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# The City is Ours: An Examination of Motivation within the 31st Massachusetts Regiment in Occupied New Orleans, 1862-1863

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New Orleans was the largest city in the Confederacy. It was politically, economically, and culturally important to the South. Strategically positioned at the end of the Mississippi River, New Orleans served as an important port through which the Confederate States exported Southern commodities. On May 3, 1861 in a correspondence with Maj. Gen. George B. McClellan, Winfield Scott, Union General-in-Chief, wrote, "Finally, it will be necessary that New Orleans should be strongly occupied and securely held until the present difficulties are composed."[1] When it was decided that New Orleans should be reclaimed by the United States Federal government, General Benjamin Butler, of Massachusetts, was authorized, on September 10, 1861 to raise no more than six regiments. It was among these regiments that the 31st Massachusetts, known then as the Western Bay State regiment was born. After several months in Camp Seward, the 31st was moved to Boston on February 20, 1862 to prepare for their voyage to Ship Island. On March 25, 1862 the 31st landed on Ship Island, a small island roughly 97 kilometers from the city of New Orleans where a variety of regiments were camped prior to the Battle of New Orleans. Many from the 31st make note of the island, but it is Luther Clark Howell, of Co. D who provides us with the most interesting description, writing, "My old ideas of the "Great Sandy Sahara" are fully realized into the ankle at every step we go on this lower end of the island. We walk in the sand, sleep on the sand, and eat sand pudding."[2] On May 1, 1862 Union forces reached New Orleans. The 31st Massachusetts was the first regiment to enter the city.

Our perception of the Civil War is one of blood and battle, brother fighting brother, and a nation at war with itself. Rarely does one study the less gruesome but important role of the

[1]Scott, Winfield. "The Anaconda Plan (Scott to McClellan)." Shotgun's Home of the American Civil War. May 3, 1861. http://www.civilwarhome.com/scottmcclellananaconda.html (accessed March 23, 2016).
[2] Howell, Luther Clark. "Letters of Luther Clark Howell, 1861-1862." *31st Massachusetts Volunteers.* March 3, 1862. https://31massinf.wordpress.com/correspondence/letters-of-luther-clark-howell-1861-1862/ (accessed March 23, 2016).

occupation forces who reconquered rebel cities. The story of the 31st Massachusetts Volunteer regiment is not one of glory or battle, but of duty and honor. Like many men who volunteered to serve the Union armies, the 31st exhibited typical motivation factors. Prior to the occupation of New Orleans, the 31st Massachusetts spent several weeks in Camp Seward in Pittsfield, Massachusetts, where soldiers began to grow tired of camp life. Joshua W. Hawkes of Co. C writes, "It is not pleasant, remaining here week after week on this bleak hill hoping each will be our last, yet still we are here."[3] This attitude was not uncommon among soldiers in the early war and while it does provide us with some insight, we should not interpret their boredom as a lack of motivation. Soldiers all throughout the Union and Confederacy experienced pre-war depression, and while some may have been reluctant, many simply sought action. The 31st Massachusetts was unique to the Civil War in that they were inexperienced soldiers whose first major interaction with the Confederacy was during the Battle for New Orleans, which resulted in several months of Union occupation. This occupation would lead to the development of a unique experience for the men of the 31st Massachusetts as they became veteran soldiers without experiencing battlefield combat. Occupying soldiers, therefore, develop their own type of motivation as a substitution for battle motivation.

Much has been written about motivation and much has been written about occupation. Studies relating to both of these subjects are, however, quite limited. Even more limited is the study of specific regiments during occupations of Confederate cities. Author Gerald M. Capers, attempts to address some of these issues in *Occupied City: New Orleans under the Federals 1862-1865.* While Capers provides readers with some examination of motivation, he does little

[3] Hawkes, Joshua W. "Letters of Joshua W. Hawkes — Part 2, Jan. – Jun. 1862." *31st Massachusetts Volunteers.* January 5, 1862. https://31massinf.wordpress.com/correspondence/letters-of-joshua-w-hawkes-part-2-jan-jun-1862/ (accessed March 23, 2016).

