections. Children are found to have greater achievement in their studies when parents are involved in school events as they grow familiar with what their child goes through at school and become more invested in their child's success (Hill & Tyson, 2009). Parents who take initiative in showing up for their LGBTQ+ child actively assist in decreasing dropout and absenteeism rates (Newcomb et al., 2019). More specifically, when parents are more invested issues of their LGBTQ+ child, the child is found to have better overall mental health and a lesser likelihood of substance abuse or suicidal ideation (Newcomb et al., 2019). One recommendation to support this is through the promotion of LGBTQ+ advocacy organizations to educate parents on how to support their LGBTQ+ child throughout their education. This can be completed through collaborative efforts between nonprofit organizations and other community partnerships that provide similar forms of support.

In connecting the power that parents have in creating change in schools with its benefits, parent's ought to exercise their abilities toward advocating for school policies that protect LGBTQ+ youth. Additionally, parents must allow LGBTQ+ youth into the conversation, as these students' stories are crucial in implementing changes across school districts (Davidson, 2017). This method not only supports LGBTQ+ youths' educational experiences and mental health, but it also builds a better parent-child relationship as children are better understood by their parents and are appreciative of the support their parents provide.

### **CONCLUSION**

Using the minority stress model as a guide, it can be concluded that policy impacting LGBTQ+ youth impact their educational experiences. This result is caused by stressors which have been provoked by the debate of LGBTQ+ youth in legislative sessions. Additionally, the language used in promoting anti-LGBTQ+ legislation produces a stigma toward the LGBTQ+ community that non-LGBTQ+ people adopt to incite hatred toward LGBTQ+ youth. The hatred, violence, and harmful stigma toward LGBTQ+ youth produce setbacks in their overall well-being, which in turn impacts educational experience and success (Meyer, 2003).

Due to these proven issues, measures must be taken to reverse or put an end to the actions that induce harm to LGBTQ+ youth. This must be advocated for by looking interchangeably and interrelatedly into the lens of policy and stigma. Since both are key stressors impacting the welfare of LGBTQ+ youth, professionals ought to seek out how these are exactly impactful and

how to reverse these impacts. This can be done by advocating for policies that protect LGBTQ+ youth and educating the public on how to be an ally to the LGBTQ+ community. Additionally, policies must be enacted specifically to make schools safer, instill protective factors, and equip educators with the knowledge on how to facilitate an affirming learning environment for

LGBTQ+ youth. Furthermore, we must recognize the lack of agency that LGBTQ+ youth in K-12 education settings have and work toward increasing agency while infusing caregivers and parents into conversations on supporting their LGBTQ+ child (Newcomb et al., 2019).

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# For the Birds

Makayla Bounds

## ABSTRACT

"For the Birds" (2023), oil on canvas, 18" x 24", is an exploration of the responsibility of maternity, emphasizing mortality and morality, while discussing the effects of growing up too soon. The title itself is derived from an idiom, "for the birds," describing a topic that is deemed worthless or invaluable. The artist wanted to take this phrase and turn it into a pun, as literal birds are being depicted within the painting, thus making a physical representation of the idiom. Additionally, this piece is the artist's first step into utilizing their own face within a composition, to directly tie the viewer to the artist's personal thoughts and feelings. Within the painting, the birds cry upward toward their "mother"; however, the figure stares straight forward at the viewer. Her expression unreadable. The woman's eyes are whitened out, and her frame stiff and sculptural. This displays the powerful and sometimes soulless feeling of the overbearance of motherhood. Additionally, the birds and the figure both represent the artist's struggles to protect their own fragile mind. These struggles have caused the woman in the painting to guard herself with an outwardly cold demeanor.

A very notable aspect of the painting comes from the colors themselves. The artist has intentionally limited the palette to emphasize the contrast between the feathers and the figure similar to the birds with the nest. The bright and vibrant yellow feathers let the eye flow up and down the piece gracefully as the excited brush strokes imitate the excitement of the birds nestled within the figure's hands. The cool purple tones graduate and flow smoothly, guiding the eye toward the face of the woman. This unsettling palette creates an otherworldly energy to the figure. The figure seems to reflect the face of a human and yet their garments are purely reflections of the animals they hold within their hands, while their hair dripping like oil within the fine tufts of feathers. A swirling purple



background highlights the enveloping loneliness and eventual dependence the subjects have on each other. Similar to the birds, the artist had to live in a state of perpetual anxiety and fear for a long time. "For the Birds" reflects the personal conflicts and feelings that the artist has had to experience throughout their artistic development and depicts the boundless potential that the future holds.

## ACKNOWLEDGMENTS

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# Examining Septic Tank Pollution in Eastern Shore Waterways Through Evaluation of Optical Brighteners

Connor Morningred

## ABSTRACT

We collected water samples along Chesapeake Bay tributary rivers (Wicomico, Pocomoke, and Nanticoke) in order to examine septic tank pollution. In order to accomplish this, we tested for optical brighteners which are fluorescent chemical compounds found in standard washing detergents. In the Wicomico, Pocomoke, and Nanticoke rivers, we found decreased optical brightener readings (indicating less septic tank pollution) in more developed areas, with greater optical brightener readings (indicating more septic tank pollution) in less developed areas, signifying more septic tank pollution. This may be because more homes in developed areas are likely to be connected to municipal sewage, while homes in more rural areas are reliant upon septic tanks for wastewater treatment. Furthermore, we investigated the photo-decaying properties of optical brighteners in order to better understand how optical brighteners can accurately be used as a tracing mechanism for septic tank pollution in future studies. We discuss key findings, both of optical brightener properties and concentrations, as well as recommend further study in these areas, in order to increase awareness and knowledge of septic tank pollution problems across the Chesapeake Bay system.

## INTRODUCTION

The Chesapeake Bay watershed spans several states and is one of the largest estuaries worldwide (Kemp et al., 2005). Historically, the diverse ecosystems of the bay, including marshes, wetlands, open water, and aquatic reefs provide a safe place for many plant and animal species to live. Furthermore, this region provides recreation, flooding protection, food, economic value, water, and other functions to the nearly 20 million people living within the watershed. However, in recent years, human population growth, expansion of living territory, and poor wastewater treatment, have created a human wastewater pollution problem, negatively impacting the health of the Chesapeake Bay as well as the many services it gives (Kemp et al., 2005). Leakage from failing septic tanks into nearby watersheds, referred to as septic tank pollution, can arise due to mismanaged equipment, old systems, and inconsistent inspections. Septic tank pollution is a cause of wastewater pollution; therefore, it is of high importance to quantify levels of septic tank pollution, identify areas of concern, and outline measures to stop pollution in order to protect the Chesapeake Bay. Interestingly, despite the strong negative effects of septic tank pollution, this remains a highly understudied area of research, especially on the Chesapeake Bay.

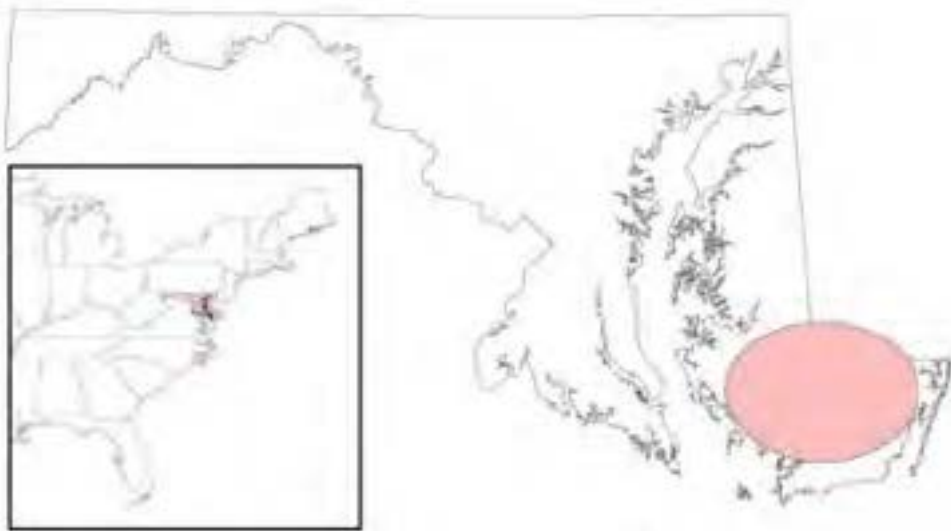
In many urbanized areas, wastewater is taken from municipal zones to be cleaned before it is safely returned to waterways. This process includes the untreated water passing through water treatment plants, where it undergoes filtration, bacterial decomposition, and screenings to ensure that it is properly

cleansed (Saravanan et al., 2021). However, it is not feasible to build water treatment plants everywhere, especially in rural areas with low population densities. In these regions, septic tanks are used to store human wastewater. Properly maintained septic tank systems can be an effective way to deal with wastewater, however, failing septic tanks can have numerous negative environmental effects. On the Eastern shore of Maryland, septic tank use is high. As of 2009, in Wicomico County, where Salisbury University is located, 68% of homes were reliant on septic tank use (Wheeler, 2011). Greater reliance on septic tanks increases the likelihood of wastewater pollution in a region; having more systems can exacerbate problems regarding inspections, maintenance, and old age. A higher chance of pollution, in conjunction with the Eastern Shore's geographical proximity to the Chesapeake Bay, is cause for concern.

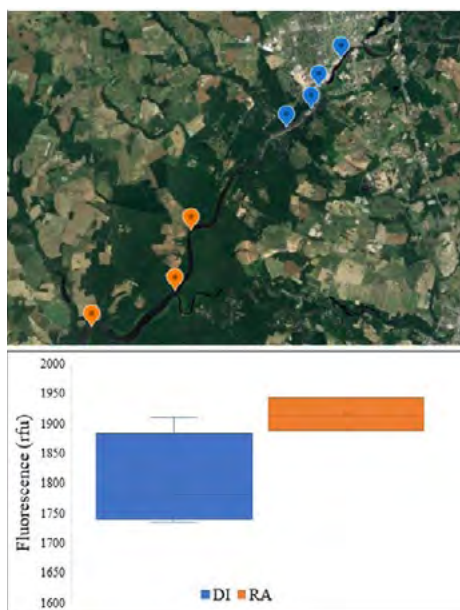
Tributaries of the Chesapeake Bay, including (but not limited to) the Nanticoke River, Pocomoke River, Wicomico River, carry water, nutrients, organic material, and pollution into the Bay. When excess nutrient pollution enters the bay, this process, eutrophication, often leads to rampant growth of phytoplankton, which can have a range of cascading environmental effects. Over the past several decades, eutrophication in the Chesapeake Bay has led to severe environmental consequences including loss of plant and animal species, diminishing water quality, and hypoxic zones (Kemp et al., 2005). In addition, enteric bacteria which can be readily found in human wastewater can be highly infectious and cause adverse health effects. In fact, interacting with contaminated water can

lead to respiratory tract infection, gastroenteritis, and more (Shuval, 2003). At the ecosystem level, high fecal contamination, especially from anthropogenic sources, in marine environments has been found to significantly decrease aquatic microbiota diversity, which is an important predictor of water health (Paruch et al., 2019). Overall, waters containing fecal contamination have been shown to have a variety of negative effects, making identification and cleanup of these waters a top priority.

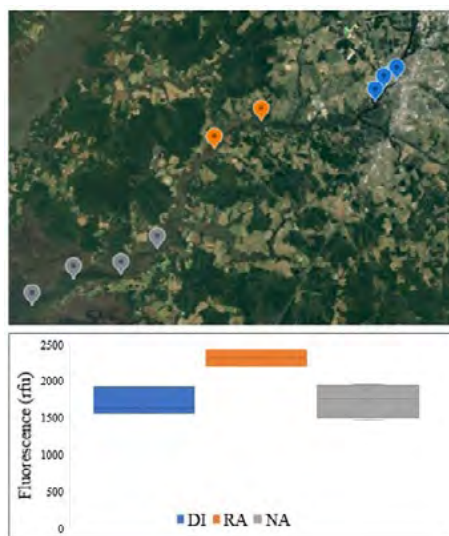
In order to investigate septic tank pollution within Chesapeake Bay tributaries, we directly studied optical brightener concentrations at different locations along the Nanticoke, Pocomoke, and Wicomico rivers. Optical brighteners are non-naturally occurring compounds which are common ingredients found in laundry detergents and soaps. These compounds do not break down readily, except in the presence of sunlight; therefore, optical brighteners can be found in septic tank pollution. These compounds fluoresce under certain wavelengths of light, and it is this quality that allows their presence to be identified and quantified through the use of fluorometric techniques. In fact, the use of optical brighteners as a tracing mechanism has been proven to be an inexpensive, effective, and powerful way to study wastewater pollution in aquatic environments (Tavares et al., 2008; Hartel et al., 2007). In addition to using this method to track potential leaking septic systems, this paper presents preliminary results as to the physical properties of optical brighteners, specifically, their photodegradation properties.



**FIGURE 1:** Map of Maryland and general sampling location.



**FIGURE 2:** Sampling locations on Nanticoke River (top). Fluorescence measurements from samples collected in development influenced (DI) and rural agricultural (RA) zones on Nanticoke River (bottom), with median represented as horizontal line, mean as "x," and upper and lower quartiles as vertical lines.



**FIGURE 3:** Sampling locations on Wicomico River (top). Fluorescence measurements from samples collected on Wicomico River (bottom), with median represented as horizontal line, mean as "x," and upper and lower quartiles as vertical lines. Development influenced (DI), Rural Agricultural (RA) and Natural (NA).

## METHODS

### STUDY SITES

We collected water samples from the Pocomoke, Wicomico, and Nanticoke rivers. All rivers are tributaries of the Chesapeake Bay and primarily run through the Eastern Shore of Maryland (Figure 1). We used information from Google Earth to assign land use zones to sampling locations along each river. Zoning is as follows: DI (development influenced), RA (rural agriculture), NA (natural), RFW (rural forested wetland). Sampling locations on each river within each land use zone were kept equidistant

from one another, with coordinates determined through Google Earth. Predetermined sampling sites were reached via GPS on a boat, where samples were subsequently taken.

### SAMPLING

At each selected sampling location, samples were captured using a Niskin bottle. Samples were collected at half the depth of the river at the sampling site. Directly after acquiring, water samples were transferred to darkened Nalgene bottles. Each darkened Nalgene sample collection/storage bottle was wrapped in duct tape prior to sample storage to deter exposure to sunlight and thus, degradation of the optical

brighteners. Samples were captured during June and July 2022. Fluorescent readings were taken using a Tecan Infinite 200 Pro. An excitation wavelength of 360 nm and emission wavelength of 420 nm was set according to standard protocols (Burres & Cass, 1989). A gain of 100 and settle time of 10 milliseconds was also set.

### SUNLIGHT EXPOSURE EXPERIMENT

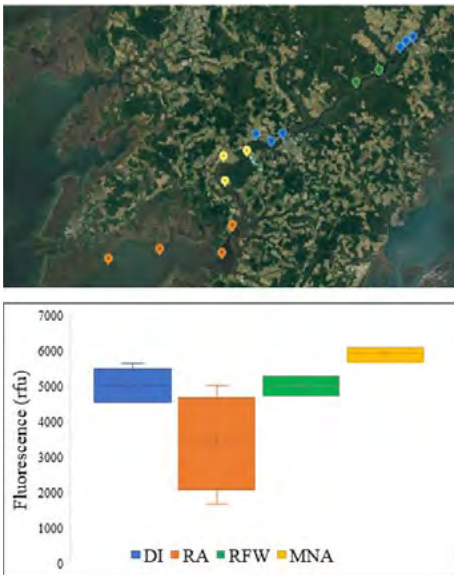
Aqueous standard solutions were created by serial dilution to a v/v concentration of 1/100,000 using ultrapure water which were spiked with Tide liquid laundry detergent. Fluorescent readings were taken every 5 minutes following creation, for 35 minutes after exposure to the sun. Two more readings were taken at 39 and 69 minutes, respectively. Readings were averaged and plotted against time using a line graph to demonstrate the effect of short duration sunlight on samples containing optical brighteners.

**Data Analysis.** We used box and whiskers plots in order to display the fluorescent levels of samples according to the river from which they were taken. Fluorescence was averaged across each land use zone and plotted to show relative differences.

### RESULTS AND DISCUSSION

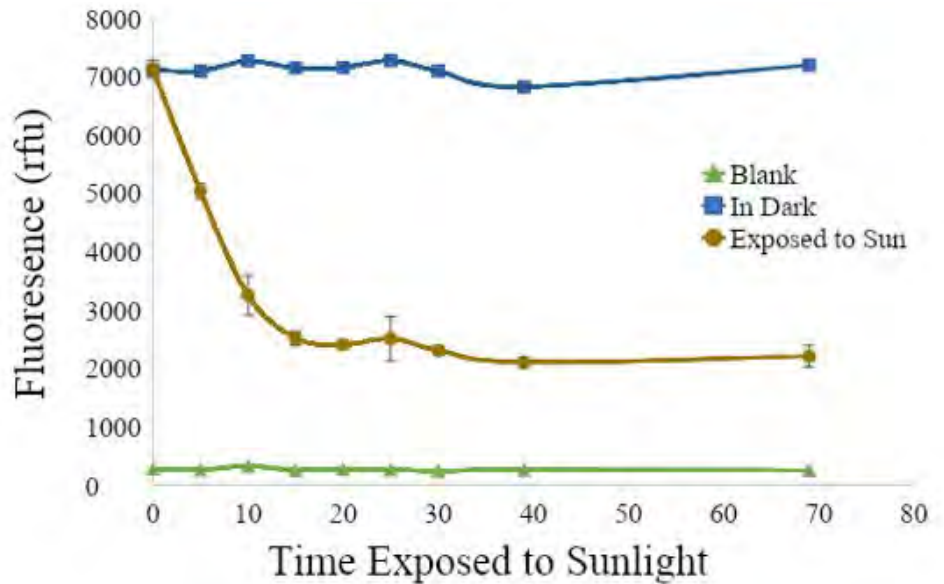
We postulate that in general, people living closer to cities (Seaford, Salisbury, etc.) are more likely to be connected to a wastewater treatment plant, foregoing use of a septic tank. Further distance from these treatment plants leads to an increased dependence of septic tanks in rural areas. Despite greater reliance upon septic tanks in rural areas, higher populations near cities have the possibility of signifying more total septic tank use in a near urban area. Increased septic tank use, and the possibility of failure, could lead to heightened pollution in near urban areas. Population densities around an urban area may have a greater impact on septic tank pollution in other locations, however, we found that rural areas have the highest optical brightener concentrations. Samples from the "Development Influenced" zone had lower fluorescence than their counterparts taken from the Rural Agricultural zone of both the Nanticoke and Wicomico River (Figure 2, Figure 3).

Increased fluorescence of river water sampled in this zone could indicate septic tank pollution and be the site of future studies or potential remediation. Interestingly, in the Wicomico River, we sampled a third zone, "Natural," where the fluorescence of water samples was similar to that of the "Development Influenced" zone. This zone is largely natural, and with fewer people, it makes sense to see less septic tank pollution. Additionally, the "Natural Zone" is downstream



**FIGURE 4:** Sampling locations on Pocomoke River (top). Fluorescence measurements from samples collected on Pocomoke River (bottom), Wicomico River (bottom), with median represented as horizontal line, mean as “x,” and upper and lower quartiles as vertical lines. Land use zones, Development Influenced (DI), Development in DI (development influenced), RA (rural agriculture), NA (natural), RFW (rural forested wetland).

of the “Rural Agriculture” zone, and may indicate degradation of optical brighteners as they move downstream by sunlight before making it to the following zone. Our results are inconsistent when we include findings from the Pocomoke River. Once again, we found that water collected in less anthropogenically affected zones had fluorescence levels similar to the “Development Influenced” zone on the river. However, the Rural Agricultural zone on the Pocomoke River was less fluorescent than that found in the other zones. Although unclear, these results could be attributed to the sampling locations’ proximity to the mouth of the river, where tidal flushing and width of the river may have caused some level of dilution, contributing to decreased concentrations. Furthermore, the fluorescent readings of samples taken from the Pocomoke River are 2 – 2.5 times that of the other rivers (Figure 4). While the exact reason behind this is not yet understood, it is believed that qualities pertaining to this particular river played a role in these differential data. First, the depth at which the samples were taken. Since all samples were taken at half the depth of the river, and the Pocomoke is generally much deeper than the Nanticoke and Wicomico, samples were taken from further below the surface. Additionally, the Pocomoke River had less transparent water (Secchi disc readings, not published) compared to the other rivers at the time of sampling. The combination of these factors could have



**FIGURE 5:** Results of sunlight exposure experiment.

hindered the photo decay of optical brighteners at the sampling locations, leading to higher fluorescence values. Furthermore, the darker color of the water could be due to dissolved plant matter, which generally have fluorescent excitation and emission wavelengths around 300-400nm, and could inaccurately increase fluorescent values (Mostofa et al, 2012); samples have been stored for future analysis to elucidate this potential confounder. Alternatively, the Pocomoke River could simply be polluted to a higher degree than the other rivers samples.

These results give a relative idea of which parts of each river contain higher levels of optical brighteners and highlight how areas more dependent on septic tanks generally see greater septic tank pollution. It should be noted that all our findings are relative to one another, as there is not currently a way to standardize fluorescence of water samples and compare septic tank pollution across rivers, partly due to differing environmental conditions found in each location. We suggest further study in this topic, across different pH's, temperatures, seasons, depths, etc, so that a sample of river water with a quantified optical brightener fluorescence may be equated to a general level of septic tank pollution. One investigation we performed into understanding the physical properties of optical brighteners was quantifying its breakdown and associated fluorescence in sunlight. We found that fluorescence was held relatively stable while in the dark, however, just 10 minutes of sunlight exposure halved the fluorescence of the sample (Figure 5).

Another consideration when dealing with dissolved particles is the length of time it may

take for those particulates to percolate through the ground, into the water table, and into a river where they can then be identified and/or quantified. While there have not been any studies directly examining the percolation rates of optical brighteners, studies have been done on the percolation rates of varying soil compositions surrounding the Chesapeake Bay. Poorly drained soil, which surrounds the Pocomoke River, has slow percolation rates (United States Soil Conservation Service, 1980). If optical brighteners adsorb to soil particles, perhaps similarly to phosphorus, optical brighteners could build up in the soil. The effect of this process would be to reduce readings of the compound in water samples, and thus, underestimated pollution levels. If this were the case with optical brighteners, potential characterization of septic tank pollution due to optical brightener field levels could be underestimated.

## CONCLUSION

The Chesapeake Bay is an important estuarine ecosystem, providing the Eastern shore of the United States many valuable benefits. However, anthropogenic pollution has had a history of damaging the Bay, interrupting functions previously described. In the United States, septic tank leakage from equipment failure, poor maintenance, and erratic inspections of installed systems is a key source of wastewater pollution (Wear et al., 2021). Human wastewater often contains excess nutrients, pathogens, feces, and detergents. Pollution from human wastewater into waterways has numerous effects on aquatic environments and landscapes in which we live

and has been referred to as a public health crisis (Macintosh et al., 2011; Wear et al., 2021; Withers et al., 2014). We report how optical brighteners can be used to show relative levels of septic tank pollution across a river. Specifically, we found that in the Wicomico and Nanticoke Rivers, "Rural Agriculture" zones have higher incidence of optical brighteners compared to water samples in their respective "Development Influenced" zones. We further displayed the effectiveness of optical brighteners as a pollution indicator, where a decrease in fluorescence was

shown in the Wicomico River's "Natural" zone. Observed optical brightener readings on the Pocomoke River were 2 - 2.5 times higher than on the Wicomico or Nanticoke River, however, due to a lack of study on optical brighteners, we describe how our results may be interpreted. Furthermore, a lack of study on optical brighteners and their relationship to septic tank pollution may be a cause of systematic underestimation of septic tank pollution when conducting future studies. Lastly, although most do, not all detergents contain optical brighteners,

therefore our findings may under-represent real levels of septic tank pollution. We recommend further study into the physical properties of optical brighteners, as well as their ability to detect septic tank leakage. By continuing to enhance our understanding of pollution in Eastern Shore waterways, we will be better apt to propose solutions that will ultimately protect humans and the environment within the Chesapeake Bay region, as well as other watersheds globally.

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# Accessible Restroom in Downtown Salisbury

*Elizabeth A. Wash, Hayden Davis, River Myer*

## ABSTRACT

The lack of accessibility within the United States is a wicked problem that negatively impacts thousands – if not millions – of people daily. Widespread inaccessibility unfairly discriminates against people with disabilities and prevents them from enjoying the same facilities, events, and places as people without disabilities. Downtown Salisbury is a thriving center of business and community activities that connect the Greater Salisbury community through events such as the Folk Festival, 3<sup>rd</sup> Fridays, concerts, and more. The lack of accessible bathrooms in Downtown impacts tourists, residents, business owners, and people with disabilities. As members of the Presidential Citizen Scholars program, we sought to address this institutionalized exclusion through a research study. We have conducted an Institutional Review Board-approved survey over the last several months to gather the wants and needs of the community. Through our data collection, we have partnered with multiple local city and county leaders to help spread the word and bring awareness to this issue. Our survey will close at the end of March, and then the data will be analyzed to be presented to residents and city leaders.

## INSPIRATION

The United Nations “recognizes the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights” (UN Resolution 64/292, 2010). When picking a topic to focus on, the idea of wicked problems became apparent, problems with no true solutions that cannot be measured in the sense of true or false, but rather the feelings of right and wrong (Rittel et al., 1973). Problems of this nature are vast, including homelessness, accessibility, poverty, children’s rights, healthcare, and numerous others. The wicked problem we chose to address during our time with the Presidential Citizens Scholars program was the idea of accessibility. However, no one problem truly stands alone, as they are often intertwined with countless other issues, each as wicked as the last, and we found ourselves confronted with not just accessibility, but homelessness, public safety, the opioid and heroin crisis, and the environment.

Our path to changing the accessibility within our community was brought to our attention by several community leaders, as they all wished for a public restroom. Downtown Salisbury currently does not have an always-available ADA-accessible public restroom that is not attached to another business or establishment. The nonexistent bathroom is an issue, because private businesses do not have to adhere to standards set by the Americans with Disabilities Act and do not have to offer a restroom to the public. Unfortunately, most businesses choose not to provide a restroom to the public in Downtown Salisbury. For those businesses that allow the public to utilize their restrooms, such as Roadie Joe’s and the Public Library, both restrooms are located on the second floor, requiring individuals to travel to the second floor before accessing a restroom. These businesses are also only open at certain

hours each day, leaving Downtown visitors, residents, and tourists without a restroom on weekends, early mornings, and late nights. With countless events occurring in Downtown Salisbury each night and weekend, a publicly accessible restroom is necessary to promote the growth of our community. Every individual should have the basic right to clean and safe sanitation, whether you are someone with a disability, a small child, or enjoying a night on the town. Everyone in our community can benefit from a public restroom in the Downtown Salisbury area.

## BACKGROUND

Public health is vital to establishing a healthy and safe community, with the primary purpose of promoting the health of the individuals living within that community. Access to safe and clean water, but also safe and clean sanitation, are leading determinants of health (Maroko et al., 2021). Safe and clean sanitation is an ideal acknowledged by the United Nations and several advocacy groups, focusing on bringing safe sanitation to every individual worldwide. Public restrooms are of vital importance to bringing safe sanitation to individuals within vulnerable populations and creating a community (Maroko et al., 2021). The private and safe space created by a public restroom can provide individuals with a space to manage menstruation in a clean environment, provide those with greater needs easier access, whether those who have young children or those with disabilities, and return vital aspects of humanity to those suffering from homelessness.

With the current population and size of American cities, there are not enough public restrooms in America, and those that exist remain hard to find (Building the Open Restrooms Movement | Department of Economic

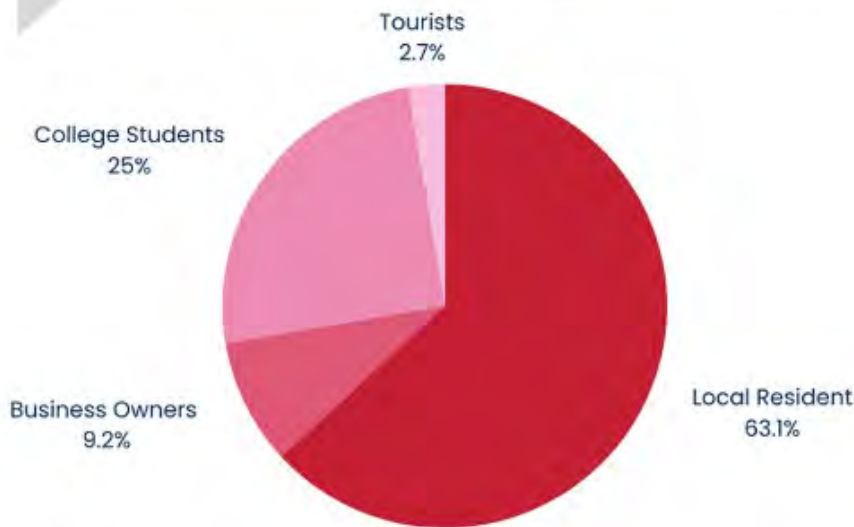
and Social Affairs, 2023). Businesses can deny public access to restrooms and require individuals or groups to purchase items or services to gain access, a strategy that effectively prevents individuals experiencing homelessness or struggling with poverty from being able to access a restroom. The United Nations Department of Economic and Social Affairs Sustainable Development Taskforce has put forth the Building the Open Restrooms Movement, which promotes the recruitment of companies and businesses to address the problem of restroom access (Building the Open Restrooms Movement | Department of Economic and Social Affairs, 2023). Listed as a vital human right, clean sanitation is a problem that needs to be addressed, and Downtown Salisbury can become an example for other American cities by taking a step in the right direction.

## SURVEY

To gauge the community’s interest in adding a public restroom in Downtown Salisbury, we created an Institutional Review Board (IRB) approved survey, protocol 131. This survey was then distributed through flyers and via social media posts on Instagram and Facebook. We received grant funding for 240 dollars to advertise on Instagram to promote the survey to individuals within the Salisbury area. We reached approximately 11,548 people and got 165 direct taps on the post. Flyers were hung around Salisbury University’s campus, Downtown businesses, government buildings, and local restrooms.

The survey was open from the end of October 2022 until the beginning of April 2023 and received over 500 responses from local residents, business owners, college students, and tourists. Once the survey was closed, Dr. James Fox of the Seidel School of Education at Salisbury University assisted in the cleaning of the data. The cleaning

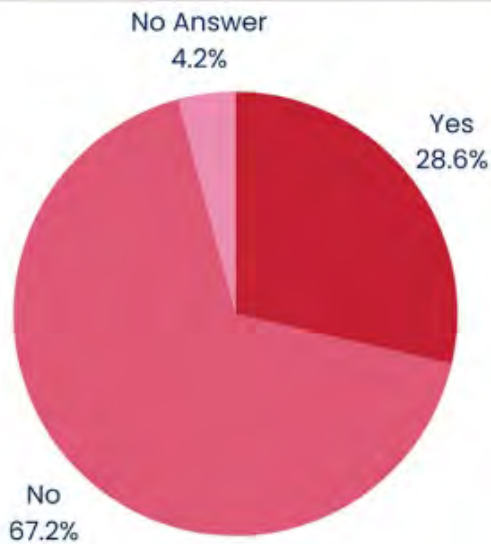
## Overall Demographics



**FIGURE 1 & 2: Overall Demographics and Breakdown of Local Resident Classifications**

We constructed Figures 1 and 2 using Canva with data input after cleaning and receiving results from Qualtrics. The first graph represents the general makeup of demographics, and the second graph demonstrates the breakdown of local residents, as the demographics question allowed for multiple selections of identities.

## Has the absence of an accessible public restroom negatively impacted your visit to Downtown Salisbury?



**Figure 3. Absence of Public Restroom Negative Impact Quantitative Results**

We constructed Figure 3 using Canva with data input after cleaning and receiving the results from Qualtrics. The pie chart displays the percentages of yes, no, and no response quantitative results given to the question analyzing if the absence of a public restroom has resulted in a negative impact.

of the data process included removing any survey responses that did not answer the consent question of being over 18, left survey answers blank or otherwise did not provide complete and comprehensive survey results.

### DEMOGRAPHICS

Based on the over 500 survey responses, 63.1% of responses were those of local residents, 9.2% responses were business owners, 2.7% of

responses were tourists, and 25% of responses were college students. Due to the nature of the survey, individuals could select multiple categories that described them. We observed that out of the overall responses of local residents, 7% stated that they were both local residents and business owners, 5.2% stated that they were both local residents and college students, and 87.9% stated that they were just local residents.

### ABSENCE OF PUBLIC RESTROOM

The survey results indicate that 28.6% of respondents said yes that the absence of an accessible public restroom has negatively impacted their visit to Downtown Salisbury, while 67.2% responded no, and 4.2% did not respond. This specific data suggests that a significant majority of respondents have not had a negative experience in Downtown Salisbury due to the lack of an accessible public restroom. This could be due to most respondents being able to access businesses that allow for public use of their restrooms, a lower response rate of individuals with disabilities and those who are parents of young children, and respondents not spending long amounts of time in the Downtown area.

Based on the qualitative data received through an optional question on the survey allowing respondents to provide feedback, several quotes were received. One of which stated, "When friends with disabilities come to visit, our possible activities can not include Downtown Salisbury or any events there. They have to have access to a restroom." This quote shows that the Downtown Salisbury area is not being utilized to its fullest extent, resulting in a loss of potential revenue to all businesses and events in Downtown. "There are no public restrooms, let alone ADA-accessible ones in downtown, so if I need to use the bathroom, that means I have to leave and will spend less time than I would like in this area." This shows that the current infrastructure of Downtown Salisbury is not accommodating or accessible to the community. Instead, it has caused people to leave the area earlier than they would like to due to a lack of appropriate infrastructure.

### ENHANCE VISITATION

The results of the survey demonstrated that 61.2% of respondents said yes that a public restroom would enhance their visit to Downtown, while 30.9% said no, and 7.9% did not respond. We believe that these results suggest that an accessible public restroom would allow individuals surveyed to have a more pleasant and enjoyable experience within the Downtown Salisbury area, making them more likely to return, increasing the number of patrons for our businesses and restaurants, and

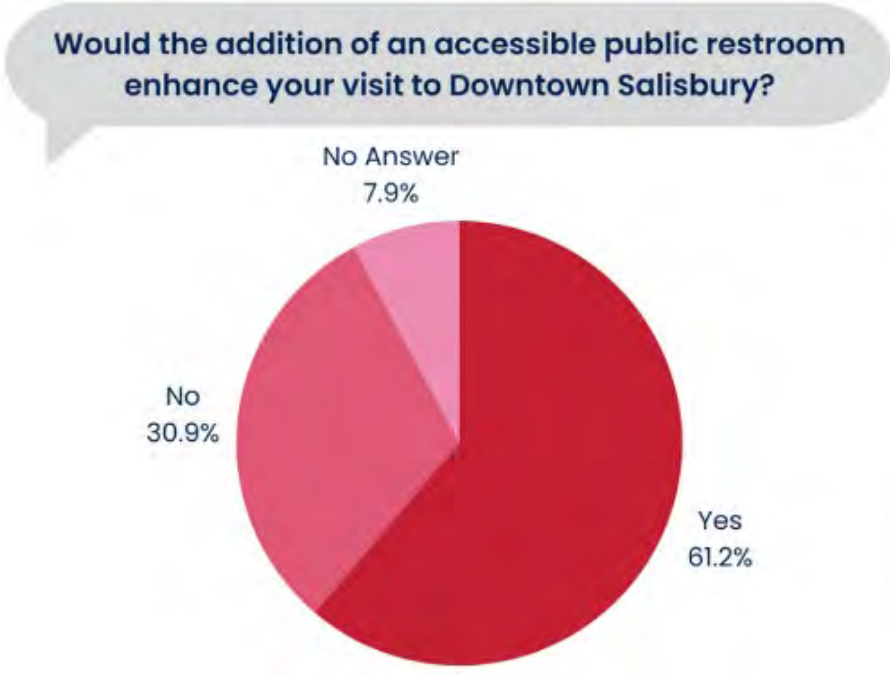
promoting our community growth.

Based on the qualitative data received through an optional question on the survey allowing respondents to provide feedback, the following quotes were received: "Visitors to the downtown area have asked me where a public restroom is available. Always have to answer there is none!" This shows the constant burden that the lack of a public restroom has on business owners, having to disappoint customers and risk losing sales. "I would be able to go places independently rather than relying on an able body person helping with access needs." "Having a place to go will make a world of a difference and reduce anxiety for when you have to go and there's nowhere to go." These quotes show the burden that the lack of a public restroom imposes on individuals within the community, preventing them from enjoying everything that Downtown Salisbury has to offer and the serenity that a public accessible restroom could offer.

### VISITING FREQUENCY

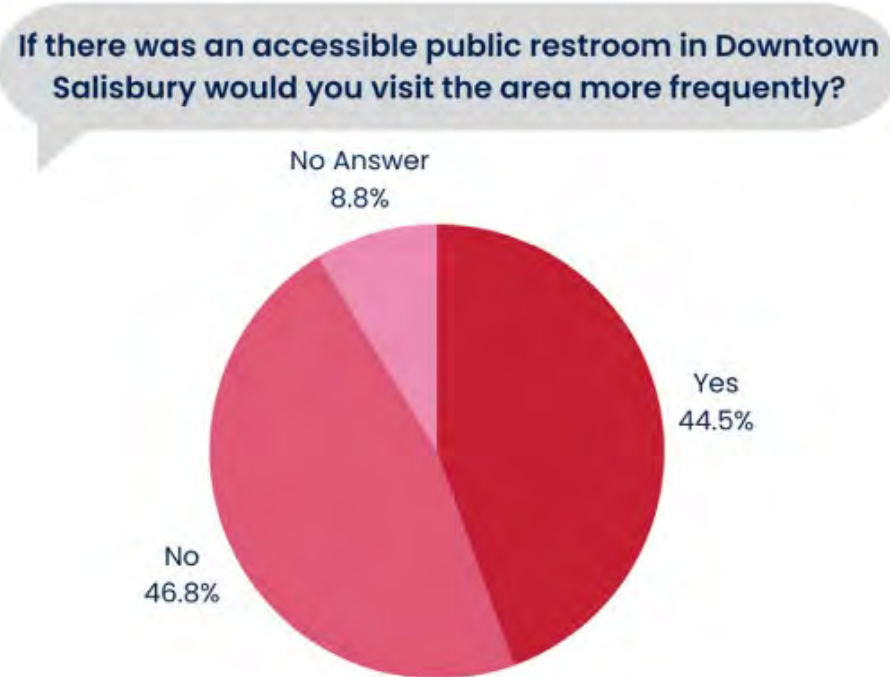
The survey results showed that 44.5% of respondents stated that yes, they would visit the Downtown Salisbury area more frequently with the addition of a public restroom, while 46.8% responded no, and 8.8% did not respond. The survey results suggest a relatively even result of individuals saying that they would attend the Downtown area more frequently and that they would not attend the Downtown area more frequently. We believe the even trend resulted from most local residents being accustomed to the current format of Downtown without public restrooms, some respondents working Downtown and already having a reliable place to use the restroom. For the individuals we described above, the specific addition of a public restroom will not cause them to visit the area with an increased frequency.

Based on the qualitative data received through an optional question on the survey allowing respondents to provide feedback, the following quotes were received: "Sure! I don't go downtown that much, but I think having an accessible restroom would really boost the attendance of event-goers. Parents who bring kids for Treat Street or someone with a disability participating in Third Friday would benefit greatly. I would definitely encourage more people to visit downtown if it was more accessible." This quote emphasizes community support of the idea that it may not impact each individual's visitation frequency, but the overall attendance of events could be increased and individuals are more likely to promote events to family and friends if they



**Figure 4. Public Restroom Enhance Visitation Quantitative Results**

We constructed Figure 4 using Canva with data input after cleaning and receiving the results from Qualtrics. The pie chart displays the percentages of yes, no, and no response quantitative results given to the question analyzing if a public restroom would enhance one's visit to the Downtown Salisbury area.



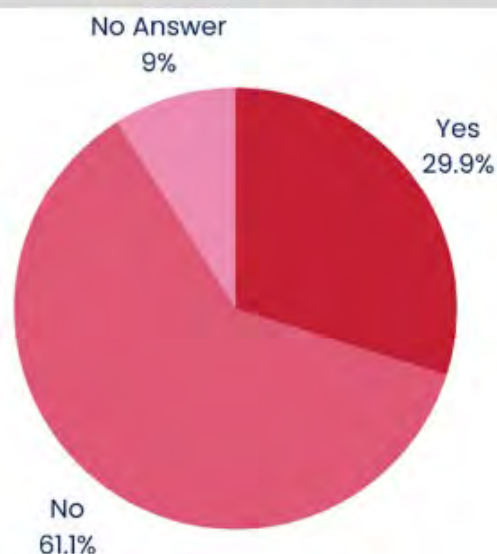
**Figure 5. Visiting Frequency Due to Public Restroom Quantitative Results**

We constructed Figure 5 using Canva with data input after cleaning and receiving the results from Qualtrics. The pie chart displays the percentages of yes, no, and no response quantitative results given to the question analyzing if a public restroom would increase visiting frequency to the Downtown Salisbury area.

knew it was accessible. "I would attend the third Friday events more frequently. I would be more inclined to attend music events, etc., knowing there was a public facility. I would stay longer at

events." This example directly correlates to those individuals who replied yes that they would visit the Downtown area more frequently, and also provided insight that they would stay longer

**Do you have any concerns if an accessible public restroom were to be added to Downtown Salisbury?**



**Figure 6. Concerns Regarding Public Restroom Quantitative Results**

We constructed Figure 6 using Canva with data input after cleaning and receiving the results from Qualtrics. The pie chart displays the percentages of yes, no, and no response quantitative results given to the question analyzing if the population has any concerns about the installation of a public restroom in Downtown Salisbury.

within the area, as they would not be fearful of having to use the bathroom if there was an accessible public restroom available to use.

**CONCERNS**

The survey results indicate that 29.9% of respondents stated that yes, they had concerns if an accessible restroom was added to Downtown Salisbury, while 61.1% of respondents stated no, and 9% of respondents did not respond. One example of a comment received in the survey was, "It would need to be properly monitored if it was implemented. I feel like it could become a nuisance if not properly monitored." As shown below, 29.9% of respondents were concerned about adding a public ADA-accessible restroom in Downtown Salisbury. Of this 29.9%, many of the qualitative concerns communicated through the survey leaned toward an expression of negative bias toward homelessness and drug abuse. We do not believe these concerns should discourage the city from installing a publicly accessible restroom.

A few examples of bias against those experiencing homelessness and drug abuse are: "Who will keep it clean? Concerned about safety in there. Will it just be used for drug deals/hits and the homeless population." "We have a huge

homeless population that would render these unusable." There is no data or suggestions from the two locations currently providing Downtown with a restroom during operating hours that the unhoused population is causing any issues or interfering with the restrooms, suggesting that the community has a pre-existing bias toward members of the unhoused population.

**SOLUTIONS**

To address the potential issues of drug use within the restroom, we do not propose using blue light bulbs in the restroom, as while the initial purpose of blue lights is to deter drug use, many drug users would still attempt to inject in a blue-lit restroom, making injecting more dangerous (Crabtree et al., 2013). We propose the implementation of several needle drop-off locations within the Downtown area. For violence and security, we suggest hourly police patrol, security cameras, programmable electric locks, and spotlights outside the restrooms.

For concerns with the unhoused population, we suggest offering vocational opportunities to become a sanitation worker through American Jobs Center or work for educational credits at local colleges/universities. As a general safety measure, we also suggest the installation of smoke detectors.

**LOCATIONS FOR INSTALLATION**

We suggest several possible locations to install the public restroom, the main one being the old courthouse location, previously the home of segregated restrooms. The courthouse is a prime location, as it already has water and sewer lines present. We also suggest the restrooms are single-use, genderless, and incorporate both a baby changing station and an adult changing station to accommodate all needs. Our final suggestion is to create a commemorative plaque to acknowledge the history of segregation at the old courthouse and turn a once-exclusive landmark into an inclusive one. The community could object to this location due to the history surrounding the area, as well as the potential need for renovation. While there are water lines and sewer lines, renovations are required to account for accessible purposes, such as changing tables for adults and children, pull up bars, automatic sinks, etc.

Other locations suggested were to include the restroom in the creation of Unity Square, a new town center that is currently being worked on by developers and stakeholders within the Downtown area. Standalone restroom locations could also be created and placed near the City of Salisbury Government building, on the corner of Together Cafe, or outside of the Wicomico County Health Department. There are numerous locations where an accessible public restroom can be placed within the Downtown Salisbury area, and after speaking with business owners, tourists, and local residents, there is a deep desire for an accessible public restroom within the community.

**PORTA POTTIE PRICE ANALYSIS**

The businesses within Downtown Salisbury do not open their bathrooms to the public during events such as the Folk Festival, concerts, or parades. This forces those participating in events to either not use the restroom during their entire visit or cut their visit early to find a restroom for themselves or other members of their party. This puts pressure on individuals hosting various events to rent Porta Potties to provide a place for individuals to safely use the restroom. However, the costs of renting Porta Potties can quickly add up for any individual event planner.

In 2021, one event planner spent over \$6,000 on Porta Potties across all their events (J. Heater, personal communication, 2022). This amount does not account for the price paid by all other event planners or from individual events that occurred Downtown. The typical range for Porta Potties is \$75 - \$100 per day, with accessible ones ranging from \$125 - \$150 per day, and hand washing stations ranging

from \$125 - \$150 per day. Typically, 2 - 4 Porta Potties are needed for small to medium events, and 40 - 50 Porta Potties are needed for large events. These prices can significantly add up and prevent smaller groups from hosting events in the Downtown area.

The creation of a publicly accessible restroom would solve the issue of not being able to find a restroom in Downtown Salisbury, as well as allow smaller committees and organizations to host events within Downtown, as the cost associated with the rental of Porta Potties would no longer be a financial concern. Small committees would not have to allocate portions of their budget to directly pay for Porta Potties and, instead, spend

more money on the events themselves. Public restrooms would be beneficial during Third Friday events, allowing small business owners to avoid leaving their table or goods for large periods of time to try and track down a Porta Pottie that could have a long wait time and not meet their accessibility needs, but could instead use the public accessible restroom, that would ensure that all of their needs are met in a timely manner.