analysis beyond general statements, writing "He came [Union soldiers] or was sent to conquer, with no intention of making his sojourn any longer than was absolutely necessary."[4] Although Capers did not write much about motivation, the selection from his work above demonstrates that he had an understanding of occupying soldiers, at least during early occupation. Capers statement is only relevant within, perhaps, the first month or less of occupation. It is certainly true that soldiers in the 31st Massachusetts felt this way prior to their arrival in the city. What becomes clear, however, is that over time the men of the 31st develop a sense of respect and admiration for the city. James B.T. Tupper of Co. D writes, "I have got quite attached to my little confiscated room in New Orleans & warm bed, more so than I imagined till I came to leave."[5] The same can be said of Emory P. Andrews of Co. C. In an 1889 letter, he reminisces on how he was spit on by a young woman and then became friends after a meeting with her father. "They had come to swear everlasting allegiance to the glorious "stars and stripes!' The oath administered, a happy half hour made friends for me of that once rebel family." This change in attitude is critical to understand the ideology and motivation of the 31st Massachusetts. Stephen V. Ash, author of *When the Yankees Came: Conflict and Chaos in the Occupied South, 1861-1865,* provides readers with another study of occupation but focuses primarily on the experiences of the citizen of occupied areas, stating, "This study deals principally with Southern whites."[6] Ash's study also utilizes sources from various regiments throughout the South, providing readers with a broader study of the occupied South rather than examining regiments individually. Understandably, Ash offers little analysis of Union soldiers as his goal is to exam occupation on

[4] Capers, George M. *Occupied City: New Orleans Under the Federals 1862-1865.* University of Kentucky Press, 1965.
[5] Tupper, James B.T. "Letters of James B. T. Tupper — Part 1, December 1861 — June 1862." *31st Massachusetts Volunteers.* December 1861. https://31massinf.wordpress.com/correspondence/letters-of-james-b-t-tupper-of-hardwick/ (accessed March 8, 2016).
[6] Ash, Stephen V. *When the Yankees Came: Conflict & Chaos in the Occupied South, 1861-1865.* Chapel Hill: The University of North Carolina Press, 1995, ix.

a large scale. Much more focused is *Shifting Loyalties: The Union Occupation of Eastern North Carolina,* by Judkin Browning. Rather than examining the South as a whole, Browning examines eastern North Carolina and explores various aspects of occupation including soldier motivation. While much of his findings revolve around the experience of southern citizens, Browning dedicates a chapter to the exploration of the effects occupation had on Union soldiers. His study of the Union soldiers who occupied eastern North Carolina suggests a more pessimistic attitude about motivation. He suggests that these soldiers experienced low levels of morale and did not believe that they were serving the Union best through occupation.[7] While Browning's findings may prove true among Union soldiers in eastern North Carolina, it is certainly not the case among the 31st Massachusetts in New Orleans. Other studies of Civil War occupation, including Walter T. Durham's *Nashville: The Occupied City, 1862-1864* and *Reluctant Partners: Nashville and the Union, 1863-1865* provide only general statements about soldiers and focus almost exclusively on the citizens. Interestingly, the trend to include the study of soldiers through the lens of occupation may be gaining popularity among historians. In 1965, when Capers wrote his study, the focus was very broad and textbook like in style. In Browning's 2011 study of occupation included soldiers. Perhaps, in the future, the occupying soldiers will gain the attention from historians that they deserve.

With the limited availability of Civil War sources dealing with occupation, it begs the question, why is this not studied more commonly and if it is studied, why is the focus so rarely the soldiers? This is perhaps best addressed by answering the questions separately. Why is occupation a less commonly studied aspect of the Civil War? While there may be a variety of reasons, the simplest might suffice. People, in general, would much prefer to read of battles than

[7]Browning, Judkin. *Shifting Loyalties: The Union Occupation of Eastern North Carolina.* Chapel Hill: The University of North Carolina Press, 2011, 124.

occupation. Occupation is not perceived as heroic or romanticized to the level of battles. When people do have a perception of occupation, it is almost always a negative one. This was certainly true in the case of the thousands of civilians who were to be under Union occupation. While looting and stealing certainly occurred during the occupation of New Orleans on the part of the Union, much of the large-scale destruction came in the days prior to occupation largely caused by the Confederacy. Rumors spread throughout the South of the brutalities that the Union brought to a city when they occupied it. Ash writes, "When Confederate troops prepared to pull out, citizens who earlier had welcomed their presence now found reason to deplore it. In such cities as Nashville and New Orleans military authorities grew desperate in their effort to remove war material."[8] Because of the large-scale destruction of public and private property, our memory of occupation has been negatively affected. New Orleans in particular suffered heavy losses. "The citizens of New Orleans watched in dismay as thirteen thousand bales of cotton went up in flames along the levee; nearby in the water drifted the burning remains of boats that could not be taken away."[9] Occupation is justifiably viewed as negative, but much of the blame lays with the Confederacy, especially in New Orleans. While the Union was not wholly responsible for the destruction of the city, they are remembered for bringing about the conflict that resulted in the destruction. For this reason, occupation remains, in modernity, a controversial and sensitive subject to many in the South. As result, studies of occupations remain less popular.

Just as James McPherson, author of *For Cause and Comrades: Why Men Fought in the Civil War* wrote that motivation was based on ideology; the volunteers in the 31st were no different. It was ideology that made them join the army and ideology that made them stay. There were a variety of different factors in the lives of occupational forces, however. Our perception of

[8] Ash.1995, 17.
[9] Ibid.

traditional soldier's roles in the Civil War places them on a battlefield, or in a camp. These soldiers experienced a more dangerous yet easier to interpret lifestyle. Their motivating factors vary, but often include a sense of duty and a desire to restore the Confederacy back to the control of the Union. Soldiers who enlisted in the 31st Massachusetts frequently displayed their excitement and motivation to contribute to the war effort. Frank S. Knight, from Co. D writing to his mother on February 4, 1862, he says, "We are all ready to go down South into the Enemy's country. Most of the men are anxious to be in the fight. We mean that our battles shall be battles of principal, truth and justice, and if we fall 'twill be a glorious death to die, fighting for one's Country."[10] While Frank S. Knight and his comrades showed enthusiasm to fight, quotes similar to those above also display a degree of naivety. Joshua W. Hawkes, of Co. C writes to his mother before leaving for New Orleans saying, "I am by no means sick of soldiering, but I enlisted to go south, not to freeze in Pittsfield."[11] Ironically, these inexperienced soldiers would soon wish for cooler weather after they began to settle into the city of New Orleans.

Soldier motivation is complex and changes over time. Using the methods of John Lynn, who studied French Revolutionary armies, McPherson writes that there are three types of motivation: initial motivation, sustaining motivation, and combat motivation. He writes, "The first consists of the reasons why men enlisted; the second concerns the factors that kept them in the army and kept the army in existence over time; and the third focuses on what nerved them to face extreme danger in battle"[12] McPherson's study of soldier motivation, however, revolves around the traditional view of soldiers, who experienced the war on the battlefield. As we are

[10] Knight, Frank S. "Letters of Frank S. Knight, Co. D." *31st Massachusetts Volunteers.* November 14, 1861. https://31massinf.wordpress.com/correspondence/letters-of-frank-s-knight-co-d/ (accessed March 10, 2016).
[11] Hawkes, Joshua W. "Letters of Joshua W. Hawkes — Part 1, 1861." *31st Massachusetts Volunteers.* November 23, 1861. https://31massinf.wordpress.com/correspondence/letters-of-j-w-hawkes-part-1-1861/ (accessed March 23, 2016).
[12] McPherson, James M. *For Cause & Comrades: Why Men Fought In The Civil War.* New York: Oxford University Press, 1997, 12.

now discovering, Civil War soldiers can no longer be viewed through a single lens and should not be studied as simply Northern or Southern. Through analyzing the correspondences and diaries of men of the 31st Massachusetts, another type of motivation must be explored. In addition to McPherson's three types of motivation, the 31st Massachusetts experienced a unique set of motivating factors that arise only among an occupying force. This occupation motivation revolves around circumstances that do not arise on the battlefield. Because these men experienced little in the way of actual combat, their hatred for the South does not develop as fully as it did among regiments who regularly experienced combat. A sense of sympathy and respect for Southern citizens developed throughout the occupation. While this in no way means that members of the 31st Massachusetts believed that the South had a right to autonomy, it is significant to note that these men were able to put aside their bias of the South so that they could restore New Orleans to the Union.

Prior to the capture of the city, attitudes about the fight are somewhat unclear. While some soldiers such as James B.T. Tupper of Co. D writes, "I don't imagine our regiment will be much exposed & I should be glad if we could take New Orleans without firing a gun, but we have to go prepared, of course."[13] While others such as Frank S. Knight did not share his optimism, writing, "We expect a hard fight soon. We have a wide difference – they outnumber us."[14] Initial attitudes towards the capture of New Orleans are overwhelmingly positive, however. Whatever lack of enthusiasm or fear may have arisen, with the capture of the city, morale soared. Joshua W. Hawkes writes, "This has been one of the proudest days of my life! Secession is at a discount. The Yankees have sailed up to the braggart city of New Orleans

[13] Tupper, James B.T. "Letters of James B. T. Tupper — Part 1, December 1861 — June 1862." *31st Massachusetts Volunteers.* December 1861. https://31massinf.wordpress.com/correspondence/letters-of-james-b-t-tupper-of-hardwick/ (accessed March 8, 2016).
[14] Knight, 1861.

without so much as a gun being fired."[15] Similarly, 1st Sergeant Abram J. Nichols, of Co. I writes, "We shall remember this day as long as we live."[16] The retaking of the city was the first and most significant achievement of the members of the 31st Massachusetts. It would set the tone for the remainder of their service.