**CONCLUSION**

In conclusion, the Downtown Salisbury area could benefit from the creation and installation of a public restroom. With letters of support

(included below) from developers, county leaders, and city leaders, and over 500 survey results, our results further our mission and goal of our research to prove the dire need for a public restroom in the Downtown Salisbury community. As we conclude over three semesters of work dedicated to the Downtown Salisbury community and the creation of an always-available ADA-accessible public restroom, we urge the city and community leaders to consider the data and wants of the community, and proceed with the installation of a public always-available ADA-accessible public restroom.

**ADDITIONAL FIGURES**



**Figure 7. Letter of Support from Jacob R. Day**  
Letter of Support from former Mayor of the City of Salisbury and current Secretary of Housing and Community Development for the State of Maryland. Our project also received support from Jack Heath, former City Council President and current Mayor of the City of Salisbury.



**Figure 8. Letter of Support from Joseph Gilkerson**  
Letter of Support from the Principal at Gillis Gilkerson Development Company and NAI Coastal Commercial Real Estate, and Commercial Real Estate Development Specialist in the Mid-Atlantic Region, a prominent developer in the Salisbury Area, showing support for this research.



**Figure 9. Letter of Support from Jaime Riley**

Letter of Support from the Director of Wicomico County's Local Management Board and the Wicomico Partnership for Families and Children, providing context for the support of Wicomico County in favor of this research.

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## ACKNOWLEDGMENTS

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# Trace Metal Concentration in Sediment from Two Chesapeake Bay Tributaries, the Wicomico and Nanticoke Rivers

Samantha Peters, Julia Frankis and Katherine R. Miller

## ABSTRACT

Sediment can serve as a sink for potentially toxic trace metals that enter waterways through a variety of anthropogenic and geochemical sources. In 1998, a study conducted by Gupta and Karupiah used dated sediment cores from the Wicomico River to find that the trace metal concentrations increased during the years 1966-1995.<sup>1</sup> The aim of this new study is to quantify the total metal concentration of copper, lead, and zinc in sediment collected from sites on the Wicomico and Nanticoke Rivers. Sediment samples were digested in nitric acid solution to extract the metals which were quantified using flame atomic absorption spectrometry (AAS). Sediment samples collected in this study from the Wicomico River showed a decrease in concentration in comparison to the data collected from 1966 to 1995. Even though these concentrations have decreased from the previous study, most samples showed moderate to significant enrichment, suggesting anthropogenic input. Potential sources of metals in the Wicomico River include ship building or barges, agricultural practices, and wastewater discharge. There was large variability in the enrichment factors determined for sediment collected from the Nanticoke River, but overall, they suggest anthropogenic inputs such as poultry processing, agricultural practices, and wastewater discharge. For both rivers, the concentrations of copper, lead, and zinc decrease as sampling sites progress further downstream, suggesting upstream sources. There were no consistent correlations between the metals for either river, indicating that the metals likely originate from different sources.

## INTRODUCTION

Sediment is an integral component of most aquatic environments and can be used to determine the extent and source of metal pollution.<sup>2</sup> Metals can enter waterways through natural sources which include geological weathering, soil erosion, and airborne dust.<sup>3,4,5</sup> These natural sources produce low background concentrations of metals. Metal concentrations greater than the expected background usually results from anthropogenic, or human influenced, activity. Such samples are considered enriched and are indicative of polluted sediment. Enrichments can be attributed to anthropogenic sources, many of which are associated with industrial and agricultural practices, as well as effluent from domestic sewage treatment plants.<sup>1,5</sup> Zinc (Zn) is most commonly seen from the run-off of fertilizer application; additionally, some fertilizers also contain copper (Cu).<sup>3,4,6</sup> Enriched copper concentrations are often seen close to marinas because copper (I) oxide is one of the active ingredients in antifouling paint used to prevent growth of organisms on the underside of boats.<sup>4,6,7</sup> Lead (Pb) is seen in the discharge of wastewater and atmospheric emissions of a variety of industries. The atmospheric deposition can introduce contaminant particles on a regional to global scale.<sup>4</sup>

Naturally occurring decomposition processes cannot effectively remove metals that enter waterways. The sediment acts as a sink or storage compartment for metals leading to an accumulation.<sup>2</sup> The primary component of sediment is the relatively uniform aluminosilicate matrix, containing Al, Fe, K, Mg, Mn, and Si.<sup>8</sup> These crustal elements are

found within the silicate outer shell of the earth. Other metals that are not found within the aluminosilicate matrix, such as Cu, Pb, and Zn, are considered trace metals.<sup>9</sup> The enrichment of trace metals, or their enrichment factor, can be determined using **Equation 1**. The trace metal concentration is normalized against the concentration of a crustal element, commonly Fe or Al. The concentration of these metals should remain fairly uniform throughout the study area.<sup>8</sup> For this study, Fe was chosen due to availability of laboratory resources. Additionally, Conrad et al. reported that Fe may be a better predictor than Al given that Fe has a uniform natural concentration in sediment.<sup>10</sup> An enrichment factor close to one indicates the trace metals likely originate from natural sources. Small, nonsignificant enrichments can arise due to differences in soil composition between the sample and the values chosen for the concentration of trace metals in the crust. Ideally, local crustal measurements should be used in enrichment factor calculations; however, if these values are not available, global crustal values can be used instead. Significant enrichments, greater than an enrichment factor of 5, can be attributed to anthropogenic sources.<sup>8</sup>

Once metals enter the aquatic environment, they exist as either free metal ions or are adsorbed to particulate matter.<sup>11</sup> Once adsorbed, the complexes settle through the process of sedimentation.<sup>2</sup> The specific behavior of the metals depends on properties of the water column: pH, dissolved oxygen, and nutrient concentration.<sup>12,13</sup> The behavior of metals can also be modified by sediment composition.<sup>12</sup> There is an equilibrium that exists between the sediment and the overlying water. A change in water chemistry such as pH or redox potential can cause remobilization of metals.<sup>11,15</sup> Upon remobilization, sediment can be classified as a secondary source of pollution. Remobilization increases the bioavailability of the metals and therefore increases the risk to aquatic life and the entire food chain. Many metals possess the ability to bioaccumulate in aquatic organisms through incorporation into soft tissue.<sup>16</sup>

There exists no explicit guideline for the maximum allowable concentration of metals in sediment; therefore, the EPA guidelines for metals in drinking water can be used to emphasize biological toxicity. Zinc is not identified as a drinking water contaminant. The maximum contamination level goal (MCLG) for copper is 1.3 ppm.<sup>18</sup> Short term exposure to excessive copper concentrations can lead to gastrointestinal distress in humans, while long term exposure can result in damage to the liver and kidneys. The MCLG for lead is 0 ppm, so the presence of any lead is considered toxic.<sup>17,18</sup> In adults, long-term lead exposure can increase blood pressure and kidney issues. Adverse effects are increased in children where lead exposure can cause irreversible neurological damage

$$EF = \frac{\frac{[M]_{\text{sample}}}{[Fe]_{\text{sample}}}}{\frac{[M]_{\text{crust}}}{[Fe]_{\text{crust}}}}$$

**Equation 1.** Enrichment Factor Determination

**Table 1. Metal Concentrations in the Wicomico River Determined Gupta and Karuppiah<sup>1</sup>**

Depth (cm) (estimated period-yr)	Zn		Pb		Cu	
	Sediment	Pore water	Sediment	Pore water	Sediment	Pore water
<i>Wicomico River (WR2)</i>						
0–7.5 (1986–1995)	90.75 <sup>a</sup>	9.91 <sup>a</sup>	18.01 <sup>a</sup>	5.12 <sup>a</sup>	5.23 <sup>a</sup>	0.039 <sup>a</sup>
7.5–15.0 (1976–1985)	72.16 <sup>b</sup>	9.50 <sup>b</sup>	7.60 <sup>b</sup>	0.54 <sup>b</sup>	4.30 <sup>b</sup>	0.028 <sup>b</sup>
15.0–23.0 (1966–1975)	63.75 <sup>c</sup>	1.85 <sup>c</sup>	7.43 <sup>b</sup>	0.42 <sup>c</sup>	3.73 <sup>b</sup>	0.022 <sup>c</sup>

\*Metal concentrations in ppm shown here were extracted from Table 3 in Gupta, G.; Karuppiah, M. Chronological changes in toxicity of and heavy metals in sediments of two Chesapeake Bay tributaries. 1998, 59, 159-166.

that leads to behavioral changes, and, at high enough levels, can be fatal.<sup>17,18</sup> Since copper and lead possess the ability to bioaccumulate, they can be passed up the trophic levels of a food chain. These metals pose a threat to not only the organism itself, but to the potential consumer once harvested.<sup>19</sup> In Maryland and Virginia, the Chesapeake Bay generates nearly 500 million pounds of seafood annually.<sup>20</sup>

The Wicomico and the Nanticoke Rivers are tributaries of the Chesapeake Bay, therefore any sediment they transport ends up in the Bay. A study was conducted by Gupta and Karuppiah in 1998 to determine the concentration of five EPA priority pollutants- Cu, Pb, Zn, As, and Cd- in sediment collected on the Wicomico and Pocomoke Rivers. Using dated sediment core analysis, they estimated concentrations for three ten-year periods from 1966-1995 (Table 1). Data collected for the years 1966 to 1975 served as the baseline, since it had the lowest calculated toxicity. In the period from 1976-1985, the relative increase in Zn concentration was reported as 414%. Gupta and Karuppiah noted an increase in industrial activity from ship building and barges during this period, as well as domestic wastes, non-process wastewaters, and storm runoff as potential sources of Zn to the Wicomico River. For the period 1986-1995 there was a 137% increase in the Pb concentration. Based on their communications with the City of Salisbury Wastewater Treatment Plant, Gupta and Karuppiah attributed the increase in Pb and Cd concentration to metal fabrication and finishing, the food industry, poultry processing, water treatment, plastic, and pharmaceuticals. There was a less dramatic increase seen in the Cu concentration and they indicated poultry litter, herbicide, and fertilizer as potential sources of copper. Overall, Gupta and Karuppiah found

increasing metal concentration and toxicity over a thirty-year period. The municipal sewage treatment plan was identified as the greatest

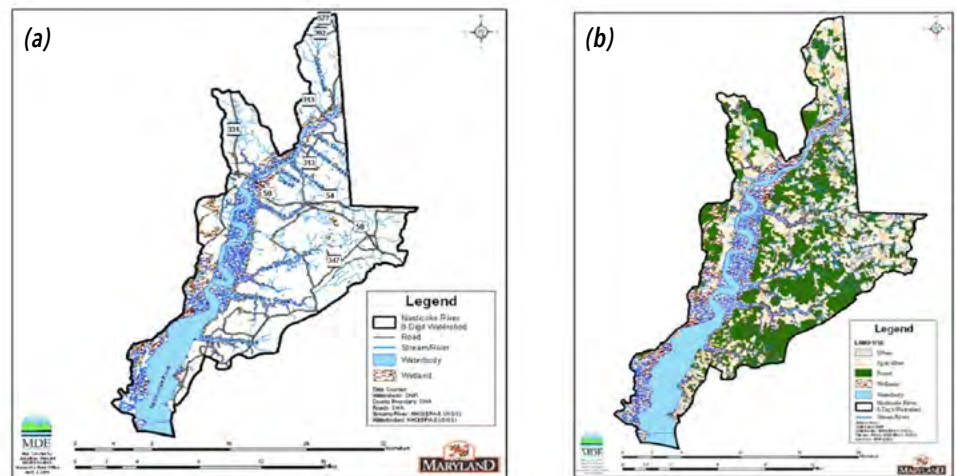
source of metal contamination in the Wicomico River.<sup>1</sup>

In this study, we collected new sediment samples to determine the total concentration of copper, lead, zinc, and iron in sites along the Wicomico and Nanticoke Rivers. Enrichment factor calculations and statistical analyses were utilized to determine the level of metal contamination.

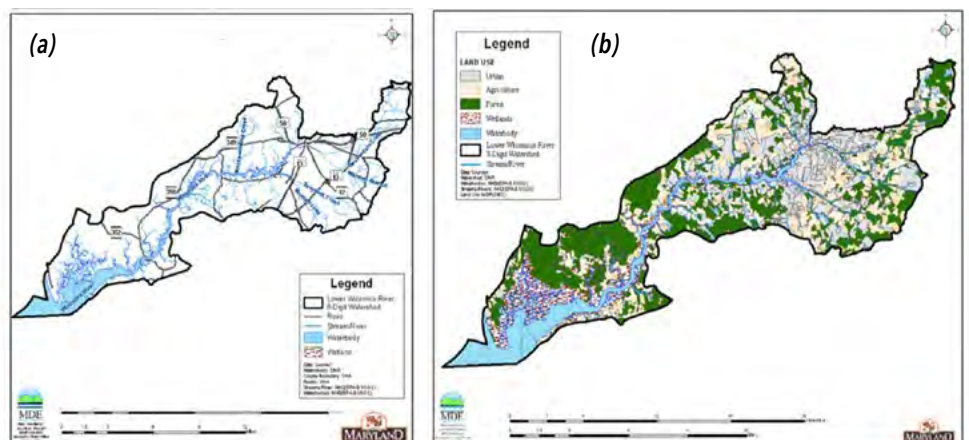
## METHODS

### 2.1 SAMPLING AREA

The Nanticoke River watershed drains approximately 800 square miles as seen in Figure 1a. Over 88 miles in length, the river's head is in Sussex County, Delaware. It then traverses west into Maryland to form a border between Dorchester and Wicomico Counties, and ultimately ends up emptying into the Chesapeake Bay. The land use can be broken down into three categories: forest, agricultural,



**Figure 1. Location and Land Use Maps of the Nanticoke River Watershed.** (a) Location map of the Nanticoke River Watershed (b) Land use map of the Nanticoke River Watershed. Figures obtained from Maryland Department of the Environment report (2014).



**Figure 2. Location and Land Use Maps of the Lower Wicomico River Watershed.** (a) Location map of the Lower Wicomico River Watershed, (b) Land use map of the Lower Wicomico River Watershed. Figures obtained from Maryland Department of the Environment report (2014).

and urban (Figure 1b). The land use of the watershed is 61% forest. There are large plots of forest, specifically pine plantations used for the production of fiber for paper manufacturing. The next largest portion of land use is agricultural, comprising 30% of the watershed. The primary modes of agriculture, poultry production and grain crops, have known associated risks for water quality. Poultry production generates large amounts of animal waste with limited means of disposal and the runoff from the use of manure, or animal waste, has previously impaired water quality.<sup>21</sup>

The sampling sites chosen were found within the Lower Wicomico River watershed. The watershed is approximately 19 miles in length containing two large urban areas, Salisbury and Fruitland, Maryland, and its confluence is seen with the Monie Bay in Somerset County, Maryland. Overall, the watershed drains an area of approximately 73,000 acres as seen in Figure 2a. Similar to the Nanticoke River watershed, the land use of the Lower Wicomico River watershed is broken into forest, agriculture, and urban. Depicted in Figure 2b, the largest portion is forested land which makes up 49% of the watershed. Urban land is responsible for 31% of land use with 7% being attributed to impervious surfaces. In the past several decades there have been two distinct stages of urban development. The first stage of development was at the expense of wetlands and forested land. The next stage of development was seen using previously agricultural land that now comprises only 20% of the Lower Wicomico River watershed.<sup>22</sup>



**Figure 3:** Map of sampling sites in Wicomico County, Maryland. Samples were collected along the Wicomico River at Pemberton Park in Salisbury Maryland at 3 sites (see inset) and at Whitehaven Ferry. Samples were collected at three sites along the Nanticoke River at Wetipquin Park, Tyaskin Wharf and Cove Road Beach. Map was created using information from Google Maps

**Table 2.** Flame Atomic Absorption Spectrometer Settings<sup>23</sup>

	Copper	Lead	Zinc	Iron
Wavelength (nm)	324.8	217.0	213.9	248.3
Sensitivity (ppm)	0.077	0.19	0.018	0.10
Linear Range (ppm)	5.0	20.0	1.0	5.0

## 2.2 SAMPLING SITES

There were four sites along the Wicomico River. One site was located at the Whitehaven Lower Ferry and the three other sites were located in Pemberton Park. There were three sites chosen at publicly accessible parks along the Nanticoke River: Wetipquin Park, Tyaskin Wharf, and Cove Road Beach.

## 2.3 SAMPLE COLLECTION

Sediment samples, approximately 0-3 inches in depth, were collected approximately three feet from shore with 50 mL conical tubes. The conical tube was inserted into the water with the lid off and then manually dug into the sediment. The lid was returned to the conical tube at sediment level before removal from the water. Samples were refrigerated awaiting sample preparation.

## 2.4 SAMPLE PREPARATION

All glassware used for sample preparation was acid-washed using 3M HCl. Each sample was transferred to a funnel lined with a Whatman Ashless Filter Paper and rinsed with deionized water before being transferred to a glass dish

and dried overnight at 60°C. After drying, the mass of sediment was recorded. A small amount of deionized water was added to the sediment to obtain a slurry. The slurry was then reacted with a 5:1 v/v solution of concentrated nitric acid and 30% hydrogen peroxide while cooling the reaction on ice. A ratio of 0.0903 mL of nitric acid solution per gram of sediment was required to achieve a reaction pH of 2. The reaction was stirred and left to react overnight. The pH was checked the following day. If the pH was greater than 2.0, more nitric acid solution was added dropwise until the digestion reached a pH of 2.0. The digested sample was filtered using Whatman Ashless Filter Paper. The filtrate was then filtered a second time using a Thermo Scientific 0.22 µm syringe filter into a 50 mL volumetric flask. A couple drops of HCl were added to the resulting solution before it was diluted to the mark with deionized water. The acidic environment was confirmed using pH strips. The samples were then stored in 50 mL conical tubes.

## 2.5 SAMPLE ANALYSIS

The metal concentrations were measured using a Thermo Scientific iCE 3000 series atomic absorption spectrometer. A standard curve of the metal of interest was run before the analysis of each set of samples. The concentration ranges were chosen based on the range of linearity reported for the instrument (Table 2). All standards were prepared from AAS standard solutions. The standards for copper, lead, and iron had concentration ranges of 0, 2, 4, 6, 8, and 10 ppm. Zinc standards had a concentration range of 0, 0.2, 0.4, 0.6, 0.8, 1.0, 2, and 4 ppm and were prepared in 0.1 M HCl.

Samples whose absorbance measurement appeared outside the range of the standard curve were diluted at a ratio of 1:10, 1:25, or 1:50. The dilution ratio was determined based off the initial measurement of the undiluted solution and the range of linearity for the standard curve. The linear range for each element, as well as the wavelength of the light source and sensitivity are defined in Table 2 below.

## 2.6 DATA ANALYSIS

The enrichment factor (EF) for trace metals

**Table 3. Scale for Enrichment Factor Evaluation<sup>4,14</sup>**

Enrichment Factor Range	Classification
<2	Enrichment Deficient
2-5	Moderate Enrichment
5-20	Significant Enrichment
20-40	Very High Enrichment
>40	Extremely High Enrichment

**Table 4. Average Metal Concentration in Sediment from the Wicomico and Nanticoke Rivers**

	Copper Concentration (ppm)	Lead Concentration (ppm)	Zinc Concentration (ppm)
Wicomico River Sites			
Pemberton Park Site 1	5.256 ± 0.969	14.36 ± 1.65	41.37 ± 6.95
Pemberton Park Site 2	2.776 ± 0.604	4.210 ± 1.187	22.72 ± 2.10
Pemberton Park Site 3	3.424 ± 2.829	2.752 ± 1.742	7.683 ± 5.691
Whitehaven Lower Ferry	0.8208 ± 0.1436	3.835 ± 0.849	2.205 ± 1.123
Nanticoke River Sites			
Wetipquin Park <sup>a</sup>	1.378	10.51	4.445
Tyaskin Wharf	1.134 ± 0.241	2.084 ± 1.054	1.937 ± 1.206
Cove Road Beach	ND	0.2304 ± 0.0403	0.2705 ± 0.1832

<sup>a</sup> Average of two samples ND - not detected

can be determined using Equation 1, where S corresponds to sample value and Cr corresponds to global average crustal values. The crustal values utilized for Cu, Pb, and Zn were 25 ppm, 20 ppm, and 71 ppm respectively.<sup>24</sup> The concentration of Fe was reported as 4.5 wt% FeO, which converted into 3.5x10<sup>4</sup> ppm Fe.<sup>24</sup> For each site, the ratio of concentration for metal of interest to iron concentration in each sample was averaged and the final enrichment factor was determined using this value. The enrichment factors were then evaluated according to Table 3.

To determine correlation between Cu, Pb, and Zn at each site, a Pearson correlation analysis was performed using a two tailed significant test on OriginLab program with a statistical significance of P < 0.05.

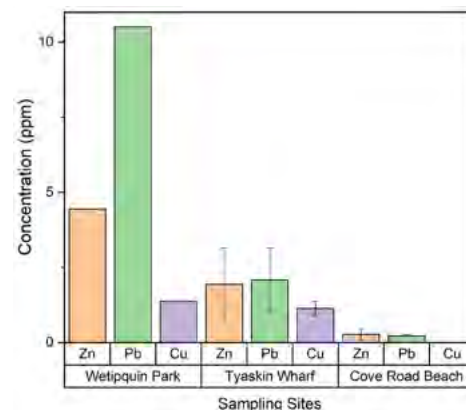
### RESULTS AND DISCUSSION

Table 4 lists the average metal concentration for each site. For the period of 1986-1995, Gupta and Karuppiyah found that the average concentration of copper in the Wicomico River was 5.23 ppm (Table 1); the copper concentration at Pemberton Park Site 1 is consistent with their results, but the concentration at the three other sampling sites along the Wicomico River showed a decrease in concentration. The average lead concentration at Pemberton Park Site 1 decreased slightly in comparison to Gupta and Karuppiyah's results and showed greater decrease for the three sampling sites farther downstream. The average zinc concentration also demonstrated a similar trend. There was an overall decline in trace metal concentration in

the Wicomico River since the study conducted by Gupta and Karuppiyah. The observed trend of chronologically increasing concentrations recorded by Gupta and Karuppiyah has appeared to stop, but a greater number of samples at a variety of sites on the Wicomico River should be collected to increase accuracy of results.

Standard deviation and the relative standard deviation (%RSD) provide insight to sample homogeneity. The smaller the standard deviation and %RSD, the more homogenous the samples collected at the site were. For example, for Pemberton site 1 the %RSD for copper is 18%, for lead is 11% and for zinc is 17%. These lower values represent moderately homogenous sediment. For comparison, the %RSDs for Pemberton Site 3 were found to be 83% for copper, 63% for lead and 74% for zinc. These much larger values suggest greater heterogeneity. Generally, sediment is more heterogenous in nature so larger standard deviations are expected. The increased heterogeneity results from differing mineral composition of sediment as well as uneven dispersal in transportation. Different minerals differ in the trace metals which bind, therefore the change in mass and density of the particulate matter leads to a non-uniform dispersal. Various other factors including tidal variation, erosion, or accretion result in increased heterogeneity of the sediment.<sup>25</sup>

Figure 4 depicts the trends in metal concentration between the sampling sites along the Nanticoke River. The greatest concentrations of zinc, lead, and copper were observed at Wetipquin Park, the most upstream sampling site on the Nanticoke River. Progressing further downstream to Tyaskin Wharf, the concentration of zinc, lead, and copper all decrease in comparison to Wetipquin. There is another decrease seen in all three metal

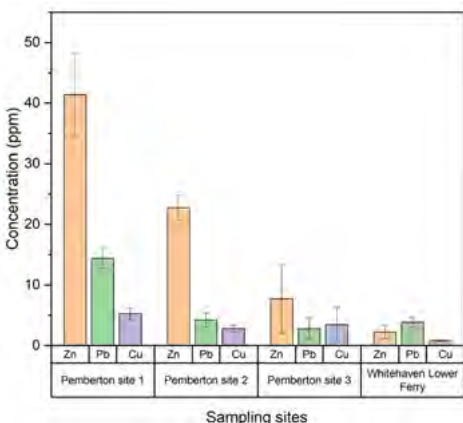


**Figure 4. Average Concentration of Zn, Cu, and Pb on the Nanticoke River.** Concentrations were calculated based on standard curves run prior to measurement. Wetipquin Park values are an average of two samples so no standard deviation can be calculated.

concentrations progressing further downstream to Cove Road Beach. The subsequent decreases in concentrations while progressing downstream could potentially indicate sources of metal contamination originated upstream. As the current travels downstream, metals are dispersed and immobilized in the sediment, decreasing the concentration available for accumulation at later sites.