Restoring New Orleans to its proper place with the Union, in fact, was a significant aspect of the 31st Massachusetts' motivation. Although this was present initially, it was further developed once soldiers had established themselves within the city. As they became more familiar with New Orleans and its inhabitants, soldier desire to save the city became stronger. While it had always been the intention of the 31st to take back the city, it was not until they lived within it that they developed a legitimate desire to help it. To a certain extent, there was an ideological change. Prior to their arrival and perhaps during the first week of occupation, soldiers were under the impression that they would be fighting rebels rather than policing a city. It was not until they had become more familiar with the circumstances and established themselves that these ideals change. Frank S. Knight writes,

> The streets are filled with smiling faces — business has again thrown open doors. The wealthy have left the City for summer watering places, property is secure, and I think Abraham Lincoln, President of the United States (and thank God the only one) might walk unharmed and unaccompanied at any time through these streets in full safety, and to the joy and delight of very many, who have heretofore been accustomed to link his name with curses and execrations.[17]

The soldier perception that they had returned order and safety to New Orleans was common among the 31st and was a large part of their occupation motivation. James B.T. Tupper writes, "New Orleans is getting to be quite a respectable city. The people consider Yankees just as good

[15] Hawkes, 1862.
[16] Nichols, Abram J. "Abram J. Nichols — Ship Island to New Orleans." *31st Massachusetts Volunteers.* July 17, 1863. https://31massinf.wordpress.com/narratives-letters-diaries/abram-j-nichols-ship-island-to-new-orleans/ (accessed March 8, 2016).
[17] Knight, 1861.

as anybody else & as I walk along the street folks bow as politely as though I was an old resident."[18] While battlefield soldiers experienced this to a degree, they did not develop the same amount of care for liberated areas as did the 31st. Occupation motivation therefore leads to a longer sustained motivation among soldiers. Although this has, to my knowledge, not been addressed prior to this study, it should not come as a surprise. Occupation forces, especially members of the 31st Massachusetts saw immediate positive results from their work in New Orleans. While soldiers on the battlefield could only develop a sense of success from a decisive victory, the men of the 31st experienced gratification from simply living in the city that they had restored to order.

Although the 31st did not fall into the category of soldiers who actively participated in combat, their contributions were significant. The capture of New Orleans was an early victory for the Union and served as a morale boost to not only the 31st Massachusetts, but to the Union as a whole. Gerald M. Capers, author of *Occupied City: New Orleans under the Federals 1862-1865,* writes, "By far the most important consequence of the capture of New Orleans was its effect upon northern morale and upon the attitude of Europe."[19] Occupying a city was significantly different from fighting a battle. Despite the fact that the 31st Massachusetts served the Union more similarly to police rather than soldiers, this did not affect their morale. Rather than finding glory through participating in combat, members of the 31st developed a sense of gratification by liberating and securing the city of New Orleans. Whether they did so knowingly or not, the 31st Massachusetts volunteers substituted potential battlefield glory with a sustained sense of purpose. The men of the 31st experienced an evolution from green soldiers into veterans

[18] Tupper, 1862.
[19] Capers. 1965, 52.

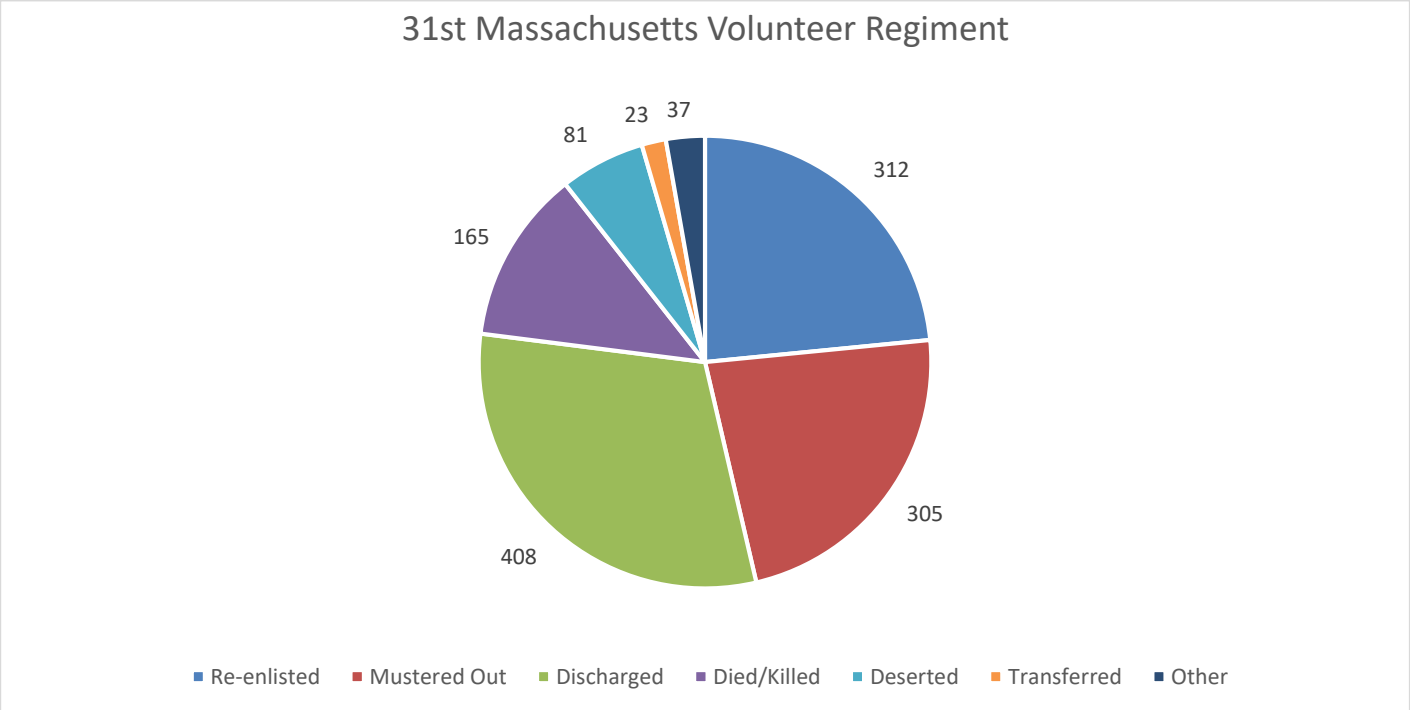
without being involved in battlefield combat. Again, the 31st Massachusetts challenges our cultural perception of soldiers.

Motivation is undeniably linked to ideology and morale and therefore the preferences and attitudes of these soldiers must be taking into account. Occupation duty was, understandably, boring, and the men of the 31st certainly made this known in their letters home. Writing to his mother, Joshua Hawkes writes that the long nights were "rather wearing" but was able to remain positive writing, "My motto, however is – Do present duty to the best of my ability and let the future take care of itself."[20] Boredom affects all soldiers, but occupying forces experience boredom at high levels. As we saw in the case of Luther Clark Howell, who quickly grew tired of the new sandy terrain of Ship Island, the environment certainly affected soldier behavior. The climate of New Orleans was significantly warmer than that of Massachusetts and the men frequently documented this. Equally torturous to the men were the mosquitos. Frank Knight, writing to his mother, provides a description, "I have been to bed, but the mosquitos are so thick could not go to sleep. They almost take one out of bed. You can hear them buz [sic] all around the room."[21] In the same letter from above, Joshua Hawkes also notes the difficulties presented by the heat and mosquitos writing, "It is hot here and no mistake. Take it about noon with coats and buttoned close, don't we sweat? The "Skeeters" here are "very ferocious". You lie down at night for a little sleep – you are fortunate if you get asleep – only to wake, smarting from the bites."[22] The environment impacted many Union soldiers. Browning's study reveals this was as common in North Carolina as it was in New Orleans. Browning writes, "North Carolina might as well have been a foreign country for that is how many northern soldiers viewed the climate,

[20] Hawkes, 1862.
[21] Knight, 1861.
[22] Hawkes, 1862.

landscape, and inhabitants."[23] Soldiers of the 31st certainly experienced many of the same feelings. The climate and everything it brought with it, plagued those in North Carolina as well. Mosquitos and intense heat brought frustration disease in North Carolina just as it did in New Orleans. Browning writes, "In addition to the ferocious insects, northern soldiers were struck by the unusual duration and intensity of the southern summer, producing a heat for which they were not acclimated."[24]

Among battlefield soldiers, desertion became increasingly common, especially when morale was low. In the *Encyclopedia Virginia*, Civil War historian, Aaron Sheehan-Dean estimates that the desertion rate among Union troops was between nine and twelve percent.[25]




[23]Browning. 2011,126.
[24] Ibid, 128.
[25]Sheehan-Dean, A. Desertion (Confederate) during the Civil War. (2015, October 27). In *Encyclopedia Virginia*. Retrieved from http://www.EncyclopediaVirginia.org/Desertion_Confederate_during_the_Civil_War.