A Pearson's correlation analysis was performed on the concentration of copper, lead, and zinc in all samples by each sampling site. Wetipquin was omitted from the correlation analysis because data from only two samples was available for analysis. There was no statistically significant correlation seen between the metal concentrations at both Tyaskin Wharf and Cove Road Beach. There was no determined correlation between metal concentrations in the Nanticoke River.

The enrichment factors appear to vary greatly between sites along the Nanticoke River. Overall, the lowest enrichment factors were observed at Cove Road Beach where zinc was found so low it can potentially be attributed to natural sources. The concentration of lead at Cove Road Beach was determined to have a significant enrichment indicative of anthropogenic sources of metal. For Tyaskin Wharf, the zinc concentration was on the border of significant and very high enrichment. The copper and lead concentrations were classified as extremely high enrichment. Agricultural land composes a significant portion of land use in the Nanticoke River Watershed. The practices of poultry production and the use of livestock manure as fertilizer could have increased concentrations of zinc in the Nanticoke River through groundwater leaching or stormwater runoff.<sup>3,21</sup> Synthetic fertilizer application could potentially introduce copper and/or zinc into the waterway.<sup>3,4</sup> Lead and copper enrichment can also be attributed to



**Figure 5. Average Concentration of Zn, Cu, and Pb on the Wicomico River.** Concentrations were calculated based on standard curves run prior to measurement.

**Table 5. Results of Pearson's Correlation Analysis Performed on Concentrations from Whitehaven Lower Ferry**

		[Lead]	[Zinc]	[Copper]
[Lead]	Person Corr.	1	-0.79798	0.99088
	p-value	-----	0.20202	0.00912
[Zinc]	Person Corr.	-0.79798	1	-0.75512
	p-value	0.20202	-----	0.24488
[Copper]	Person Corr.	0.99088	-0.75512	1
	p-value	0.00912	0.24488	-----

**Table 6. Enrichment factors for sediment from the Wicomico River**

	Copper	Lead	Zinc	n
Pemberton Park Site 1	2.0 (11%)	7.0 (8.5%)	5.7 (17%)	3
Pemberton Park Site 2	2.3 (33%)	4.2 (21%)	6.7 (22%)	5
Pemberton Park Site 3	5.7 (100%)	6.8 (120%)	3.7 (28%)	5
Whitehaven Lower Ferry	9.0 (90%)	54 (95%)	7.2 (79%)	4

\* Percent RSD reported in parenthesis to two significant figures

wastewater discharge, byproducts of the metal plating industry, and atmospheric deposition.<sup>1, 3,4</sup> Because of the high variability in enrichment observed, more testing along the Nanticoke River, with a greater number of samples collected at each site, is necessary to draw any strong conclusions.

In **Figure 5**, the most upstream site appears first, and the following sites are listed as they progress downstream. Overall, the concentrations of zinc, lead, and copper were greatest at the most upstream site, Pemberton Park Site 1. The concentrations of lead and copper are decreased downstream, but do not follow a stepwise pattern. A stepwise pattern would strengthen the indication of an upstream source of copper and lead, the greatest concentrations would be seen closest to the source and decrease progressing downstream as the sediment sequesters the metal.

The average concentration of copper increases from Pemberton Park Site 2 to Site 3, and the concentration of lead is seen increasing from Pemberton Site 3 to the farthest downstream site at Whitehaven Lower Ferry. Since the concentrations overall greatly decrease from the farthest upstream site, it suggests the presence of a source upstream.

A Pearson's correlation analysis was performed on the concentrations at each site along the Wicomico River. As seen in **Table 5**, the only statistically significant correlation was seen between lead and copper at Whitehaven Lower Ferry with a p-value of 0.00912. The Pearson correlation coefficient was determined to be 0.99088, indicating a very high correlation

between the metal concentrations. A strong positive correlation suggests a common source of copper and lead. The mutual dependence between the metals can also indicate similar behavior of copper and lead during transport.<sup>14</sup> Since no other statistically significant correlations were determined, the mutual dependence is applicable to only the one site along the Wicomico River.

**Table 6** summarizes the enrichment factors calculated for each sample site along the Wicomico River. The enrichment factor for copper at Pemberton Park Site 1 bordered between enrichment deficient and moderate enrichment suggesting a naturally occurring source of copper. The enrichment of copper and lead at Pemberton Park Site 2 and the enrichment of zinc at Pemberton Park Site 3 were found to have moderate enrichment. As these values are below the threshold of significant enrichment the source could potentially be attributed to natural sources or a minor anthropogenic input. The majority of samples along the Wicomico River were determined to have significant enrichment indicating an anthropogenic source of the metals. With an enrichment factor of 54, the concentration of lead at the Whitehaven Lower Ferry was classified as extremely high. The sampling site for the Whitehaven Lower Ferry is a common fishing spot, therefore the enrichment could arise from use of lead fishing weights. Increased levels of copper and zinc can arise from fertilizer application, leaching of antifouling paint, and livestock manure, such as poultry litter, as identified by Gupta and Karupiah in their analysis.<sup>1,3,4</sup> They also suggested that increased

zinc concentrations could be attributed to ship building and barges, wastewater, or storm runoff.<sup>1</sup> Previous lead enrichments were potentially attributed to metal fabrication and finishing, poultry processing, and water treatment. Additionally, the emission into the atmosphere from various industrial processes can introduce lead on a regional to global scale through atmospheric deposition.<sup>4</sup>

## CONCLUSION

Sediment collected from the Wicomico and Nanticoke Rivers was analyzed to determine trace metal concentration. The majority of the sampling sites had moderate heterogeneity as indicated by the modest standard deviations. This level of heterogeneity was expected due

to differing mineral composition and natural variation in sediment dispersal during transport. Despite this heterogeneity, there were clear trends in the sediment metal concentrations on both rivers.

The average concentration of Cu, Pb, and Zn on the Wicomico River has decreased from those reported by Gupta and Karupiah in 1998. Gupta and Karupiah had identified the municipal sewage treatment plant as the greatest source of contamination. While concentrations along the Wicomico River have decreased, there were significant to extremely high enrichment levels seen for copper, lead, and zinc, suggesting continued anthropogenic sources, including the use of poultry litter as manure, ship building and barges, and water treatment. There was great

variation in enrichment factors determined for the Nanticoke River. Samples collected from the dredged material at Cove Beach varied from enrichment deficient to significant enrichment seen in the Zn concentration. Tyaskin Wharf samples ranged from very high to extremely high enrichment for Cu, Zn and Pb. Overall, most of the samples were at least significantly enriched suggesting the metals originated from anthropogenic sources, potentially from byproducts of the agricultural industry which accounts for 30% of land use in the watershed. For both rivers, the average concentration of copper, lead, and zinc decreased as sampling moved downstream indicating upstream sources.

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# Lighthouse Architecture and Climate Change: FEMA and Coastal Communities

*Samantha Somers*

## **ABSTRACT**

Climate change is causing an increase in the intensity of coastal hazards. Stronger and more frequent floods, storms, and erosion cause damage to coastal communities including seaside home destruction and even citizen death. The Federal Emergency Management Agency (FEMA) has a series of guidelines for coastal construction to protect beach homes. However, the guidelines have not received a major update since 2019. Although 2019 seems recent, despite major efforts from the United States Environmental Protection Agency (U.S. EPA) to mitigate and deter climate change with policies including antipollution regulations, seaside communities like Rodanthe, North Carolina are already feeling the effects of intensifying natural phenomena. In light of the rapidly changing climate, FEMA should investigate lighthouse architecture to fortify beach homes as lighthouses are designed to withstand coastal hazards and extremes. Architectural components of lighthouses such as piles, caissons, interlocking and layered walls, and an octagonal house shape could be the structural alternatives needed to enhance the integrity of coastal homes. By incorporating lighthouse architecture into seaside home construction and reinforcement, citizen death, relocation, and destruction of coastal culture may be reduced. This paper examines potential ways FEMA could incorporate lighthouse architecture into its next update of coastal construction guidelines. FEMA will need to conduct further research on the potential cost of implementation for the recommendations outlined.

**Keywords:** Lighthouse, Climate Change, Coastal Communities, Architecture

## **INTRODUCTION**

Coastal communities face increased risks of destruction from coastal hazards intensifying due to climate change, prompting the need for substantial protection to prevent total devastation. Coastal hazards are naturally occurring events such as hurricanes that can damage people's homes and harm their livelihood and financial security (Glavovic et al., 2022, p. 2170). As sea level rises and ocean temperatures increase, these storms are predicted to increase in intensity (Knutson et al., 2020 p.17; United Nations [UN], n.d. a). To protect coastal communities from destruction, the Federal Emergency Management Agency (FEMA) has a series of guidelines dictating how coastal homes should be built. However, FEMA's guidelines have not received a major update since 2019, and the hastening pace of climate change should prompt a sooner update. A promising recommendation for improving coastal resilience could be found in lighthouse architecture. In preparation for coastal hazard intensification, FEMA should consider incorporating elements of lighthouse architecture in its next coastal construction update to more efficiently fortify seaside homes against the rise in coastal hazards.

## **CLIMATE CHANGE AND COASTAL HAZARDS**

The United Nations (UN) explains climate change as "long-term shifts in temperatures and weather patterns" (UN, n.d. b). Human activity has caused the climate to shift in a direction that will force

the oceans to rise and become warmer. Sea level rise is the result of glaciers melting due to an increase in atmospheric temperature. This rise in temperature occurs because greenhouse gases, named for their high heat-trapping properties and produced from human activities like burning fossil fuels and unsustainably depositing animal and human waste, are being excessively released and building up in the atmosphere (Environmental Protection Agency [EPA], 2023b). Further complicating matters, tropical storms serve as catalysts for other coastal hazards as stronger waves enhance the erosion of coastlines (Cloherty, 2021) and heavier rainfall drastically raises water levels, increasing the risk of flooding (UN, n.d. a). As long as ocean temperatures continue to rise as a result of climate change, favoring conditions for more extreme coastal hazards, coastal communities will be facing more frequent and severe destruction.

Currently, coastal erosion destabilizes home foundations and costs \$500 million in property damage to the United States (US) each year (Cloherty, 2021). Storm intensification will speed up the process of shoreline removal because of an increase in the frequency of "wave loading" (Raby et al., 2015, p. 16; 2019, p. 12). Wave loading is the amount of force exerted by a wave on an impact location. More frequent and stronger hurricanes will quicken wave movement, pulling more sediment away from the shore, and will increase wave intensity in locations where waves were not originally as strong (Vanem, 2017, p. 292). Therefore, property damage is likely to rise in the US from enhanced

coastal erosion if it is not countered with sufficient prevention or mitigation policies.

While erosion may cause millions of dollars in property damage repairs, flooding is the more lethal result of hurricanes. Flood waters can carry bacterial diseases and potentially harmful chemicals, as well as facilitate the risk of drowning. In 2022, the National Oceanic and Atmospheric Administration (NOAA) recorded 91 total deaths from flooding, with 23 deaths in the water and 23 deaths in vehicles driving into flooded streets (Center for Disease Control and Prevention [CDC], 2020; National Oceanic and Atmospheric Administration [NOAA], 2022). Floods can also damage homes by overflowing plumbing, ruining electrical wiring, and creating a damp environment for mold to grow, thus making post-flood homes hazardous for people to live in (EPA, 2023a). Already vulnerable on the coastline, seaside communities will only become more at risk of total devastation from coastal hazards if no innovative and adaptable measures are taken to keep them standing.

## **COASTAL COMMUNITIES: CHALLENGES**

NOAA reported that 52% of U.S. citizens lived on the coast in 2010 (NOAA, n.d.); those citizens face challenges from coastal hazards which can lead to a loss of citizen life and loss of security (Glavovic, 2022, p. 2170). NOAA also stated in its weather-related fatality and injury statistics that 158 people died from both flooding and hurricanes in 2021 with many more injured (NOAA, 2022). Considering that over half of the

U.S. population resides near a coast and that hurricanes are projected to increase in intensity, risks to security and life in coastal communities are only going to increase without intervention. Hurricane Ian is a good indicator of what destruction may be to come from an increase in storm intensity.

Hurricane Ian struck Florida on September 28<sup>th</sup>, 2022 as a Category 4 hurricane with wind speeds of 150 mph, the fifth strongest winds on record (Livingston, 2022). The hurricane caused 148 deaths, over 3.4 million power outages, and is predicted to cost a minimum of \$60 billion in damages (Halliburton, 2022; Livingston, 2022; Schuppe et al., 2022), making Ian one of the worst hurricanes to hit Florida. Ian's resulting 148 deaths total only ten below NOAA's total fatality count from floods and hurricanes from the previous year, likely prompting a spike in the hurricane mortality rate. As hurricanes stronger than or as damaging as Ian become more frequent and encourage mass relocation, coastal communities will become more financially strained and therefore become less capable of effectively rebuilding and fortifying their infrastructure.

Reconstruction and damage repair are additionally challenging for seaside communities that rely on tourism for a strong economy, especially those that simultaneously face mass relocation. Expenses for reconstruction are found in the cost of destruction. For example, the United States Geological Survey (USGS) (National Hazards Mission Area, 2022) reported that Hurricane Maria (2017) cost \$90 billion in damages. Most of the destruction occurred in Puerto Rico, a U.S. territory that heavily relies on a tourist economy and is already paying for damage repairs from more recent storms like Hurricane Fiona (2022). This one example of a tourist economy reveals the problem: reconstruction after a coastal hazard destroys profits. While insurance could help some homeowners in the US with damage repairs, insurance does not cover all coastal hazards and financial hardships communities may face. The intensification of storms would make hurricanes more frequent and powerful thus making coastal communities, like all of Puerto Rico, continue to struggle to pay for repairs and recover. However, the UN does offer a variety of solutions for these coastal communities.

### **COASTAL COMMUNITIES: CURRENT SOLUTIONS**

The UN cross-chapter paper 2 "Cities and Settlements by the Sea" provides several recommendations for protecting coastal communities. Glavovic et al. (2022) note that

one possible protection is implementing hard engineering measures such as sea walls, levees, and breakwaters; however, these structures have not proven to be protective long-term and can become highly expensive to upkeep. Glavovic et al. (2022) also discuss nature-based measures such as the planting of mangroves and the revitalization of wetlands to reduce flooding from storms. While more cost-effective long-term, nature-based measures are limited by land use as communities, businesses, and industries develop the land instead. More sustainable, full-proof protection could be achieved by combining both hard engineering and nature-based measures in an attempt to improve efficiency, price, and land use (Glavovic et al., 2022, p. 2172). For example, sea walls could be installed along with seaweed and mangroves to absorb waves and slow coastal erosion.

The UN believes the surest way to protect coastal citizens is relocation (Glavovic et al., 2022, p. 2174). Relocation has the benefit of indefinitely redirecting citizens out of coastal hazard pathways. However, aside from harming coastal economies, relocation runs the risk of severing the connection people have with their coastal culture. Not only do people have to physically and financially reestablish their lives once they move away, but also readjust to a new identity and way of life separate from their proximity of the coast. For example, fishermen and small family businesses may have to find new jobs or a new way to provide for themselves. Thus, it is beneficial to make an effort to protect the homes of coastal residents rather than automatically opting to relocate.

FEMA offers solutions to fortify beachside homes with its guidelines for coastal home architecture, reducing the need for coastal populations to uproot their lives and relocate. FEMA's overall mission is to help "people before, during, and after disasters" (FEMA, 2023e). To prepare oceanfront residents before disasters, FEMA published FEMA P-499, the "Home Builder's Guide to Coastal Construction" (FEMA, 2010), which outlines requirements and provides instructions on home foundations, building materials, exterior walls, and more. For home foundations, FEMA recommends coastal homes should have a "pile" (FEMA, 2010) type foundation. In other words, the homes are built on stilts to protect them from flooding and hold them in place against coastal erosion. The length and width of the piles will vary depending on how close the home is to the ocean or shoreline (FEMA, 2010). The materials used for piles consist of wood, easy to handle in matters of cutting and adjusting when building, and concrete, stronger than wood when it comes to coastal hazards

(FEMA, 2010). Wood is used for the walls of the home, with metal to support the walls against storm winds and hurricanes (FEMA, 2010). The most recent update to the FEMA guidelines was in 2019 with overview pages on the 2010 guidelines and improvements on protecting windows (FEMA, 2019). However, even with FEMA's 2010 guidelines and 2019 updates, many coastal homes are still being damaged by coastal hazards. FEMA's guidelines may require another update with more substantial information to keep up with the increasing rate of climate change.

### **UPDATING FEMA'S COASTAL CONSTRUCTION GUIDELINES**

Although the U.S. Environmental Protection Agency (EPA) has produced an onslaught of anti-pollution rules to fight climate change and protect U.S. citizens (Milman, 2023), there is no guarantee that the EPA will be able to fully enforce them. The U.S. Supreme Court has undermined the Clean Water Act, an EPA regulation to prevent and protect water from pollution (EPA, 2023c). This occurred during the case *Sackett v. Environmental Protection Agency* (2012) when the Supreme Court decided to limit which waterways the EPA can stop people and businesses from constructing buildings on (Barnes et al., 2023). The ecosystem most at risk of destruction is wetlands which serve as a major carbon sink, a natural location that pulls in and holds carbon dioxide from the atmosphere and the oceans. Wetlands have the capacity to slow down climate change and protect seaside communities from floods. With the setbacks it faces, the EPA likely will not be able to fully implement its regulations to protect vital ecosystems like wetlands and further reduce pollution. Without the EPA's regulations being successfully implemented to counteract the effects of accelerated climate change, coastlines and their communities are at an even greater risk of devastation, amplifying the need for an update in FEMA's guidelines.

For an example of how climate change threatens coastal communities, look to Rodanthe, North Carolina. As of May 2023, erosion has caused four houses to collapse and has put many more at risk of the same fate (Dennis, 2023b). The community has been struggling to find a long-lasting remedy to the issue because solutions like beach nourishment are expensive for communities with a low tax base like Rodanthe (Dennis, 2023a). Government assistance is necessary to reinforce the community against more coastal erosion and damage. This assistance would technically fall under FEMA's jurisdiction; however, because of

Rodanthe's small size and meager tax base, it is currently not getting any assistance from the federal government.

Nevertheless, Rodanthe holds geographic importance as a part of the Outer Banks barrier islands. These islands serve as a first line of defense against coastal erosion for North Carolina's inner coastline which can be seen in the USGS's Coastal Change Hazards Portal (USGS, n.d.). Rodanthe's infrastructural demise acts as a warning for the fate of coastal communities with inadequate architecture and funding until FEMA updates, promotes, and gives financial aid to struggling coastal communities. After all, FEMA's goals do include promoting climate resilience and adaptation.

As of now, FEMA has a goal to lead the US in climate resilience (FEMA, 2023a). One way FEMA has been promoting resilience is by investing in flood maps for coastal communities (FEMA, 2023b). The focus on flooding is further seen in the inclusion of "freeboards" which provide extra elevation for buildings, described in FEMA's nationwide study on the usage of building codes (FEMA, 2020a). The study was conducted to help achieve FEMA's goal of climate resilience by encouraging building code usage, ideally saving communities money from not having to repair homes post-disaster (FEMA, 2023c). Unfortunately, 65% of study locations in the US were not up to date with the building codes, and North Carolina was one of those states (FEMA, 2020b). One reason for this lack of upkeep could be found in funding deficiencies similar to Rodanthe's. Considering that this failure to follow building codes is present throughout the US, FEMA should update its guidelines sooner and to the advantage of coastal states that have not yet reached current building code standards; these updates would include providing the newest procedures to protect against coastal hazards, ultimately saving beachside residents money as they would only pay for guideline update projects and fewer damage repairs. The updated guidelines would further elaborate on flood prevention but also give attention to other coastal hazards such as hurricanes and coastal erosion that are damaging to coastal communities. One place FEMA could look for inspiration in their update would be in architecture designed to withstand coastal hazards and predicted to survive climate change. This architecture belongs to the symbol of coastal communities: lighthouses.

### **FORTIFYING COASTAL COMMUNITIES WITH LIGHTHOUSE ARCHITECTURE**

Lighthouses have long been an important part of coastal communities. Since their origins

in helping maritime navigation, they have been a symbol of seaside living. Lighthouses symbolize strength and perseverance, offering a sense of coastal nostalgia that brings people together (Blake, 2007, p. 15). Their emblematic importance has led communities to keep lighthouses standing even though they have become obsolete as navigation technology has evolved. Lighthouses now contribute mostly to the tourism industry, bringing in money for coastal communities and providing some jobs for local residents (Gomez y Patino, 2010, p. 48). No matter their usage, lighthouses demonstrate a resilience which seaside communities should attempt to emulate in surviving coastal hazards.

The General Lighthouse Authority, an organization dedicated to helping sailors in the United Kingdom, conducted studies on lighthouses to find out if they could survive climate change and be used for maritime navigation again. Both lighthouses reviewed were projected to survive to the mid-to-late 21<sup>st</sup> century despite being constructed in the 18<sup>th</sup> century. The first lighthouse analyzed was the Eddystone Tower near Cornwall, England; researchers discovered that the lighthouse could survive increased wave loading and suffer from minimal damage to the structure (Raby et al., 2015, p. 26). A second assessment was conducted on Wolf Rock Lighthouse, located near the southwestern tip of England, where researchers found that the lighthouse could survive to the year 2067 with minimal damage as well (Raby et al., 2019, p. 23). The architecture of the lighthouses has and will continue to withstand coastal hazards. Since lighthouses are a symbol of strength for coastal communities, their architecture could hold answers on how to fortify coastal homes and protect coastal communities amid climate change. There are multiple ways to implement lighthouse architecture into construction plans to protect coastal communities. These ways consist of building deeper, stronger foundations, strengthening the walls of coastal homes, and building homes in a more wind-friendly shape. The effectiveness of these fortification measures will vary depending on the location of a coastal community and which specific environmental challenges each community faces.