Paul Cimbala, author of *Soldiers North and South: The Everday Experiences of the Men Who Fought America's Civil War,* writes, "At least 200,000 Union soldiers intentionally deserted…"[26] Upon analyzing the companies of the 31st Massachusetts regiment, of approximately 1331 soldiers, only eighty-one deserted, or approximately six percent. This calculation shows a significant decrease in the percentage of soldiers deserting from the 31st Massachusetts. While these figures do not demonstrate a causation of soldier desertion, there is undeniably a correlation between morale and desertion. One should note, however, that desertion may have been less common among the 31st due to the distance they were from home. While this may have influenced some to stay, there is no instance of this being a primary factor in any of the letters or diaries left by these men. In New Orleans, the men of the 31st remained motivated and sustained relatively high levels of morale. While this is largely due to the lack of violent death among its members, it also demonstrates a feeling of success that was much less costly than a battlefield victory. The 31st also experienced a significantly higher level of autonomy than the average battlefield soldier. Living within a city also afforded these men with more comforts than life in a camp. Living with simple comforts such as buildings with roofs instead of tents made life much less difficult for the 31st, sparing most from the hardships of battlefield camps. Other comforts were more controversial, at least to Joshua Hawkes. Writing to his mother, Hawkes notes the "many and varied temptations" of New Orleans.

> Women and Strong Drink are two prominent rocks over which many a young man who left home temperate, will make a wreck of his character. I desire, my dear mother, an interest in your prayers that I may be able to withstand all the attractive temptations of the wicked City and live near to God.[27]

[26] Cimbala, Paul A. *Soldiers North and South.* New York: First Fordham University Press, 2010.
[27] Hawkes, 1862.

While some, such as Hawkes, attempted to restrain themselves from such temptations, others, no doubt, found these temptations comforting. Re-enlistment was also an important factor when examining motivation. Of the same 1331 men from the sample above, 312 re-enlisted, or approximately twenty-three percent. While it is difficult to interpret this information without similar statistics from other Union regiments, it is notable that reenlistment numbers were much higher than the number of soldiers who deserted. Desertion remained a serious problem for both Union and Confederate armies. Because of the various activities available for the men in New Orleans, desertions seem to be much less common among the 31st Massachusetts.

With the capture of New Orleans, the 31st Massachusetts experienced their most important role during their service in the Union Army. While many would go on to serve in various other locations in Louisiana and the South, the successful occupation of New Orleans was their finest hour. Many within the 31st seemed to understand the importance of this occupation, because their morale and motivation do not seem to decline in any significance. The soldiers, overall, do not seem to have a disdain for being there. Most report that they enjoyed their time there. Despite being excited to be in combat, they adapted reasonably quickly and began to sympathize with and respect southern citizens to an extent. Union soldiers fought for a variety of reasons. Honor, duty, and justice are cited commonly among soldiers in the North and South. Northerners, however, had a unified sense of purpose in that they were fighting to end a rebellion against the Federal government. This source of motivation inspired many throughout the North, and the 31st Massachusetts regiment was no different. Although they spent several months in the South, they never lost sight of what they were there to do. Ultimately, the experiences shared by the 31st led these soldiers to a greater appreciation of their role in the conflict. Because restoring Confederate states back to the Union was such an important aspect of

why they fought, occupation was certainly worthwhile and proved to be affective, as that is essentially what was done. While battles on the field awarded both North and South strategic advantages, occupational victories, like New Orleans, awarded the North with real results and visible change. Even though the roles of occupying forces and combat forces are so different, it did not significantly alter the 31st's view of the war. They remained committed to serving the Union, even when life in New Orleans became monotonous or too hot, as many of them complained it was. Again this demonstrates the strength of Union ideology. It transcends traditional military regiments and allows for soldiers outside combat roles to remain motivated and support their cause. The applications of this study extend beyond simply gaining an understanding the 31st Massachusetts regiment. Several other regiments spent time occupying the city and would perhaps experience ideological changes and motivating factors similar to those in the 31st. Beyond New Orleans, other cities were occupied by the Union including Memphis, Alexandria, and Charlottesville. While we cannot assume that circumstances will be the same, we may ultimately find similarities among these occupying forces.

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# EXPLORATION OF TEPHRAS FROM DOTSERO VOLCANO AND NATHROP VOLCANICS, COLORADO: CAN GLASS GEOCHEMISTRY DISTINGUISH CHARACTERISTICS OF ERUPTIVE UNITS?

Submitted December 10, 2015

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ABSTRACT

Central Colorado has been experiencing rifting and subsequent volcanism for the last 30 million years. In this study, the glass chemistry of two such volcanic areas, Dotsero Volcano and the Nathrop Volcanics, have been studied in order to determine their eruptive units and distinctive chemical characteristics. Samples for the Dotsero Volcano, taken from two sites near the source volcano, contain a consistent basaltic chemisty with varying degrees of crystallization in the matrix. The Nathrop Volcanics samples, taken between the Ruby Mountain and Sugarloaf Volcanoes, demonstrate two chemically distinct units and have experienced alkali exchange as a result of hydration of the units.

# INTRODUCTION

Volcanic eruptive units, particularly tephras, are often important when determining the chronologic or chemical aspects of a study area. They are often chemically distinct, deposited over a very short time, and can produce ash layers that can be correlated over large distances, sometimes entire continents (Pyne-O'Donnell et al, 2012). In 1981, researchers observed that silicic volcanic classes are often chemically homogeneous within erupted ash deposits, and subsequent studies have revealed the value of glass chemistry for tephra correlation (Anders et al, 2009). These volcanic eruptions often can be fingerprinted based on their major- and trace- element chemistry, isotope dating and petrographic analysis (Anders et al, 2009), which allow them to be used as a particularly accurate method of relative dating (Pyne-O'Donnell et al, 2012). Tephrochronology is a high-precision process of geochemical dating in which volcanic ash layers, known as tephras, are used as isochrons to link sedimentary layers (Pyne-O'Donnell et al, 2012). This process has found applications in a variety of studies, including archaeology, paleoclimatology, paleolimnology, geomorphology, neotectonics, and volcanology, because of its precision and capability to create widespread correlations (Kuehn et al, 2011).

Natural glasses, a major component of most tephras, are brittle, noncrystalline solids which transition from ductile liquids as they undergo cooling (Brown and Nash, 2014). Primary crystallization of these glasses occur during the cooling process of the initial depositional event (Lipman, 1965). This transition, which depends on a rapid cooling rate of the material, can create a metastable substance which undergoes a process of devitrification after the initial cooling (Brown and Nash, 2014). As a result of gradual crystallization (devitrification) and weathering, the oldest known preserved glasses are from the Cretaceous (Brown and Nash, 2014).

In this study, the geochemical fingerprints of tephras from two extensional volcanic sites in Colorado, USA, were studied in order to determine whether the different eruptive units are distinguishable. The Nathrop Volcanics in Brown's Canyon Colorado and the Dotsero Crater north of Dotsero, Colorado, *Figure 1*, are two relatively unstudied volcanic areas in the United States, without much prior geochemical analysis. The Nathrop Volcanics are discussed as one unit in this study, but

textural, lithological and mineralogical differences have been recorded between the Ruby and Sugarloaf Mountains that suggest at least two distinct magma sources (Hernandex, 2014). By distinguishing the chemical signature of the volcanic units, light can be shed on the processes that occurred during and post-deposition and the units may be used as future geological isochrons.

## GEOLOGIC SETTING

### Rio Grande Rift

The Rio Grande Rift System is a north-south trending continental rift zone that extends from central Colorado to Chihuahua Mexico (Emery, 2011). This rifting, which has taken place in western North America over the last 35 million years, is driven by low-angle faulting and local crust extensions in the upper crust that are believed to have developed as a result of the softening of the crust by Middle Tertiary convective heat flow (Hudson and Grauch, 2013). The northern termination of the rift system is enigmatic, characterized by north-striking half grabens separated by accommodation zones, but some researchers argue that the Arkansas Graben was the termination point for late Cenozoic extension (Emery, 2011). The system is named for the Rio Grande River that flows through most of its extent (Hudson and Grauch, 2013).

In the Rio Grande Rift Zone, the lithosphere is undergoing alteration through thinning and to a lesser extent intrusion of mafic magmas (Baldridge et al, 1984). Most of the volcanism associated with the Rio Grande rift is basaltic and was erupted less than 5Ma (Baldridge et al 1984). Several low volume late Cenozoic felsic volcanic fields are associated with this rift and align in an east-northeast direction, the Jemez lineament, which coincides with the orientations of other rift-age structures (Hudson and Grauch, 2013). Although rift-related volcanism is not a major driving factor for continued rifting, pre-rifting orogeny-driven volcanism provided the heat and crustal softening required to help initiate it (Baldridge et al 1984).