Houses and lighthouses are built on foundations to hold the structure up and support it. Coastal home foundations, as directed by FEMA, are constructed using "pile" foundations, most commonly built with wooden beams for flexibility or concrete for strength (FEMA, 2010, p. 61). Despite FEMA's specifications, these foundations are still being damaged by flooding and coastal erosion. Lighthouses, in solution to

the issue, use "caissons" (National Park Service et al., 1997, p. 10). Caisson foundations work by burrowing into softer soils like sand or mud to anchor the building. For seaside homes, caissons would have to be built with concrete for strength and to keep the house from being swept away by coastal erosion and flooding. While caisson design has only been incorporated successfully south of the Chesapeake Bay once, at Sabine Bank Lighthouse (National Park Service et al., 1997, p. 10), the design could still be worth using in southern locations because the houses, unlike lighthouses, would not be built directly on the water. By adding caissons as an alternative foundation for coastal homes, FEMA would be increasing the probability that a seaside structure would be able to withstand coastal hazards and remain protected.

Coastal home walls face heavy amounts of rain, wind, and waves from hurricanes and other storms. Hence, FEMA has guidelines to ensure exterior walls can take the force load (FEMA, 2010, p. 11). Nevertheless, exterior walls, too, could be updated with lighthouse architecture. The "wave-swept tower" design was constructed to survive powerful wind and waves by giving lighthouses exterior walls with interlocking stone bricks (National Park Service et al., 1997, p. 6). Coastal homes could implement this design by having interlocking stone (or concrete for a lower expense) in between the interior and exterior walls; by placing the stone in between walls, the homes would still look aesthetically appealing while adding needed protection to prevent the elements from entering the home. Wood, while not as strong as stone or concrete, might also work if layered for strength as an even cheaper alternative. The target location for this design is more equatorial parts of the US, such as Florida and Puerto Rico, that experience intense waves and wind coming from hurricanes (National Aeronautics and Space Administration, 2019). However, the design is not limited to regions near the equator. Including such a measure in the guideline update would help FEMA to keep coastal citizens safer in their homes during high winds and waves from storms.

Even with extra wall reinforcement, the classic, rectangular home design typical of coastal houses could benefit from modifications derived from lighthouse architecture. Homes are not built to be aerodynamic, resulting in greater damage from storm winds; conversely, lighthouses, with a more octagonal shape, are predicted to survive extreme storms brought by climate change (Raby et al., 2015, p. 17; Raby et al., 2019, p. 5). Looking at Eddystone Tower and Wolf Rock Lighthouse, both of their shapes could imply an aerodynamic benefit to

octagonal buildings over the traditional square home which would protect buildings from wind and storm damage. Octagonal houses are also more efficient than square homes for building on stilts (Topsider Homes, n.d.), as demonstrated in the currently-used pile design. This house shape was popular in the mid-1800s, and blueprints still exist (Topsider Homes, n.d.). If FEMA were to update its guidelines with these structural changes, it would need to cross-reference the old, octagonal house blueprints with lighthouse architecture or update the blueprints to modern standards. FEMA would then have to regulate housing design for new homes while old homes would use other components from lighthouse architecture for fortification projects. There is no evidence that the construction of octagonal houses in coastal communities is limited by geography. By incorporating these three aspects of lighthouse architecture into future guideline updates, FEMA could help to better prepare coastal communities for more intense coastal hazards and for increased potential for damage; a guideline update of this nature has a greater likelihood of success than one that excludes lighthouse architecture.

#### **POTENTIAL CONSIDERATIONS AND FUTURE RESEARCH**

Despite the potential benefits of updating the coastal housing guidelines to include lighthouse architecture, FEMA might still be hesitant to update its plan. One reason could be financial concerns. There is currently no cost estimation for a project like lighthouse architecture integration. For a financial prediction to be made, there would first have to be an initial investigation of lighthouse architecture to understand specifics on how each lighthouse is built for a starting estimation. Expenses also need to be considered when designing and testing these fortified new and old buildings that could withstand intensified hurricanes, with supplies and labor also driving up costs. To obtain the money, FEMA would have to receive more funding from

the government budget, especially if FEMA does not wish to rebalance its own budget away from current projects. Alternatively, to save on finances, FEMA could delegate some of the design-testing aspects and costs to universities and organizations with other means of funding outside of FEMA. To save money on implementation, FEMA could also give grants to local, coastal businesses to assess and fortify coastal homes with lighthouse architecture, like post-disaster house repairs (FEMA, 2023d). Another way to save on project execution is for FEMA to team up with the U.S. Department of Housing and Urban Planning (HUD) which provides loans for home improvement and seeks to improve people's quality of life with housing (U.S. Department of Housing and Urban Planning [HUD], n.d. b; HUD, n.d. a). By partnering with HUD, FEMA would not have to bear the full burden of updating old buildings and paying for the construction of new buildings. In addition to HUD's assistance, homeowners and construction companies would also need to bear part of the financial weight for house construction. Between HUD, homeowners, and construction companies, FEMA has options to mitigate its own financial strain when adding lighthouse architecture to seaside communities.

Another consideration is the lack of research on the effectiveness of lighthouse architecture on coastal homes. Further research is necessary to explore the validity of using lighthouse architecture in this novel way. If FEMA does not conduct the research itself, it could delegate the task to universities or independent researchers with a passion for helping seaside settlements and people. The delegation of responsibility in design-testing would come with financial benefits for FEMA similar to those suggested before. Nevertheless, FEMA might not wish to use lighthouse architecture, particularly the octagonal house idea, because decently effective, less extreme ideas are already in place like pile foundations. Still, an investigation into utilizing lighthouse architecture for coastal protection

could benefit coastal communities all over the world, not just in the US, as updated guidelines could also inspire other nations to fortify their coastal communities and protect their people from worsening coastal hazards in ways other than relocating.

#### **CONCLUSION**

FEMA should update its guidelines to include lighthouse architecture to protect seaside communities against the predicted increase in coastal hazards. An update of this nature proves necessary as recent coastal destruction in the US highlights the inadequacy of the current regulations regarding climate change mitigation. A loss of coastal communities would be devastating for the US since the seaside carries substantial cultural significance. The coasts are not only a tourist destination but are home to a little over half the U.S. population. Seaside communities hold historical value in old harbor cities and provide connections to ancestral and geographic identity. Without protecting the coastal communities of the US, the country would lose a significant part of its past. As long as houses remain ineffectively fortified, storms will continue to destroy homes, forcing people to relocate and severing their ties to the coast.

Once the connection to culture is lost, the significance of the physical shoreline is at greater risk of washing away too. While there will always be a "coastline," a place where land meets water, the current one which is home to these communities will vanish and put more inner continental towns and cities in danger; these settlements would be even more at risk than today's oceanfront residences because they are even less fortified and not designed to withstand coastal hazards. Hence, the importance of protecting coastal communities extends beyond the safety of seaside towns themselves, for if there is failure to strengthen the outer communities, the inner ones shall become the new front lines against climate change.

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# Barack Obama, the Election of 2008, and Post-Racial America: Conservative Myth or Fact?

*Kieran Bethke*

## ABSTRACT

In November 2008, the American voters elected Barack Obama president of the United States. As the first Black man to hold the presidency, the significance of his candidacy and presidency cannot be overstated. Big celebrations emerged nationwide, accompanied by optimistic feelings about the future of race relations in the United States. However, amid these celebrations, some southern conservatives prematurely claimed that America was post-racial because a Black man was elected president, citing substantial support from White voters. Rather than believing that Obama's election represented a panacea to racism in the United States, I take a more nuanced position considering the environmental factors that led to Obama's presidency. The racism that surfaced against Obama and his family during his election and presidency and a breakdown of the White vote reveal that race in the 2008 election worked to Obama's disadvantage. Dispelling the conservative myth of a post-racial America is crucial to safeguarding protections for minority populations. Acknowledging the achievements in electing a Black president should not overshadow the ongoing challenges posed by racist rhetoric and systemic inequalities. Only after Americans reject post-racial myths can society address racism and create an honest discourse.

## INTRODUCTION

On November 4, 2008, American voters elected Barack Obama President of the United States. In a nation where political power has been historically elusive for Black people, the election of a Black president was a momentous occasion. Big celebrations emerged throughout the nation, accompanied by optimistic feelings about the future of race relations in the United States. Capitalizing on the optimism, southern conservatives proclaimed that America was post-racial because a Black man was elected president, citing substantial support from White voters. While this statement does not appear dangerous, its implications could be catastrophic for the Black community because it is a fabrication. For instance, what purpose would affirmative action or protections won in the Civil Rights Movement have in a post-racial nation? The preceding question is precisely what some southern conservatives wanted the public to ask themselves.

Instead of embracing Obama's presidency as an invitation to continue progress toward equality, southern conservatives acted like Obama's individual success invalidated the hardship of 25.9% of African Americans living in poverty.<sup>1</sup> Rather than believing the falsehood that the United States has transcended race, I take the position that Obama's election did not represent an end to racism in the United States, specifically among White Americans, but instead reflected several race-independent factors that leaned the populace toward Barack Obama and the Democratic party. Widespread disenchantment with Bush, the Republican party, and the Iraq War benefited Obama's candidacy, and economic populist movements,

sparked by the 2008 fiscal crisis, favored Obama's economic plan. Furthermore, Obama's demographic characteristics, particularly his age, made him more attractive than his opponent in the general election. On the other hand, racist propaganda both during and after the election and a thorough analysis of the White vote prove that the 2008 election was not devoid of racial considerations. For the purposes of this paper, "race-independent factors" are interpreted as elements of the political environment in 2008 that would have remained influential if both candidates had been of the same race. However, no issues are truly race-independent, gender-independent, or class-independent because all intersections of an individual's identity affect how they perceive and respond to issues.

## RACE-INDEPENDENT FACTORS IN THE 2008 ELECTION

The Iraq War became progressively unpopular in the last four years of the Bush presidency. Consequently, public approval of the Republican party and President Bush declined. From 2003 to 2008, average support for the Iraq war fell by 40%, and Bush's approval rating fell by 43% (Jacobson, 2010, p. 208). By early 2008, the economic recession commanded American voters' attention, but the Iraq War persisted as a deciding issue. Concurrently, public opinion on progress in the war was significantly improving. However, while the public believed the war was making progress, the war itself and President Bush remained unpopular, especially among Democrats. Aggregate support for the war did not improve, and a strong majority continued to call for withdrawal (Jacobson, 2010). Political scientist Gary Jacobson argued that widespread

negative opinions of the Iraq war influenced the primary and general elections in Obama's favor.

The Iraq War's fall from public grace helped Obama secure the Democratic nomination and later the presidency. By 2008, almost 90% of Democrats were disaffected with the Iraq War (Jacobson, 2010). The two frontrunning Democrats in the 2008 primaries were Hillary Clinton and Obama. Clinton was a well-known and more experienced candidate, having previously served as First Lady of the United States and a United States senator from New York. In October 2002, Clinton voted for the Joint Resolution to Authorize the Use of United States Armed Forces Against Iraq. On the other hand, Obama had no history of endorsing the war and consistently expressed his opposition from the beginning. Among firm opponents of the war, who constituted 71% of participants in Democratic primaries, 60% supported Obama. This data indicates that disaffection with the Iraq War influenced Obama's nomination. Furthermore, Obama's position on the Iraq War improved his chances in the general election. Jacobson's research showed that "voters unhappy with the war were evidently predisposed to take an extra critical view of the economy and the economic competence of the governing party" within both political parties (Jacobson, 2010, p. 221). Negative opinions of the Iraq War engendered doubts about the Republican party's economic competence in an election where the economy was the deciding factor. The Democratic party offered voters a shift from the Bush deregulation policies that exacerbated the economic crisis. Overall, the Iraq War was an environmental condition in the 2008 election that favored the Democratic party.

The trend Jacobson identified led to significant Bush voter defections. While Obama's campaign energized new voters, political scientist Arthur Lupia argued that new voters were superfluous to Obama's victory because almost a quarter of Bush voters in 2004 did not vote for McCain in 2008. Lupia fabricated an alternate 2008 election where Obama won the exact number of votes that John Kerry did in 2004, and McCain's votes remained the same. Obama would have won the electoral college in 2008 with only the support of 2004 Kerry voters because 23.6% of 2004 Bush voters did not vote for McCain in 2008, with 15% voting for Obama. In the alternate 2008 election, Obama won 59,028,444 votes, and McCain won 59,892,681, with Obama winning the key states of Iowa, New Mexico, and Ohio and therefore the electoral college.<sup>2</sup> Disaffection with Bush and the Republican party, due to the Iraq War and the economic recession, significantly increased Obama's support in the nomination and the general election. Lupia concluded that while Obama's success attracting new voters has received the most attention from the media, defections of 2004 Bush voters were sufficient to hand Obama the presidency in 2008 (Lupia, 2010). The circumstances of the 2008 election weighed heavily in the Democrats' favor.

While the Iraq War and President Bush's plummeting approval rates increased support for Obama, economic populism dominated the 2008 election and helped Obama win the election. Since the Anti-Federalists, populism has influenced the outcome of national elections in the United States. In the 2008 election, both McCain and Obama used populist appeals to connect with voters and win their support. Populist rhetoric "aims to align candidates with ordinary people who lack power or are being oppressed by undemocratic elites who wield excessive power" (Formisano, 2011, p.106). Populist leaders create an "us-versus-them" dichotomy, with plutocrats typically in the "them" position. Candidates try to present themselves as ordinary Americans rather than the educated, wealthy, and professional individuals they always are. In recent decades, cultural populism that sets ordinary small-town, rural Americans versus big-city elites has dominated the political climate. Furthermore, cultural populism has been adopted by conservatives and the religious right to argue against marriage equality, reproductive rights, and other policy positions they deem un-American.

Ronald Formisano (2011) researched populist appeals made by the Democratic and Republican nominees in 2008. He first examined cultural populism, which ignited in the 2008

general election after Sarah Palin was named McCain's running mate. Palin successfully branded Obama as a nerdy, cultural elite and portrayed herself and McCain as mavericks who represented the beliefs of the working-class, small-town Americans, "the real America." Despite her populist appeal, Palin, a single-term governor, could not overcome doubts about her qualifications and readiness for office. While cultural populism typically prevails in national elections, as it did in 2016, the economic recession leaned the public toward economic populism. Additionally, Obama consistently affirmed his commitment to the working class and associated McCain with Bush's unpopular economic policies. Obama succeeded in leading the economic populist movement in the election and subsequently won the election. Along with the educated, Black, and young voters, Obama won high percentages of low-income White voters who tend to side with conservatives on social issues because the economic recession shifted their attention to economic issues (Formisano, 2011). Overall, Obama successfully positioned himself as the figure of economic populism amidst the economic recession.

In addition to the political environment, candidate age in the election of 2008 benefitted 47-year-old Democratic nominee Barack Obama and hurt 72-year-old Republican nominee John McCain. Ageism is a common form of discrimination in the United States and is considered a more socially acceptable form of discrimination than racism or sexism. Americans equate aging with senility and feebleness, although this is not universally true. Whether justifiable or not, political leaders have long been the victims of ageist attacks. For example, every accidental fall or trip of 80-year-old President Biden turns into a media frenzy about his fitness to serve. In July 2023, 81-year-old Senator Mitch McConnell froze for 20 seconds in front of the media. During this time, McConnell seemed to have difficulty speaking, prompting further discussions about the prevalence of gerontocracy in the United States (Epstein & Lerer, 2023). Although media criticism of gerontocracy was less prevalent in 2008, some Americans were wary of McCain's fitness to serve at 72.

In the 2008 election, John McCain faced ageist attacks by the media and Obama's campaign. The news frequently reminded the public that McCain would be the oldest president to be inaugurated if elected. Obama's campaign ads played McCain's extensive experience and age to stress that he represented uninspired, old politics, and Obama represented real change. In opposition, Republicans attacked Obama's younger age to charge that he was too young

and inexperienced to be president. However, attacks on Obama's youth failed because Obama was more than a decade older than the constitutional requirement for president and older than multiple former presidents at their time of inauguration (Kenski & Jamieson, 2010). Americans' predisposition for ageism negatively impacted McCain's candidacy while contributing to the success of Obama's campaign.

To study the empirical effects of candidate age on the 2008 presidential election, Kenski and Jamieson (2010) used data from the 2008 National Annenberg Election Survey (NAES). The NAES used telephone interviews to collect information on political behaviors in the 2008 election, including behaviors and beliefs related to candidate age. Kenski and Jamieson identified that among people interviewed in the last three weeks before the election ( $n = 4,945$ ), 34.9% believed McCain was "too old to be president," and 11.8% believed Obama was "too young to be president."<sup>3</sup> Additionally, Kenski and Jameson created a timeline of public beliefs that McCain was "too old to be president" and beliefs that Obama was "too young to be president" from March to November 2008. Their timeline showed that public beliefs that McCain was "too old to be president" started higher and increased over time, while public beliefs that Obama was "too young to be president" started lower and decreased over time. Next, they controlled for political characteristics and demographics and found that believing McCain was "too old to be president" increased voters' likelihood to vote for Obama. For instance, if a person had a minimum 25% probability of voting for Obama, that would increase to 60% if they perceived McCain as "too old to be president." Their data showed a significant increase in expectations of voting for Obama among voters with a low baseline expectation of voting for Obama. Voters with a low baseline expectation of voting for Obama were not expecting to vote for Obama before considering candidate age. The same increase was not seen among voters with a high baseline expectation of voting for Obama because perceptions of McCain's age made little difference on their pre-existing high expectation of voting for Obama (Kenski & Jamieson, 2010). Overall, Kenski and Jamieson demonstrated that perceptions of candidate age in the 2008 election were compelling, beneficial factors in President Obama's victory.

### **RACIST RHETORIC DURING AND AFTER THE ELECTION**

In 2008, Black Americans' historical fight for voting rights and political power pierced a White-male-controlled branch of the national

government. However, the election did not transform Americans' racial attitudes or prove that an absence of racism existed in the United States. It is negligible to believe that race is no longer a compelling factor in national elections when Obama, as a candidate and president, and his family were frequently the victims of explicit and implicit racist propaganda and rhetoric.

Obama's mixed parentage and untraditional upbringing separated him from the traditional African American experience "from slavery to Reconstruction to the Great Migration north" (Kachun et al., 2011, p. 39). While his racial "ambiguity" did not free him from racist attacks against his Blackness, he was exposed to accusations that he was Muslim and, therefore, open to explicit racist attacks against Muslims (Giardina, 2010). Even though Obama was wrongly identified as Muslim, the explicit racism used against a "Muslim" Obama is evidence enough that the United States is far from post-racial. Before and more excessively after 9/11, American citizens have either consciously or unconsciously held prejudice against Muslims, almost immediately associating them with terrorism. Giardina's research took a deep dive into the connection between anti-Muslim rhetoric and "othering" Obama during his campaign. After claiming that Obama was educated in a madrassa based on his two years at an Indonesian public school in a Muslim-majority country, conservatives and other citizens believed Obama was "Un-American" and sympathetic to terrorists.<sup>4</sup> The designation that Obama was "Un-American" is ironic because Obama's story, as he has described, is the epitome of the American melting pot and the American dream. He was a mixed-race man with a Kenyan father and a White mother from Kansas who rose to be the President of the United States. Conservatives counteracted Obama's uniquely American narrative by manipulating post-9/11 fears to "other" him as Muslim. Despite consistently refuting his "Muslim background," by April 2008, 10% of the electorate believed Obama was Muslim (Giardina, 2010, p. 142). This phenomenon is partially due to the actions of "trusted" Republican members of Congress. Despite knowing better, some Republican members of Congress neglected to dismiss claims that Obama was Muslim because "othering" Obama as Muslim made him vulnerable to attacks on his character and intention to protect the nation based on racist beliefs about Muslims (Giardina, 2010). If Obama had been White, his two years in Indonesia and his "funny" name would not have been sufficient to cast him as Muslim. Additionally, if America was post-racial, labeling

Obama Muslim would not have damaged his image the way it did.

The Republican nominee for Vice President, Sarah Palin, whether she acknowledged it or not, launched a vituperative attack against Obama's Americanness and that of his supporters. She fed the accusation that Obama was Muslim and anti-American (Giardina, 2010). At a fundraiser, she suggested that the small, White-majority towns she and presidential nominee McCain visited were pro-American, insinuating that other parts of America are anti-American, presumably more diverse areas. While John McCain resisted racist and prejudiced attacks on Obama from his supporters, the campaign, especially Palin, incited and supported racist ideas that Obama was anti-American and pro-terrorist. Therefore, McCain-Palin campaign events attracted supporters who questioned Obama's character based on his Blackness and falsified Muslim background. For example, one White woman was "concerned that they [Barack and Michelle Obama] could be anti-white" (Giardina, 2010, p. 146). This woman's belief reflected the racist idea that many Black Americans are "bitter" or hate White people because of Black oppression in the United States. Palin exercised a campaign of fear against Obama built upon real anger and resentment among some White Americans. Palin and the far-right media provided Americans who have seen their wages and benefits decline with someone to blame: rich liberal elites like Obama who control the government and give away opportunities to Black Americans, gay Americans, and illegal immigrants while neglecting White Americans.

While Obama was the candidate, his family, especially his wife, were not immune to racist rhetorical attacks. Michelle Obama was cast into the limelight alongside her husband when he ran for president in 2008. However, Mrs. Obama was descended from American slaves. Unlike Barack, the authenticity of Mrs. Obama's "Blackness" was uncontested, leaving her more vulnerable to traditional racist stereotypes used against African Americans. While she received positive media attention comparing her to Jackie Kennedy and praising her outfits like any first lady potential, she was the target of racist attacks because she, unlike any past first lady potential, was Black (Kachun et al., 2011). Specifically, Michelle Obama was painted as an "angry Black woman" bitter with the history of racism and oppression in the United States. Mrs. Obama was frank about the legacy of racism in the nation as well as the improbability of her husband running for president of this nation. Her words were manipulated into evidence that she was unappreciative of American freedom

and anti-White, earning her monikers like "Mrs. Grievance" and "America's angriest would-be First Lady" (Kachun et al., 2011, p. 43). Additionally, Mrs. Obama expressed feelings of racial isolation in her 1985 Princeton senior thesis, which was spread as evidence of her bitterness and anger toward America over 20 years later. Barack Obama's political opponents started to call for the "real Michelle," meaning the angry, rude Black woman they cast her as to come out. Overall, the conservative media continued to use Ms. Obama's cherry-picked remarks to cast her as an angry Black woman throughout the election (Kachun et al., 2011). All first ladies experienced misogynistic attacks and fashion critiques, but only Michelle Obama faced attacks based on longstanding racist stereotypes about African American women, most prominently the "angry Black woman" stereotype. The unfair treatment of Michelle Obama during the election, compared to that of previous potential White first ladies, demonstrated that Obama's election did not transcend race. However, Obama's historical presidency had the potential to start more meaningful discussions about race relations.

Racist propagandists did not call a cease-fire after Obama won the election. Instead, the racist rhetoric returned with "a vengeance vowing not to die," demonstrating how Obama was not a post-racial poster boy (Olds, 2011, p. 101). During his presidency, Obama was the target of many public acts of racism. Obama was the subject of multiple cartoon caricatures that associated him with watermelons and fried chicken, including an image of the White House lawn covered in watermelons for Easter. All these images are long-held connotations for Blackness in America; therefore, associating them with Obama marginalizes him and all other Black people. While the perpetrators denied they were aware of the overt racism in their "jokes," the negative effect of publicly stereotyping and marginalizing Obama remained. Additionally, a racist political cartoon characterizing Obama as a dead chimpanzee in the *New York Post* criticized President Obama's stimulus bill. While its creators defended the cartoon as a non-racial satire directed at the stimulus bill, it had clear racial intent. In the United States, associating Black people with primates is sadly widespread and sometimes even unconscious, a fact that the creators certainly recognized. Racists have dehumanized Black people with images of primates for centuries (Olds, 2011). The use of racist rhetoric and imagery throughout Obama's presidency underscores the need to dismantle the post-racial conservative theory.

Olds (2011) defined the above instances

of public racism as micro-aggressions. Microaggressions are “a statement, action, or incident regarded as an instance of indirect, subtle, or unintentional discrimination or prejudice against members of a marginalized group such as a racial minority” (Oxford English Dictionary). However, the acts of public racism Olds conceptualized as microaggressions are neither indirect, subtle, or unintentional. Olds fallaciously categorized racist statements or actions made with plausible deniability as microaggressions. A political actor’s ability to disavow the racism in their actions does not diminish the directness and intentionality of their actions. Any individual, should they choose, could deny even the most explicit racism. Mischaracterizing these actions as microaggressions serves a racist agenda that downplays the presence and severity of racism in the United States. Nevertheless, Olds included one apt example of a microaggression. During a speech to Congress, South Carolina representative Joe Wilson (R) shouted, “You lie!” during Obama’s speech. This unprecedented uncouth behavior by a member of Congress during a presidential speech demonstrated how Obama was not awarded the same respect as former White presidents. Wilson’s impropriety suggested that he believed Obama’s Blackness allowed him to transgress normal congressional mannerisms. Following Obama’s presidency, succeeding white presidents have encountered interruptions from members of Congress because of a shift in decorum that can be traced back to underlying biases against Obama. Wilson’s behavior is an accurate example of a micro-aggression because his behavior was subtly, indirectly, and potentially unintentionally racist. Wilson may have been unconscious of his motives for treating Obama differently, and his statement did not carry racial connotations. Overall, Obama was singled out negatively among former presidents for his Blackness. A White President would not be publicly associated with watermelons, disrespected by a congressman during a speech, or portrayed as an ape in the *New York Post*.

### **ANALYSIS OF THE WHITE VOTE**

The belief that Obama’s race did not matter to White voters in the 2008 election is further and unequivocally refuted by analyzing the White vote. The results of the White vote demonstrated that White voters did not abandon racism and prejudice at the polls in 2008. Pundits have claimed that since many White people voted for Obama, his Blackness must not have disadvantaged him. However, the promoters of this perspective fail to put Obama’s White voter

percentage into context with the wider political environment discussed above. Conservatives are quick to make cursory comparisons to former White Democratic candidates, specifically Bill Clinton. In 1996 and 2008, Bill Clinton and later Obama won 43% of the White electorate in the national election. Many experts determined that this statistic is evidence of overwhelming White support for Obama without any further analysis needed (Edge, 2010). However, Afro-American studies expert Thomas Edge analyzed the results of the White vote in context with the political environment of 1996 and 2008. His research indicated that Obama should have won higher percentages of the White vote than Clinton. In 2008, the Iraq War, economic populism, and Bush’s low approval ratings all favored Obama and the Democratic Party. Accordingly, the Democratic party won significant majorities in the Senate and House in 2008. Conversely, the political environment in 1996 did not favor the Democratic party, and the party remained a minority in the Senate and House after the election. Logically, Obama should have won much higher percentages of the White vote because the political environment was conducive to his party. Furthermore, the election of 1996 involved a popular third-party candidate, Mr. Ross Perot, who won 10% of the national vote. In 2008, only 1.5% of the electorate voted for a third-party candidate. Again, Obama should have won higher percentages of the White vote than Clinton because there was no strong third-party candidate in 2008. Lastly, Obama won the 2008 popular vote by a 7.2-point margin, while Clinton won by an 8.5-point margin in the 1996 popular vote (Edge, 2010). While Obama’s successes in the general election were impressive, it is important to understand his success in the context of the political environment so not to overestimate enthusiastic support from White voters and feed into the conservative fantasy of post-racial America.

Along with analyzing the results of the White vote in 2008 in context with the political environment, empirical studies of White’s racial prejudice unmistakably prove that Obama’s race hurt his success with White voters, even within his party. Political scientist Spencer Piston studied explicit racism among White Americans and its effects on Obama’s candidacy. Piston acknowledged that explicit racism has evolved into a more implicit, “modern” racism that encourages “resentment toward Blacks based on the perception that they get special, undeserved treatment from government” (Piston, 2010, p. 433). However, Piston decided to measure explicit racism using stereotypes because the prejudice involved in believing

stereotypes is less ambiguous, more concrete, and still relevant. He measured the following stereotypes: laziness and unintelligence; and asked non-Hispanic White respondents to rate the intelligence and laziness of both White and Black people. Piston found that at least 45% of the respondents believed Black people were lazier than White people and that 39% believed White people were more intelligent. After establishing that prejudice was present among White Americans, Piston compared the effects of prejudice on Obama’s candidacy versus other Democratic candidates in previous elections to determine whether prejudice hurt Obama’s candidacy. Piston’s research identified a significant negative relationship between prejudice level and voting for the Democratic candidate in 2008. The negative relationship in Piston’s research means that high prejudice levels in White voters, measured by an individual’s belief in negative stereotypes about Black people, lowered an individual’s probability of voting for the Democratic candidate in 2008. Compared to the 2008 election, no significant relationship was discovered between prejudice level and voting for the Democratic candidate in 1992, 1996, 2000, and 2004, when there was no Black candidate. Based on Piston’s research, prejudice significantly decreased support for Obama among White voters. Furthermore, the data demonstrated that Obama lost voters because of his race and not his political party. Piston demonstrated that prejudice decreased Democratic and Independent voters’ probability of voting for Obama, while Republicans’ support for Democratic candidates was low regardless of their higher prejudice levels. His findings concluded that Democrats and Independents exhibiting high levels of prejudice had a significantly lower probability of voting for Obama, which was 10% lower for Democrats and 22% lower for independents. Piston’s research demonstrated that race was a negative factor for Obama among White voters in the 2008 election, including Democrats (Piston, 2010). Piston’s research is crucial not to chastise White voters, but to counter the conservative narrative that race is no longer a barrier to success in the United States.

Furthermore, the White vote can be analyzed using a racial threat thesis. While political parties are a deciding factor in White Americans’ decisions regarding presidential candidates, racial animus can supersede party identification, especially when the party’s candidate is Black. In some instances, this phenomenon can be attributed to the racial threat thesis. The racial threat thesis suggests that “whites are more likely to fear social, economic, or political advances

by minorities when they reside in jurisdictions where the minority group's population share is larger" (Donovan, 2010, p. 864). Political scientist Todd Donovan measured the effects of the racial threat analysis in the 2008 election. He hypothesized that White support for Obama would decrease as the minority population of a state increases. Additionally, he claimed that there is a threshold, around a 40% African American population, at which White Americans are more familiar with and used to African Americans, and therefore exhibit no bias from the racial threat thesis. Donovan collected data on the relationship between state African American populations and Obama's relative advantage or disadvantage over McCain compared to Hilary Clinton's. Donovan's research demonstrated that Clinton had more support from White voters against McCain than Obama did in southern states with larger African American populations. Inversely, Obama had more White support against McCain in northern and western states with smaller African American populations. After collecting data, Donovan identified an inverse linear relationship between support for Obama, relative to Clinton, and the size of a state's African American population. The inverse relationship showed that support for Obama over Clinton declined as the African American percentage of a state's population increased from 0 to 30 percent. States with lower African American populations supported Obama more than Clinton when pitted against McCain, including Utah, Alaska, Nebraska, and Wyoming. On the other hand, White voters in Southern states with larger African American populations were more favorable of Clinton. Donovan applied the racial threat thesis to the general election by comparing the Democratic vote in southern states with the largest populations of African Americans from 1984-2008. He observed that the Democratic vote in all these states reached the lowest point since 1984, including Alabama, Mississippi, Louisiana, Kentucky, and more (Donovan, 2011). The implication of Donovan's research is significant for debunking the post-racial myth. His research supported the premise that an entire region of the United States had not made major progress toward racial equality.

Moreover, it is imperative to study the racial attitudes of White voters who voted for Obama in 2008. Some political scientists believed that Obama's Blackness was not authentic in the eyes of many White voters because of his mixed parentage and nontraditional upbringing, despite Obama's self-identification as an African American. Obama's racial ambiguity led people to describe Obama as the "racial exception," which assuaged the irrational fears of many White voters because he presumably did not possess the generational "bitterness" that African Americans who existed within the "from slavery to freedom narrative" felt (Carter & Dowe, 2015). While the argument that African Americans are "bitter" is racist, it reflects some White Americans' views. Additionally, unlike past Black candidates, Obama launched a deracialized campaign and did not actively campaign for the interests of the Black community. Obama focused his campaign on valence issues rather than race issues. Political scientists Niambi Carter and Pearl Ford Dowe (2015) conducted a study to examine the effects of Obama's racial exceptionalism on White and Black voters' perceptions of Obama's race. Carter and Dowe found that White people were more likely to identify Obama as biracial or racially ambiguous, and Black people were more likely to identify Obama as Black. Additionally, Carter and Dowe collected data on White and Black Americans' favorability of Obama, their perception of whether opposition to Obama was race-based, and their perception of race relations as worse, better, or the same after Obama's election. Carter and Dowe's data discovered a positive relationship between Black people and favorability of Obama and, conversely, a negative relationship between White people and favorability of Obama. The relationships in the data demonstrated that White Americans had a more negative perception of Obama than Black Americans, regardless of their opinions on Obama's Blackness, proving that race did matter to White voters in the election of 2008. Furthermore, the data showed a negative relationship between White voters and perceptions about race relations in the nation after the 2008 election, meaning that White voters believed race relations were slightly worse

following the election (Carter & Dowe, 2015). Overall, the data revealed significant differences among White and Black populations regarding racial attitudes, which provides evidence that the United States has yet to move beyond race if it ever will.

## CONCLUSION

The Southern strategy to describe the election of 2008 and simultaneously the United States as post-racial should continue to be exposed for the falsehood that is. The prejudice Obama faced from explicit and implicit racist rhetoric and discrepancies between the actual White vote and claims of widespread White support forced Americans to confront the race factor in the election of 2008. Additionally, Americans must pay attention to the environmental factors in the election of 2008 to rationalize Obama's victory rather than attributing his victory to White voters' unconditional embrace. Only after Americans reject post-racial myths can society address racism and create an honest discourse. White Americans need to reject "comfortability" and colorblind perspectives to address racism and inequalities in this nation. Discussion and concerted action are the way to change the "hearts and minds of the people of this great nation" (Olds, 2011, p. 107). While Obama's racial reticence has limited his presidency to be more symbolic than substantive for the Black community, his presidency elevated the spirits of many underrepresented communities. The 2008 election redefined what it means to be presidential by including formidable Black and female candidates. Obama inspired Black Americans to participate in politics and continue an attainable fight against racial injustice (Reed, 2010). Lastly, the election of Barack Obama brought attention to the influence of the Black vote in national elections because Obama won over 90% of the Black vote in 2008. Furthermore, the Black vote influenced eight key electoral states in Obama's favor (McFayden, 2013). Hopefully, the results of the 2008 election may persuade candidates, specifically Democratic candidates, to reevaluate the influence of Black voters and subsequently be more concerned with issues affecting the Black community.

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## ENDNOTES

- <sup>1</sup> This is the rate of African Americans living in poverty in 2009. It should be compared to the rate of White Americans living in poverty in 2009, which was 9.4%. The source for this information is the Census Bureau.
- <sup>2</sup> In 2008, Obama won 69,394,675 votes and McCain won 59,892,681.
- <sup>3</sup> The symbol 'n' represents the total number of individuals or observations in the sample.
- <sup>4</sup> Madrassa is an Islamic religious school.

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# You Are Not Forgotten – Crafting a Theological-Political Mythos

Ryan Chandler

## ABSTRACT

Jon McNaughton is an American evangelical artist known for his political artwork depicting right-wing political figures with prominent Christian iconography and allegory, seeing himself as a voice for the farther political right. He uses a realist style evocative of famed classical artwork juxtaposed with contemporary figures and blunt religious-political symbolism. His work is often mocked or dismissed as mediocre political cartoons and propaganda. However, McNaughton and his audience do not view his paintings this way, instead constructing a kind of theological-political mythos underpinning their sense of identity. While McNaughton's realist style and mythological storytelling may be unconvincing to those in the out-group, they are extremely appealing to the intended audience. Seeking to understand this allure, this essay examines *You Are Not Forgotten*, his 2017 oil painting of then-newly elected President Trump and an American family stamping a snake and nursing a flower, symbolizing the creation of a new Garden of Eden. This essay uses rhetorical theorists Rudolph Arnheim and Charles Hill and their ideas on visual rhetoric as the analytical lens. Understanding the potent social and psychological forces at the heart of McNaughton's work should allow us a deeper understanding of the people, values, and outrage around it. However, McNaughton's controversial work should not be written off or reduced to cheap artistry. It is because such unsettling work is so popular and so clearly resonant with his audience that *You Are Not Forgotten* and pieces like it should be studied. They are a valuable portal into a community we should understand.

***"The purpose of my painting is to communicate my ideas. American politics is filled with nuance and shades of grey, but I see the world through a prism of light and truth. My art reflects who I am and doesn't use nuance or shades of grey to make my point. I want future generations to know exactly how I felt during this time in our country's history."***

**– Jon McNaughton (The Artist)**

Jon McNaughton is one of America's most prolific conservative artists, employing a realist allegorical style evocative of Renaissance art, which is often viewed with a sense of high-class culture and society, to render a kind of evangelical-political mythos around former U.S. president Donald Trump. His technical skill is obvious, but he's commonly criticized and written off for what many reduce to uncomplicated, unsubtle messaging, shallow bathos-ridden symbolism, and unsettling fanatic religiously coded political propaganda masquerading as "high art." And it is all those things. However, it is too reductive and too dismissive of their success. His work's extreme popularity among some right-wing circles is a bright indication of his rhetorical resonance and concerning reflection of powerful right-wing outrage over the state of American politics. His art is a kind of mythological distillation of this fervent political spirit, a valuable window into his audience's dearest sensibilities. It is especially important to unpack the mentality so clearly crystallized by McNaughton's work so that we can understand what values inform and construct this particular American right-wing mythos.

## TWIN PAINTINGS

Pictured right is McNaughton's first Trump



**Figure 1.1** You Are Not Forgotten (2017)

painting, his 2017 piece, *You Are Not Forgotten*. McNaughton's earlier politically charged work caught fame and public ire (Knight), though it was this kind of work created during Trump's highly polarizing Oval Office tenure that cemented him as one of America's foremost conservative artists. *You Are Not Forgotten* is kind of a foundational mythic illustration to this

extreme right-wing culture. It centers around the nondescript "Forgotten Man," a recurring character in his other works like *The Forgotten Man*, *The Empowered Man*, and *Wake Up America*, and his family, a woman and child, tending to a solitary flower sprouting up from dry soil. They are backdropped by blue skies and overlooked by the gleaming White House while



Figure 1.2 The Forgotten Man (2010)



Figure 1.3 The crowd's eyeline is drawn toward The Forgotten Man and his garden.

a crowd of active and retired American military men, their family members, and police officers gather around to watch with the newly elected President Trump. The crowd looks on with quiet admiration for the man and his garden while the gentle smiled open-palmed president stamps an intrusive snake's head with quiet, unbothered grace.

*You Are Not Forgotten* was McNaughton's first of many paintings to feature former President Trump, and it is especially important to recognize it in conversation with the previous McNaughton's previous piece and twin predecessor, *The Forgotten Man*. Pictured above, this 2011 painting was made in response to former President Obama's Affordable Care Act. *The Forgotten Man* first introduces the titular nondescript character who would later be painted tending to the garden of Trump's America. In his first appearance, the man slumps in a bench beside the White House lawn as darkened skies

hang oppressively over. Like in its sister Trump-centric piece, a crowd gathers around the man, but it is divided. Made entirely of former U.S. presidents, some comfort the grieving neglected man while others commemorate Obama's work. The former president crosses his arms and turns away from the Forgotten Man, casually stamping the U.S. Constitution with his heel. This act symbolizes him bringing America to ideological ruin.

*The Forgotten Man* and *You Are Not Forgotten*'s mirrored composition and inverted symbolism makes clear the right-wing theological-political ideology is reactive to the previous administration. McNaughton's work crystallizes his audience's sacred values, their perceived enemies, and their chosen narrative of Trump's America as redemption from a previous administration. Though this essay's focus is *You Are Not Forgotten*, the Obama provides essential cultural knowledge for understanding it. The

two pieces will be contrasted now and then to better understand the ideas constructing this mythologized ideal of Trump's America.

Allegorical political artwork is usually either very exaggerated, impressionistic, and sometimes caricatured, or it depicts very straightforward replicas of political actors and moments without much room for figurative meaning. However, McNaughton's art is unique. It is realist, using lifelike portraiture and environments, but symbolically charged, leaving no confusion that his pieces depict something more abstract and allegorical than pure mechanical copy of the world. Artwork excels at "inventing, selecting, and shaping [...] scenes in ways that display the relevant qualities more purely" (Arnheim 140) than a perfect imitation of the subject. Basic mechanical replication in realist art is unreflective of authentic, sensuous, storied human experience. Guided symbolism in realist art remedies that.

### STYLE AND SYMBOLISM

A realist art style also gives McNaughton's work a different kind of affect or tone than the average, more cartoonish or abstractly stylized piece of propaganda artwork might. Audience members are "influenced by the tone in which arguments are expressed" (Hill 28), and because McNaughton's style has a kind of cerebral high arts style it disguises his theological-political propaganda as elite classical culture. His pieces resemble something a person might find in a respected art museum or in a wealthy cathedral. It is easy to look overlook the spectacular unsubtlety and shallow allegory and identify his pieces in the same league as high arts. In turn, his work becomes associated with luxury, intellect, highbrow arts, and imbued with a timeless quality. There's a special kind of credibility and sincerity to his painted work that sets it apart from the average political cartoon or poster. It commands awe and admiration.

McNaughton's realist part-time symbolism has another advantage over highly stylized and abstracted symbolic art. Realistic symbolic figures "give flesh and blood to the structural skeletons of ideas" (Arnheim 141), embodying concepts with a more desirable, more immediate, more concrete "lifelike presence" (Arnheim 141). *You Are Not Forgotten*'s crowd of multigenerational military and police officers as pictured below stretching the canvas suggest a strongly patriotic culture. These people are not real, but they symbolize the combative forces of American prosperity who serving the common man, but they aren't generic either. In the crowd are people of white and black Americans young, old, and deceased there in spirit. There are veterans

with prosthetics, mobility devices, and service dogs too, though their disabilities are not shown as something to be pitied. Instead, they are to be understood as symbols of great sacrifice.

So, while McNaughton renders these people, even former President Trump, as audience to the Forgotten Man, McNaughton's cultural myth demonstrates great pride, respect, and compassion for them. Celebration of military and police forces is a common theme of American patriotism, but nationalism too. This depiction toes the line, holding back from that extreme by having them play audience to the Forgotten Man rather than characterize them with a superior and mighty tone. The gleaming White House crowning the upper half of the composition suggests the audience's familiarity and reverence for other existing nationalistic American political myth too.

The Forgotten Man is also not a real man. In *The Forgotten Man*, he is the symbolic face given to "every man, woman and child of every color and creed who is an American" ("The Forgotten Man" [Interactive]). He represents those who felt abandoned as their America collapsed into some kind of dystopian Socialist Apocalypse under Barack Obama's presidency, something McNaughton illustrated in his piece *One Nation Under Socialism*, depicting the former president burning the Constitution ("One Nation Under Socialism"). Furthermore, there's the idea that the common man is the firmament of America, placed forefront and center of the piece as all eyes gaze on him. He even takes spotlight over President Trump, who McNaughton imagines here as America's savior. Conspicuously, this symbol of oppression is a white man, which historically the most privileged and protected group in the United States. This makes it easier for McNaughton's audience to project themselves onto him because, really, he isn't addressing the entire nation – just the majority audience who shares his sentiment. In *You Are Not Forgotten*, Trump stands lovingly beside him, uplifting the man and those right-wing evangelicals who project themselves onto him. Believers in McNaughton's work see themselves as a once-oppressed people now free to redeem America's utopian spirit, growing a flower from barren ground.

But the most interesting symbolism in McNaughton's work is his evangelical-Christian political coding that really takes his work from simple allegory for America's supposed ruin and recovery to literal religious mythology. On its own, *The Forgotten Man* only depicts the ruin of a nation. McNaughton may have felt or implied religious allegory, but it only becomes explicit in *You Are Not Forgotten* which introduces a very



Figure 1.4 A cast of U.S. military members – active, retired, young, old, disabled, deceased – and their families.



Figure 1.5 A cast of U.S. police officers and other civilians.

hopeful and very unsubtle symbols for Christian redemption and salvation. This lens requires its audience to have very particular but very basic cultural familiarity with the subject, otherwise the symbolism reads hollow. Someone unfamiliar with Christian metaphor or who is outside Trump's cult of personality will either misread the allegory or find it deeply distasteful.

Just as McNaughton's Obama carelessly stamps the Constitution, his Trump gracefully and effortlessly stamps the head of a black snake intruding upon the Forgotten Man's new White House Garden. The snake in the garden stands for "the enemies of liberty, justice, and American prosperity" ("You Are Not Forgotten") as well as

the Christian doctrine that the villainous snake from *The Book of Genesis* is really the Devil disguised in serpentine form. Furthering the *Book of Genesis* parallels, the Forgotten Man pictured below nursing a flower outside the White House symbolizes the American people planting or reviving a new Garden of Eden under Trump's grace. McNaughton and his right-wing conservative culture don't only see their president as a hero, but rather liken him to Adam and Eve's descendent prophesied to crush the Devil and redeem humanity, or in this case, the United States, in the eyes of God.

This religious metaphor is obvious and shallow, but the lack of subtlety is entirely



**Figure 1.6** The Forgotten Man, a woman, and child grow a new proverbial Garden of Eden outside the White House. Off-center, President Trump graciously smiles on as he stomps a black snake, representing America's enemies to liberty and the serpentine Devil from Genesis. With this, America and humanity are redeemed.

purposeful. When painting *You Are Not Forgotten*, he wondered if his symbolic language was too obvious and too forceful, but decided that "sometimes, you have to speak forcefully, like the brushstrokes of [a] painting" ("*You Are Not Forgotten*"). For those not already bought into McNaughton's argument and rhetoric, his messaging reads as "[ludicrous] symbolic schematic symbolism in some amateur art, cheap oratory, or dreams" (Arnheim 149). It is written off with dismissive ridicule or as obvious propaganda, "overly cerebral [...] amateur fantasy" with its messages let down by its "preconceived ideas and hackneyed imagery" (Arnheim 149). The overly simplified representation of US politics and unsubtle Biblical parallels strikes a deafening chord which, for those outside McNaughton's circle, seems poorly tuned. His symbolic gestures are perfectly calibrated to his own culture.

It is common opinion in the arts that shallow symbolism is cheap. It is McNaughton's figurative obviousness that is key to his persuasive appeal. Politics are exceedingly complex, and the real President Trump's charismatic figure was never based upon some articulate or critical take-down of America's political climate. The former president's rhetorical celebrity is

crafted around the uncritical oversimplification and misrepresentation of complex issues, as well as an appeal to nationalistic American mythos. McNaughton did the same, infusing his image with the existent political and religious ideological symbolism of Trump's more radical audience members hold close. If McNaughton had chosen a less forceful path, more nuanced visual allegory, his work surely wouldn't be as provocative or mythological. Basic, strong symbols coalesce to form basic, strong images triggering equally strong emotion.

### IMAGES AS COMPULSION

Controversy is "complex, and arguments about issues involve assertions about facts and principles not every audience member may feel confident to evaluate" (Hill 28). Controversial conversations require uncertainty, skepticism, doubt, and thinking in an uncomfortable grey. McNaughton is successful because he doesn't seek to capture the grey nuances of real political controversy – he captures the pure, un-tempered, uncritical upwell of emotion he and his audiences feel. McNaughton takes incredibly complex issues and constructs a simplistic theological-political mythos sensitive to his audience's less informed political cultural

knowledge and very indoctrinated evangelical cultural knowledge. Envisioning Trump as some sort of divine savior enabling a neglected community to seed America's new Garden of Eden reinforces that community's feelings toward their political situation. They strongly feel overlooked and forgotten, and that someone like Trump will lift them up and set things right. McNaughton translates these basic gut feelings into a visual language familiar to them, mythologizing their hopes, fears, and core values into a powerful story that speaks to them.

McNaughton's rhetorical tactics are not "persuasive." Calling something persuasive suggests there are rational, contemplative, systematic cognitive processes at play. People are inclined to take shortcuts, lightening the cognitive load and speeding through or rerouting around logical reasoning. Images especially tend "to prompt irrational and unreflective responses" (Hill 27), overpowering reason as "the fastest and easiest root to make a decision" (Hill 33). Furthermore, the more realistic the stylized symbolic image, the stronger the trigger, producing a similar effect to if the subject were actually present. McNaughton's realist style plays upon this "spill-over effect" (Hill 34) to exert greater epistemic force, heightening audience engagement through unreflective heuristic thought.

Images prompt irrational and unreflective responses. McNaughton is especially skilled at artistically crystallizing his audience's Godvalues, "[exploiting] the between emotions, values, and particular images by creating associations between those images and abstract values that the persuader wishes to make more present" (Hill 35). His symbolic language continues to override his audience's rational faculties, tugging at their deepest heartfelt values like their patriotism, American dream, sense of oppression, and religious stories. Images like *You Are Not Forgotten* are easy to dismiss as blundering, simple, and obvious. It is easy to stop the analysis there. Though it is this very simplicity gives McNaughton's work special resonance. Almost always, playing on the link between emotion and cultural values will overcome and inhibit critical thinking (Hill 33). Here, the effect is not mere persuasion, giving an audience that feels disenfranchised and in need of direction a sense of recognition, community, and language – identity. This breeding of compulsion and obedience is what makes political propaganda, religious dogma, and the intersection between the two so powerful and so insidious.

### CONCLUSION

*You Are Not Forgotten* is a touchstone in

McNaughton and his community's political-theological mythology. Its simple, forceful infusion of nationalistic and familiar Biblical symbolism that turns so many away is the precise reason behind its radical success. Its uncomplicated imagistic mythology compels its audience with a narrative constructed of their deepest political and evangelical values and sensibilities hardly reflective of actual political nuance. This basic narrative dissuades the

audience from careful contemplation, forcefully compelling obedient and dogmatic adherence to a shared culture and ideology. Realist-style embodiment magnifies these symbols' rhetorical presence while creating a false sense of intellectual high art. Though beyond this, McNaughton's image is a perfect and sincere validation of their identity, of who they are and why, and how that came to be. Mythologies, the simple narrative distillation of identity to its

basic ingredients, are the story of humanity. Just as they provide a community with a universal language, they provide those outside the means to understand and relate. As controversial as *You Are Not Forgotten* and its themes might be, it is a valuable portal into a world we should understand. In remembering this work, we remember who it came from.

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# Supervised Learning of Cancer Types Using Gene Copy Numbers

Joseph Kim

## ABSTRACT

Cancer, a complex disease caused by genetic mutations, presents challenges in accurate diagnosis and treatment due to its heterogeneity. Researchers conducted a study on copy number variations (CNVs) in breast and lung cancer datasets using machine learning algorithms, utilizing data from the Cancer Genome Atlas Program (TCGA) to compare gene copy numbers between breast and lung cancer. They identified significant differences in gene copy numbers, with 37,381 genes exhibiting significant p-values with T-test method. The researchers employed the K-best method along with four machine learning algorithms in order to propose a model for predicting cancer type, finding that the Extra Tree algorithm performed best based on the F1 score. Further experiments confirmed that the T-test set consistently outperformed the K-best set in terms of both F1 score and accuracy. Ultimately, the study concluded that utilizing the T-test set with the Extra Tree algorithm and genes holding p-values  $< 0.01$  provided the most accurate prediction of cancer type based on gene copy number patterns. This suggests that the selected genes with significant p-values are more informative in predicting cancer type. This study holds significant potential to offer valuable benefits to healthcare professionals and patients alike by enabling the prediction of cancer susceptibility and facilitating timely interventions. Moreover, this proactive approach shows promising prospects for optimizing time and resource utilization through the implementation of preventive measures and early treatment strategies.

## OVERVIEW

Cancer is a complex disease caused by genetic mutations that results in uncontrolled growth and spread of abnormal cells. Just In 2023, 1,958,310 new cancer cases and 609,820 cancer deaths are projected to occur in the United States (Siegel, 2023). Accurate diagnosis and treatment of cancer remains challenging due to its heterogeneity and variability in clinical outcomes. In this study, we leverage machine learning algorithms to analyze copy number variations (CNVs) in cancer datasets, with a specific focus on breast and lung cancer due to their high sample sizes and prevalence. This genomic pattern recognition has the potential to significantly enhance the efficiency of our medical treatment system and reduce costs for patients.

Using genomic data from the Cancer Genome Atlas Program (TCGA), I analyzed the differences in gene copy numbers between breast and lung cancer. After filtering the data, 1,059 cases of breast cancer and 493 cases of lung cancer were identified, each with 55,719 genes, resulting in a total of 1,552 patients. I performed a T-test with a p-value of 0.01 to test the null hypothesis that there is no statistically significant difference in the gene copy number between the two cancer types. When my null hypothesis is rejected, it means, that each gene that holds a p-value less than 0.01 has at most a 1% chance of being the same, allowing the conclusion to be made that they are different. I found that 37,381 genes have significant p-values indicating a statistically significant difference in gene copy number between the two cancer types.

I compared the T-test dataset with the K-best method from scikit-learn using four different machine learning algorithms, namely Logistic regression, Support Vector Classifier, Decision Tree, and Extra Tree (Chegireddy, 1987). The performance of the models was evaluated using the F1 score. The logistic regression algorithm demonstrated the lowest number of Type I errors compared to other machine learning algorithms when tested on the entire dataset. For Type II errors, the Support Vector Classifier (SVC) and Extra Tree algorithms exhibited superior performance. Specifically, the SVC had two Type II errors in the original dataset, four in the T-test set, and five in the K-best set, while the Extra Tree algorithm had four Type II errors in the original dataset, three in the T-test set, and five in the K-best set. Based on the F1 score, the Extra Tree algorithm emerged as the best model when compared to the other algorithms. Notably, the F1 scores were the same for the original dataset and the T-test set.

Further experiments were performed with only the Extra Tree algorithm where multiple p-values ( $10^{-2}$ ,  $10^{-5}$ ,  $10^{-10}$ ,  $10^{-20}$ ,  $10^{-30}$ ,  $10^{-40}$ ,  $10^{-50}$ ) were tested to see how F1 score or accuracy score changed. The K-best set was created with the same number of genes that the p-value data sets have used. The results indicated that when  $10^{-2}$ , was used for the p-value, every data set (K-best sets or T-test sets) made it to the highest score on either F1 score or accuracy. However, the T-test set always performed better than the K-best set. In conclusion, we found that the best algorithm to predict cancer type by gene copy number pattern was the T-test set with the Extra Tree algorithm, when it used the genes that

hold p-values  $< 0.01$ . It was compared to the Original set with the Extra Tree algorithm and K-best set with the Extra Tree algorithm (used the same number of genes). The F1 score for the Original set was 0.979719, the T-test set F1 score was 0.979782, and the K-best set F1 score was 0.978125. The accuracy score for the Original set was 0.972103, the T-test set accuracy score was 0.972103, and K-best set accuracy score was 0.969957. Compare to the Original set using the 55,719 genes the T-test set used 37,381 genes but still holds a better F1 score and the same accuracy score when the model was built with genes that hold p-values  $< 0.01$ . In conclusion, employing the Extra tree machine learning algorithms in the conjunction with the T-test method set comprised of reduced number of genes exhibiting a p-value below 0.01 shows the highest accuracy and F1 score, meaning that we can efficiently differentiate between breast and lung cancer at this level.

## METHODOLOGY

### ALGORITHMS

Logistic regression is a statistical analysis method used to predict a binary outcome (i.e., 1 or 0). This technique analyzes the relationship between one or more independent variables and a dependent variable. In my study, I utilized logistic regression to predict the patient's cancer type (breast cancer and Lung cancer) (Kleinbaum, 2002). Additionally, I used the support vector machine (SVM) algorithm to predict the patient's cancer type. The SVM maps data to a high-dimensional feature space, enabling data points to be categorized. The penalty parameter, C, represents the misclassification or error term,

which informs the SVM optimization of the acceptable amount of error (Parbat, 2020). I also employed the decision tree and extra tree algorithms to predict the patient's cancer type. The depth of a decision tree measures the number of splits it can make before generating a prediction (Quinlan, 1996). In contrast, the extra tree algorithm creates many decision trees, each randomly sampled without replacement. All of these algorithms were used in my feature selection process (Ahmad, 2018). Additionally, cross-validation was used to train and test the model on different iterations of the dataset, ensuring a more accurate result by comparing every portion of the data (tests and training sets).

The T-test method is a statistical test that is used to determine if there is a significant difference between the mean of two groups (Kim, 2015). In my case, the T-test analysis helped me identify significant genes with specific p-values, indicating a substantial difference in gene copy number patterns between breast cancer and lung cancer. The K-best method is a feature selection method that employs a ranking system to select the K most informative features from a larger set of available features. It aims to identify the most relevant features that have a significant impact on the predictive power of a machine-learning model (Chegireddy, 1987). In the specific context of my study, the K-best method is utilized to select the same number of genes as in the T-test set. This allows for a fair and meaningful comparison of prediction accuracy between the T-test set and the K-best feature selection approach.

The confusion matrix serves as a fundamental tool for evaluating the performance of a classification model. It provides a comprehensive breakdown of the predicted and actual class labels within a given dataset, thereby presenting a detailed summary of the model's outcomes. Comprised of four distinct quadrants- True Positive, True Negative, False Positive, and False Negative- the confusion matrix offers a comprehensive perspective on the model's predictive capabilities. The True Positive quadrant corresponds to instances where the model accurately predicted the positive class, in this case, successfully identifying the specific type of cancer present in patients. True Negatives, on the other hand, reflect cases in which the model correctly predicted the negative class, accurately recognizing instances where the actual class was indeed negative. False Positives arise when the model predicts a positive class, despite the actual class being negative, known as a type I error. Conversely, False Negatives occur when the model predicts a negative class, while the actual class is positive, a type II error. These four outcomes yield valuable information for evaluating the



**Figure 1. Accuracy score comparison.** The accuracy scores of the different machine learning algorithms predicting cancer types are shown. Although it is not statistically significantly different, the Extra Tree algorithm exhibits the highest accuracy scores when compared to the other algorithms.

model's effectiveness, including metrics such as accuracy, precision, recall, and the F1 score. When evaluating classifications, one key metric is accuracy, or the correctness of the model's overall predictions, which measures the total correctly classified examples divided by the total classified examples, "1" being 100 % accuracy. Precision represents the proportion of correctly predicted positive instances out of all instances predicted as positive, calculated as the actual number of correct predictions divided by total model predictions. Meanwhile, recall, the ratio of correctly predicted positive instances to the total number of actual positive instances, is calculated from the number of true positives divided by true positives plus false negatives. The F1 score is a harmonic mean of precision and recall, providing a balanced assessment of model performance in situations where precision and recall may conflict (Abdualgalil, 2020; Visa, 2011).

### THE DATA SET

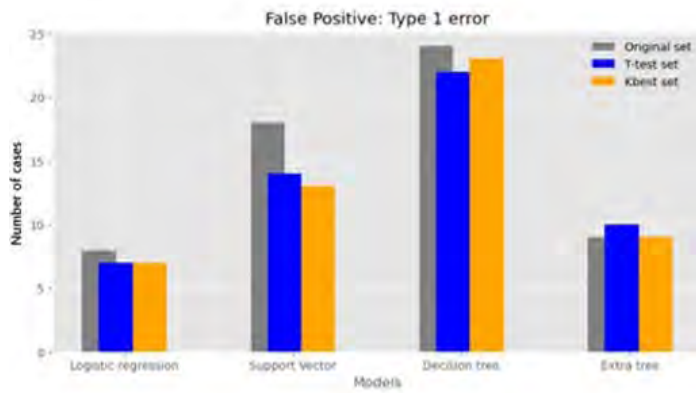
The dataset was created by identifying 1,059 breast cancer cases and 493 lung cancer cases from TCGA, resulting in a total of 1,552 patients after filtration. The original dataset consisted of 55,719 genes. The T-test method was employed to identify the most efficient and least complex approach for machine learning algorithms. The null hypothesis aimed to determine whether there was a statistically significant difference in gene copy number between different cancer

types. Initially, a p-value of 0.01 ( $10^{-2}$ ) was used to identify the best learning algorithm. Additionally, the K-best method from scikit-learn was incorporated to provide a comparative analysis with the T-test set (Chegireddy, 1987).

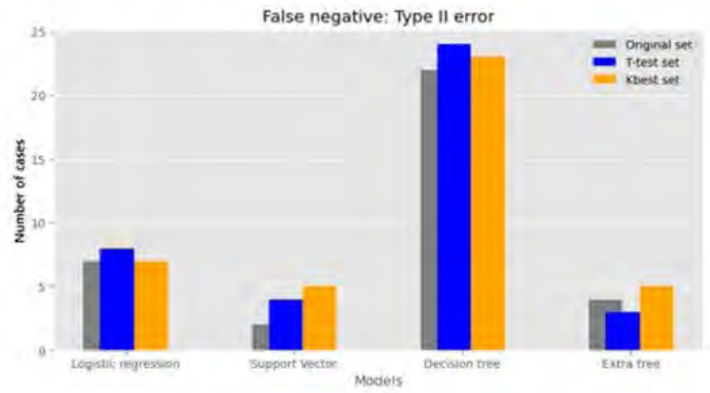
The training and testing datasets were created, including the original dataset, T-test set, and K-best dataset. The training set constituted 70% of the data, while the remaining 30% was allocated to the testing set. Each algorithm underwent cross-validation by splitting the data into 5 folds. Cross-validation is a widely used technique in machine learning and statistics to assess the performance and generalization ability of a model. It involves partitioning the available dataset into multiple subsets, or "folds," to train and evaluate the model iteratively (Schaffer, 1993). The accuracy scores of each model were compared (Figure 1). Furthermore, the confusion matrix results and F1 scores of all models were compared (Figures 2, 3). The results revealed that the Extra Tree algorithm achieved the highest F1 score.

To further test the Extra Tree model, multiple p-values were evaluated on the T-test set and the K-best set. Since the K-best set does not utilize p-values, the same number of genes as the T-test set was used in the K-best method (refer to table 1). The accuracy and F1 scores of the T-test set and K-best set were compared (Figures 4-6) to enable the identification of the superior algorithm for utilization.

**(a) Type I error**



**(b) Type II error**



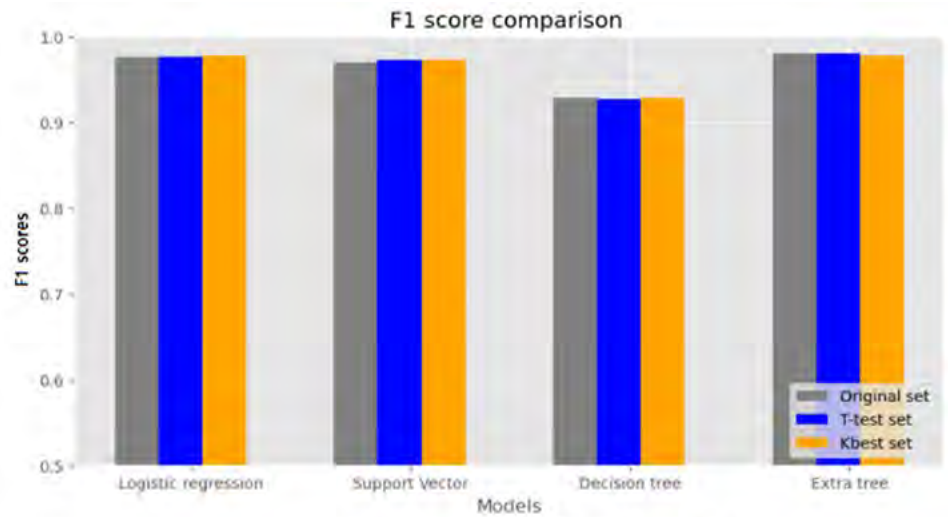
	Model	Original_set	Ttest_set	Kbest_set		Model	Original_set	Ttest_set	Kbest_set
0	Logistic regression	8	7	7	0	Logistic regression	7	8	7
1	Support Vector	18	14	13	1	Support Vector	2	4	5
2	Decision tree	24	22	23	2	Decision tree	22	24	23
3	Extra tree	9	10	9	3	Extra tree	4	3	5

**Figure 2. Type I and II Error.** Presented are the Type I (a) and Type II (b) errors that are produced by each machine learning algorithm. The Logistic regression has the lowest number of Type I errors, and the Extra Tree Algorithms have the lowest number of Type II errors compared to other algorithms. A low number of errors indicates a high degree of accuracy for a particular algorithm.

**RESULTS**

The T-test was conducted on the original dataset with a set p-value of 0.01, examining the null hypothesis that there is no statistically significant difference in gene copy numbers between different cancer types. The analysis yielded a total of 37,381 genes with a p-value < 0.01, indicating that, for the identified genes, a statistically significant difference exists for cases of breast and lung cancer. Subsequently, the T-test set was created, which retained the same number of patients as the original dataset but with a different number of genes, reflecting those that were determined to differ between the cancer types. In order to compare the performance of the T-test method and the K-best method, both approaches were applied to the Original dataset. The K-best set was designed to have the same number of patients as the T-test set, and interestingly, the 37,381 genes selected by the K-best method showed a 98% similarity to the genes in the T-test set. The following bar graph illustrates the accuracy scores of different machine learning algorithm models using various datasets.

Figure 1 presents the accuracy scores of the original set, T-test set, and K-best set. Each dataset underwent analysis using four different machine learning algorithms: Logistic regression, Support Vector Classifier, Decision Tree, and Extra Tree.



	Model	Original_set	Ttest_set	Kbest_set
0	Logistic regression	0.976452	0.976378	0.977987
1	Support Vector	0.969325	0.972136	0.972050
2	Decision tree	0.927900	0.927445	0.927673
3	Extra tree	0.979719	0.979782	0.978125

**Figure 3. F1 Score Comparison.** Presented are the F1 scores for each of the four different machine learning algorithms used for predicting cancer types. Even though it is not statistically significantly different, the Extra Tree algorithm had the highest F1 scores when compared to the other algorithms.

For the Original dataset, the accuracy scores were as follows: Logistic regression 0.967811, Support Vector Classifier 0.957082, Decision

Tree 0.901288, and Extra Tree 0.972103. Notably, the Extra Tree algorithm achieved the highest accuracy score among all the algorithms.

Similarly, for the T-test set, the accuracy scores were: Logistic regression 0.968711, Support Vector Classifier 0.961373, Decision Tree 0.901288, and Extra Tree 0.972103. Once again, the Extra Tree algorithm exhibited the highest accuracy score. In the case of the K-best set, the accuracy scores were: Logistic regression 0.969957, Support Vector Classifier 0.961373, Decision Tree 0.901288, and Extra Tree 0.969957. Both Logistic regression and Extra Tree

algorithms had the same accuracy score, which was higher than the other algorithms.

Overall, the best performing machine learning algorithm was the Extra Tree algorithm, with accuracy scores of 0.972103 for the original set, 0.972103 for the T-test set, and 0.969957 for the K-best set. On the other hand, the Decision Tree algorithm had the lowest accuracy score, with scores of 0.901288 for the original set, T-test set, and K-best set. It is interesting to note that

despite the T-test set using a smaller number of genes compared to the original dataset, they achieved the same accuracy score with the Extra Tree algorithm.

For testing the model's F1 scores, a confusion matrix was created for each model to determine the number of cases of different types of errors that were created by machine learning algorithm models using various datasets. Based on my study, the type I error, also known

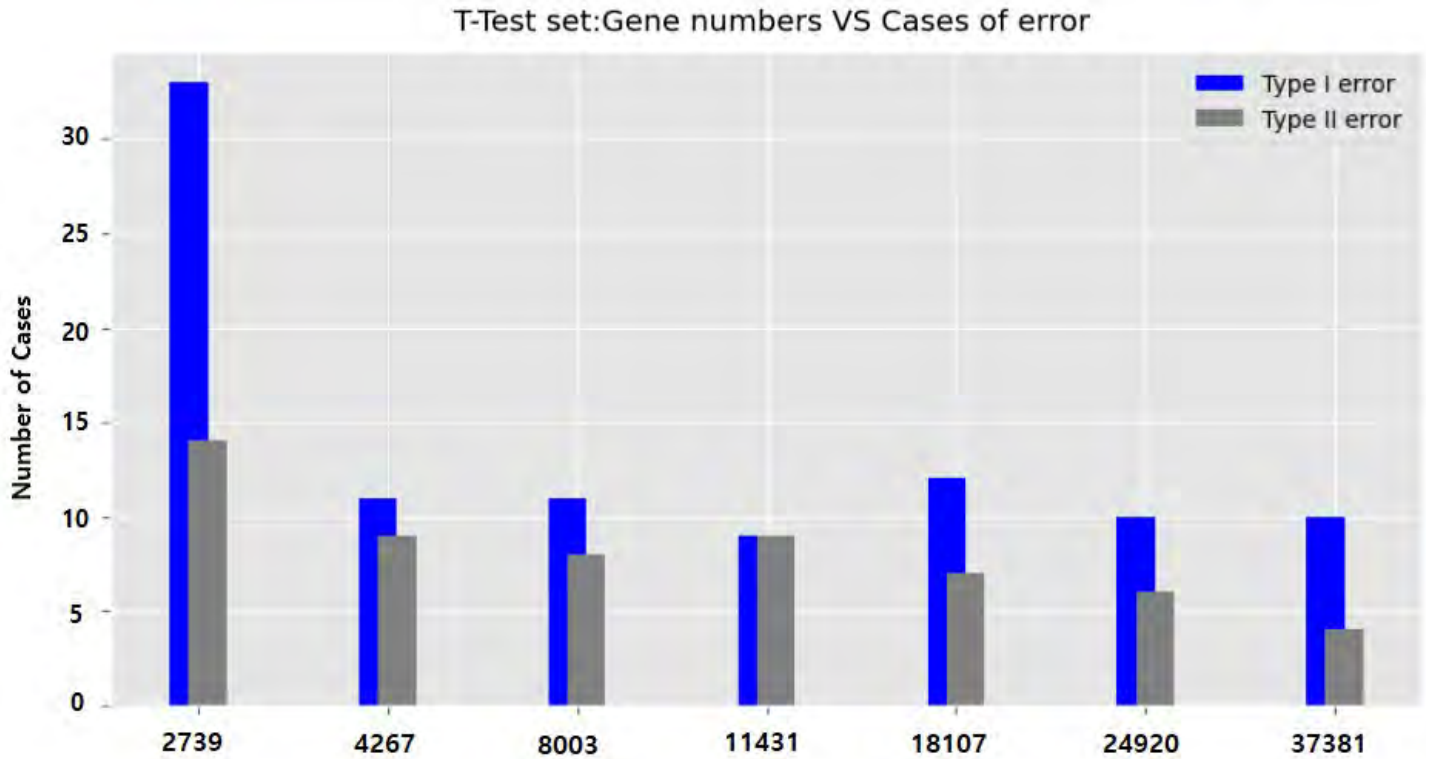


Figure 4. Illustrates the cases of errors for the T-Test set with the Extra Tree Algorithm. It demonstrates the relationship between error types and the number of genes utilized in the T-test set. Both type I and type II errors exhibit relative stability, except when the dataset includes 2,739 genes.

Table 1. Comparing Scores Between The Data Sets Built With Genes With Different P-Values"

p_values	Genes used	Gene similarity %	T-test set acc	T-test set F1 score	T-test set Type I error	T-test set Type II error	K-best acc	K-best F1 score	K-best set Type I error	K-best set Type II error
1.000000e-02	37381	98	0.972103	0.979782	10	4	0.969957	0.978125	3	5
1.000000e-05	24920	97	0.965665	0.975000	10	6	0.965665	0.975000	10	6
1.000000e-10	18107	95	0.961869	0.970359	12	7	0.952790	0.965625	13	9
1.000000e-20	11431	89	0.964615	0.971698	9	9	0.957082	0.968354	8	12
1.000000e-30	8003	86	0.957860	0.970266	11	8	0.957082	0.968750	12	8
1.000000e-40	4267	79	0.952550	0.968652	11	9	0.912017	0.935837	22	19
1.000000e-50	2739	88	0.934151	0.928244	33	14	0.929185	0.948357	18	15

Figure 5. Cases of error for K-best set with Extra tree algorithm

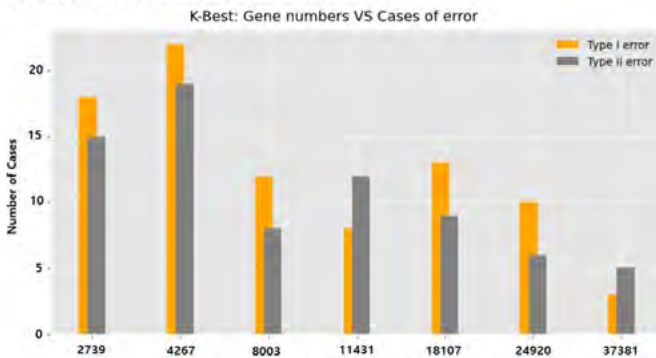


Figure 5. Type I and Type II error for K-best set with Extra Tree algorithm.

The relationship between the number of genes used in the K-best set and the corresponding trends in type I and type II errors. As the number of genes in the K-best set increased, both type I and II errors demonstrated a downward trajectory, indicating a clear correlation between the increase in gene count and the decrease in error rate.

Figure 6. Number of genes used VS Scores

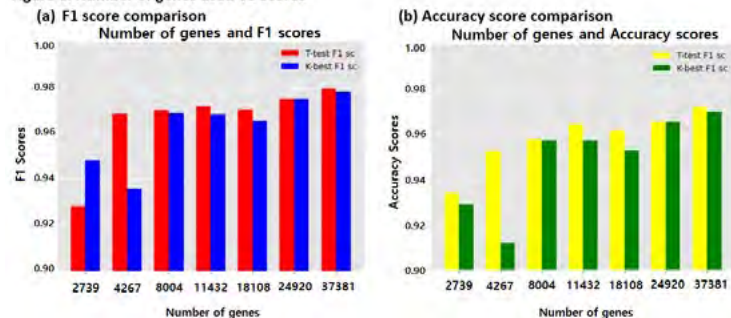


Figure 6. Number of genes versus F1 and accuracy scores. The F1 scores (a) showcase the variations in scores between the T-test set and K-best set as the number of genes they utilize varies. Similarly, the accuracy scores (b) illustrate the variations in these scores as gene numbers change. Notably, when the number of genes exceeds 8,004, the F1 and accuracy scores of both the T-test set and K-best set exhibit stability and remain closely aligned with each other. Overall, the T-test set provided better scores compared to the K-best set.

as false positive, refers to the situation where the algorithm incorrectly predicts the patient's cancer type as breast cancer when it is actually lung cancer. On the other hand, the type II error, or false negative, occurs when the algorithm incorrectly predicts that the patient does not have breast cancer (have lung cancer) when they in fact have breast cancer. It is important to minimize both types of errors for better F1 scores. Figure 2 presents the errors from all the algorithms across all the datasets, providing a comprehensive view of their performance.

Figure 2 presents the number of Type I (a) and Type II (b) errors for the original set, T-test set, and K-best set. Each dataset underwent analysis using all four different machine learning algorithms proposed. For the Original dataset, the number of Type I errors were as follows: Logistic regression 8, Support Vector Classifier 18, Decision Tree 24, and Extra Tree 9. The number of Type II errors for the original dataset were: Logistic regression 7, Support Vector Classifier 2, Decision Tree 22, and Extra Tree 4. In the T-test set, the number of Type I errors were: Logistic regression 7, Support Vector Classifier 14, Decision Tree 22, and Extra Tree 10. The corresponding number of Type II errors for the T-test set were: Logistic regression 8, Support Vector Classifier 4, Decision Tree 24, and Extra Tree 3. Similarly, for the K-best set, the number of Type I errors were: Logistic regression 7, Support Vector Classifier 13, Decision Tree 23, and Extra Tree 9. The number of Type II errors for the K-best set were: Logistic regression 7, Support Vector Classifier 5, Decision Tree 23, and Extra Tree 5.

Notably, the logistic regression algorithm exhibited the lowest number of Type I errors among all the algorithms across all datasets. Additionally, for Type II errors, the original set with the Support Vector Classifier algorithm

Figure 7. Gene similarity between T-test set and K-best set

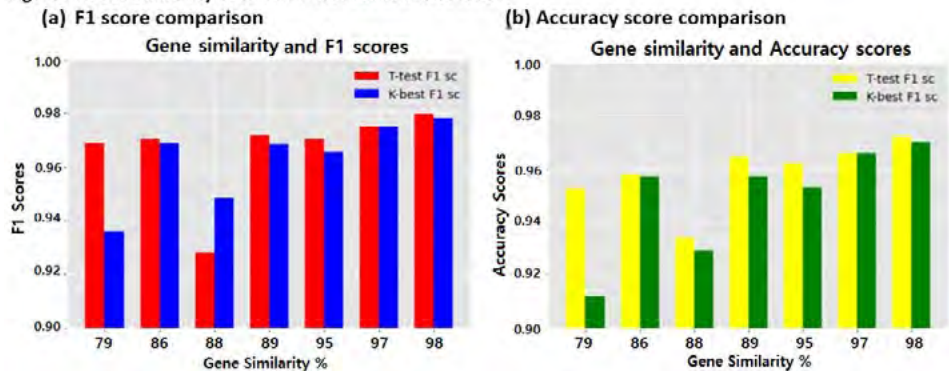


Figure 7. Gene similarity between T-test set and K-best set. (a) A depiction is given of how the F1 scores vary with the similarity of genes in the T-test and K-best sets. (b) The changes in accuracy scores with gene similarity in both sets are shown. Notable, the T-test sets consistently held better scores in both regards compared to K-best sets. However, beyond a gene similarity of 89%, both sets exhibited similar and stable performance in terms of F1 and accuracy scores.

had the lowest score, followed by the T-test set with the Extra Tree algorithm. For the K-best set, both the Support Vector Classifier and Extra Tree algorithms had the same lowest score.

Figure 3 presents the F1 scores of the Original set, T-test set, and K-best set. Each dataset underwent analysis using the four different machine learning algorithms tested. With the exception of the Decision Tree algorithm, the F1 scores for the other algorithms were relatively close, ranging from 0.969 to 0.979. For the Original dataset, the F1 scores were as follows: Logistic regression 0.976452, Support Vector Classifier 0.969325, Decision Tree 0.9279, and Extra Tree 0.979719. Similarly, for the T-test set, the F1 scores were: Logistic regression 0.976378, Support Vector Classifier 0.972136, Decision Tree 0.927445, and Extra Tree - 0.979782. In the case of the K-best set, the F1 scores were: Logistic regression 0.977987, Support Vector Classifier 0.972050, Decision Tree

0.927673, and Extra Tree 0.978125. Notably, the Extra Tree algorithm consistently achieved the highest accuracy score among all the algorithms across all datasets. The original dataset was comprised of 55,719 genes, while the T-test set contains 37,381 genes. Surprisingly, the T-test set achieved comparable or even higher accuracy and F1 scores (Figure 1, 3) when predicting the cancer type of patients. My goal was to identify a dataset with similar or improved accuracy while utilizing fewer genes, thereby optimizing the efficiency of the learning process. To achieve this, I generated multiple datasets with lower p-values (Table 1), selecting genes that displayed greater significance in gene copy number. For the evaluation of accuracy and F1 scores across these datasets, I leveraged the Extra tree algorithm, which demonstrated superior performance compared to other algorithms (refer to fig. 1 and fig. 3). The purpose of creating the K-best set was to compare the scores (accuracy and F1 scores)

of the K-best set against those of the T-test set to gauge their prediction capabilities.

In addition to the aforementioned comparisons, we can also use this data to analyze the cases of type I and type II errors. The type I error here is false positive, refers to the situation where the algorithm incorrectly predicts the patient's cancer type as breast cancer when it is actually lung cancer or other way around. On the other hand, the type II error, or false negative, occurs when the algorithm incorrectly predicts that the patient does not have breast cancer (have lung cancer) when they actually have breast cancer (have lung cancer). This consolidated table provides a concise overview of the performance metrics and error rates for both sets.

In order to accurately analyze the data, some specific steps had to be taken. The p-values used in the T-test set were  $10^{-2}$ ,  $10^{-5}$ ,  $10^{-10}$ ,  $10^{-20}$ ,  $10^{-30}$ ,  $10^{-40}$ , and  $10^{-50}$ . However, it is essential to note that the K-best method does not incorporate p-values. To facilitate a comparison between the T-test set and the K-best set, the number of genes in the T-test set has been employed as the criterion for selecting the number of features in the K-best method when constructing the K-best set. The analysis revealed that the similarity in terms of gene composition between the two sets initially decreased to 79% when employing a p-value threshold of  $10^{-40}$ . However, the similarity started to increase again when a more stringent p-value threshold of  $10^{-50}$  was applied. In contrast to the decreasing trend observed in the accuracy scores and F1 scores, the number of type I and type II errors exhibited a gradual increase as the p-value decreased. This suggests that as the significance threshold became more stringent, resulting in a smaller number of selected features, the model became more prone to both false positive (type I) and false negative (type II) errors. The trade-off between feature selection and error rates should be carefully considered when determining the optimal p-value threshold for the analysis.

**Figure 4** displays the counts of type I and type II errors across T-test sets with varying p-values or gene numbers. The number of type I errors exhibits consistency, hovering around 10, with a notable increase to 33 occurring only at a gene count of 2,739 (p-value  $10^{-50}$ ). Conversely, the lowest count of type I errors aligns with a gene number of 11,431. Conversely, type II errors begin at 10 and gradually decline as the dataset's gene count increases. However, at a gene number of 2,739, they abruptly rise to 14. The lowest count of type II errors corresponds to an x-axis value of 37,381. Both error types maintain relative stability, except at the gene count of 2,739.

**Figure 5** displays the counts of type I and type II errors within the K-best sets featuring different gene numbers. Type I errors begin at 18 for gene number 2739, declining to a low of 3 at gene number 37,381. Also, type II errors commence at 15 for gene number 2739, reaching a peak of 19 at gene number 4,267, then reducing again to 5 at gene number 37,381. Both error types generally stabilize, except at a gene number of 2,740 and 4267. The T-test set demonstrates more consistent error counts compared to the K-best set. Surprisingly, the lowest counts for both error types are observed in the results from the K-best set rather than the T-test set.

We can see that T-test set has more stable outcomes when comparing the number of errors compared to the K-best set, but interestingly, the lowest number of both error type values were found to be in the results from K-best set not the results from the T-test set.

In the analysis presented in Table 1 and **Figure 6(a)**, it is evident that the F1 score of the T-test set consistently remains above 0.96 when the dataset includes more than 4,267 genes. Conversely, the K-best set maintains an F1 score above 0.96 when the dataset consists of at least 8,003 genes. Moreover, to achieve an accuracy score above 0.95, the T-test set requires a minimum of 4,267 genes, while the K-best set necessitates 8,003 genes. These findings indicate that the T-test set demonstrates marginally higher accuracy and F1 scores compared to the K-best set. Notably, as the number of genes in the dataset decreases to 4,267, the K-best set experiences a substantial decline in F1 score, whereas the T-test set exhibits stability. Interestingly, with a further decrease in the number of genes to 2,739, the F1 score of the K-best set rebounds and surpasses that of the T-test set.

Similar trends are observed in the accuracy scores, with the T-test set consistently outperforming the K-best set. In the accuracy scores, **Figure 6(b)** shows that the T-test set consistently remains above 0.95 when the dataset includes more than 4267 genes. Conversely, the K-best set maintains an accuracy score above 0.95 when the dataset consists of more than 8,003 genes. Notably, as the number of genes in the dataset decreases to 8,003, the K-best set experiences a substantial decline in performance, whereas the T-test set exhibits stability. In summary, the F1 scores of the T-test set exhibit greater stability, even with a lower number of genes, compared to the K-best set.

Indeed, the findings from **Table 1** and **Figures 7(a)** and **7(b)** suggest that the number of genes used in the datasets has a greater impact on the performance metrics (F1 scores

and accuracy scores) than the gene similarity percentage between the T-test set and K-best set. Despite the differences in the mathematical equations used to create the T-test set and K-best set, it is interesting to observe that they still exhibit similarities in the genes they select. This implies that certain genes are consistently identified as influential or relevant for the analysis, regardless of the specific methodology employed. However, as the gene similarity percentage reaches 88% on the graph, we can see that the F1 scores of the T-test set and K-best set start to diverge, indicating that their performance begins to differ significantly. This suggests that beyond a certain gene similarity threshold, other factors, such as the specific genes selected and the way they interact, may have a greater influence on the performance of the models. Overall, the results highlight the importance of considering both the number of genes used and their specific selection in determining the performance of the T-test set and K-best set.

## DISCUSSION

My program was able to get the best F1 score and accuracy score by using the data set that was built with 37,381 genes that were chosen by the T-test with p-values  $< 0.01$ . The Extra tree algorithm was the best model to predict the cancer type of patients, since it has higher F1 and accuracy score over the other tested machine learning algorithms, Logistic regression, supportive vector classifier, and decision tree (**Figure 1, 3**). Further experiment was continued on the Extra tree algorithm with data sets that created with different p-values ( $10^{-2}$ ,  $10^{-5}$ ,  $10^{-10}$ ,  $10^{-20}$ ,  $10^{-30}$ ,  $10^{-40}$  and  $10^{-50}$ ) using T-tests. The produced T-test data sets were compared to a K-best data set that was created with an equivalent number of genes to the respective T-test set. The lower the p-value the T-test uses, the lower the number of genes the data set used for predicting cancer type of patients as well. Surprisingly, both the accuracy score and F1 score were able to stay above 90% when using only 2,739 genes (p-value of  $10^{-50}$ ) which is only 4.9% of the original gene pool collected (55,719 genes). However, the T-test set always had higher F1 and accuracy scores compared to the respective K-best set, except when K-best set and T-test set both used the 2,739 genes, in which the K-best set had a higher F1 score than the T-test set. Overall, for the Extra tree algorithm, the T-test method is the better algorithms to pick the genes that differentiate the cancer type of patients. The similarity between T-test sets and K-best sets with different numbers of genes found that the number of genes was more important than the similarity of genes (**Table 1, Figure 6, and Figure 7**).

## CONCLUSION

This study has yielded valuable insights and has ignited the potential for future endeavors in the field of cancer genomics. By expanding the program to incorporate data from healthy individuals and their corresponding normal genes, we have the potential to provide crucial assistance to patients and medical professionals in predicting the likelihood of developing cancer. This proactive approach could facilitate timely interventions before the health of individuals deteriorates significantly. The incorporation of preventive measures or early treatment strategies based on such predictions holds promise for saving considerable time and financial resources.

While the present study focused on two specific types of cancer, future research should focus on broadening the analysis to encompass

all cancer types and exploring the patterns of gene copy numbers across diverse malignancies. Expanding the scope of this research would allow the identification of common genes implicated in multiple cancer types while also discerning the genes that are specifically significant for each particular cancer type. This comprehensive analysis would provide a holistic understanding of the genetic landscape underlying various cancers.

When conducting further research, it is imperative to carefully consider various factors, including the specific type of cancer under investigation. Skin cancer, for instance, may exhibit a distinct pattern in gene copy number due to its association with UV radiation exposure, unlike other cancer types that are predominantly driven by genetic inheritance and gene mutation

(Narayanan, 2010). Another critical aspect to evaluate is the sample size available for each cancer type. In the present study, the dataset comprised 1,059 cases of breast cancer and 493 cases of lung cancer. The adequacy of the sample size is pivotal, as it directly influences the performance of algorithms employed and ultimately impacts the overall outcomes of the study.

Furthermore, it is essential to meticulously address and account for potential biases introduced by various demographic variables, such as sex ratio, age, race, and others, during the gene analysis process. By thoroughly considering and mitigating these potential biases, future research endeavors can ensure the production of robust and unbiased outcomes, thus enhancing the reliability and generalizability of the findings.

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# Untitled, Fragmentation

*Daijah Richardson*

## **ABSTRACT**

Within this vertically oriented oil painting, femininity takes the visual forefront, in addition to overlapping concepts of identity, pain, sexual fluidity and sexuality.

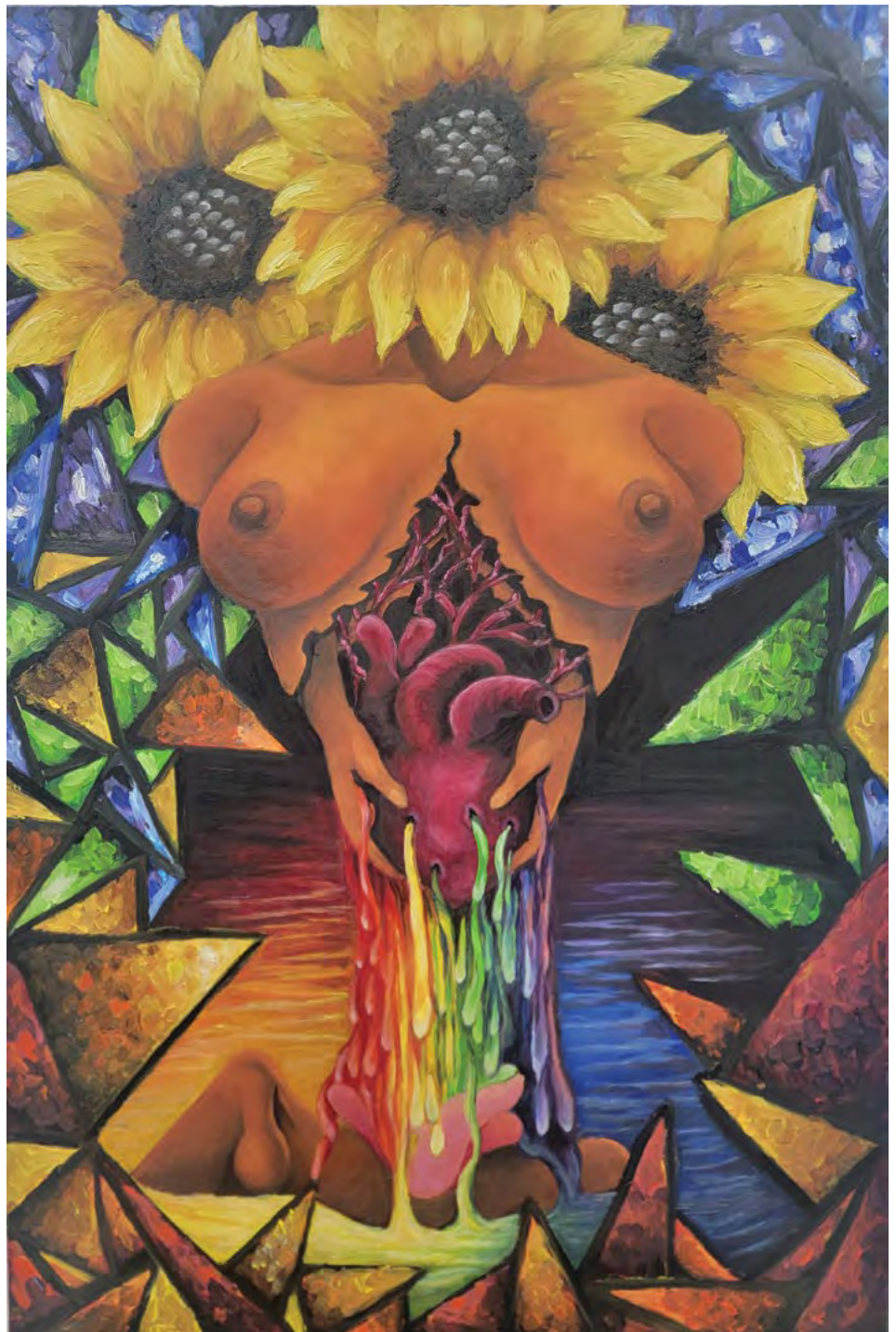
The entire color wheel can be found within the triangular shapes that frame the canvas, the drips from the heart, as well as the pool of color below. Repetition of the color scheme within the rigid shapes and within the fluid forms symbolizes rigid social constructs—such as sex and gender, ethnic heritage and sexuality—that simultaneously appropriate, yet confine the fluid nature of the inner self.

The focal point is the ample bare breast of an African decent woman, which illustrates femininity and ethnic identity. She is anonymous due to the lack of a head or face. Her face has been replaced with sunflowers to reflect her thoughts of positivity and hope. Below her breast, her arms protrude from within her chest cavity, clasping her punctured and bleeding heart. The extracted heart indicates her pain and suffering as a full spectrum of colors cascade down into a sensually open female mouth. The mouth is open in anticipation to taste the heart's colorful suffering, whilst she is also experiencing distress being submerged in the deep pool of color below.

Initially, this piece was created as a LGBT Pride piece with an emphasis on Lesbian identity, Black female identity, and the suffering that comes from keeping one's authentic truth trapped behind rigid social constructs. Once the fragility of oppression is discovered, it can be broken to allow a deeper space to be seen, felt and shared. This deeper communal space is based on the relatable experiences of distress and suffering of these ethnic women. The execution of this concept, although sensual in nature, opens to a deeper need for community, awareness, hope and overall pride.

## **ACKNOWLEDGMENTS**

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