### Dotsero Volcano

The Dotsero Volcano, a small dormant cinder cone that is the youngest volcano in Colorado, is located a mile northeast of the junction of the Colorado and Eagle Rivers (Giegengack, 1962). It is a part

of a small chain of cinder cones located along the northern-most portion of the Rio Grande Rift, where the magma erupted through Pennsylvanian sandstone (Rowe et al, 2010). This volcano, along with several other volcanic features, formed as a result of a period of basaltic eruptions (ranging from 5.5-3.9Ka) which produced scoria cones and aa lava flows (USGS, *Volcanic Hazards Program*). The volcano produced monogenetic eruptions, with the most recent (4.2Ka) resulting in a 4 mile long lava flow, followed by the development of the maar as water came into contact with the volcano's magma chamber (Bush, 2015). The Dotsero Crater, the maar, is a large crater immediately north of the old vent (Bass and Northrop, 1963) which destroyed the small chain of cinder cones and produced a small-scale tephra fallout (USGS, *Volcanic Hazards Program*).

**Nathrop Volcanics**

The Nathrop Volcanics, part of the late Eocene-Oligocene (38-29 Ma) Central Colorado Volcanic Field (CCVF), developed on the western margin of the Arkansas Graben in south-central Colorado, which forms the northern part of the Late Cenozoic Rio Grande Rift System along with the Late Oligocene San Juan Volcanic Field (Emery, 2011). They are comprised of 30.35 Ma intrusive dikes, erupted tuffs and effused lavas that originated from Ruby Mountain (~0.24 $km^2$) and Sugarloaf Mountain (~0.84$km^2$) (Hernandez, 2014 and Emery, 2011). These rhyolite lava and pyroclastic deposits, located east of Nathrop, CO, were formed by a series of exogenic lava dome growth, pyroclastic deposition and lava extrusion (Emery, 2011).

The Central Colorado Volcanic Field (CCVF) is a 22,000 $km^2$ area of discontinuously exposed volcanic and clastic deposits that were deposited from the Eocene to the Oligocene in the Rocky Mountains, and experienced faulting and erosion during the Neocene (Hernandez, 2014). Although the Nathrop Volcanics are considered part of the CCVF, they were erupted near the end of the sequence and mark the beginning of the development of topaz rhyolite-granites, a product of extension from the rollback of the Faralon Plate, in the western United States (Hernandez, 2014).

# METHODOLOGY

## Sample Collection

The samples for this study were collected in the field from Dotsero Crater in northwestern Colorado, located about 2 km west of the town of Dotero (*Figure 2*), and from Brown's Canyon between Ruby Mountain and Sugarloaf Mountain, *Figure 3*, east of Nathrop in central Colorado. The 4,200 year old Dotsero volcanics, characterized by a chain of small cinder cones, a 3 km lava flow, lahars and a maar, contain black, basaltic lava flows and iron oxidized scoria. In order to test the chemistry of the eruptive sequence from Dotsero, bulk ash and scoria samples were collected in two different areas of the field site: 1) near the peak of a cinder cone and 2) along the road downslope of the volcanoes. In contrast to the Dotsero Volcanics, the 30.5Ma Nathrop Volcanics, comprised of the compositionally distinct Ruby Mountain and Sugarloaf Mountain flows, contain lapilli tuff, tuff breccia, vitrophere (densely welded tuff) and rhyolitic lava. Although the rhyolite flows do not contain preserved glass, lapilli to bomb size pumice grains are preserved in the tuff layers which have experienced relatively little devitrification and weathering. Pebble-sized pumice were collected from a variety of tuff layers throughout the site for analysis.

## Sample Preparation and Analysis

Geochemical characterization of the samples collected from the Dotsero Volcano and Nathrop Volcanics were conducted using electron probe microanalysis (EMPA) and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS) on an ARL-SEMQ electron microprobe at Concord University. To increase efficiency of the analysis samples the glass from the samples had to be concentrated from the material to 38-250 μm and mounted. Initially, Nathrop Volcanic samples contained large pumice, and were additionally crushed to ≤ 2 mm prior to preparation. Subsamples collected from both field locations were then placed into beakers with water with a concentration of 10% HCl to dissolve any carbonate deposits in the samples. To discourage flocculation of silts and clays, ~10 mL of alconox was added to the samples, and the solution was placed in an ultrasonic to break up particles. The glass particles were then concentrated to 38-250 μm through a process of wet sieving.

For analysis, the abundances of eleven elements major and minor elements ($SiO_2$, $TiO_2$, $Al_2O_3$, FeO, MgO, MnO, CaO, $Na_2O$, $K_2O$, $P_2O_3$, and Cl) in each sample were analyzed using four WDS (wavelength dispersive) spectrometers (#1 PET, #2 RAP, #3 LIF, and #4 TAP) and an EDS (energy-dispersive spectroscopy) spectrometer (for Si and Al). MAN (mean atomic number) modeled backgrounds were used for all WDS elements, with blank corrections for improved accuracy at low concentrations (Donovan and Tingle, 1996). Analytical conditions were 14kV accelerating voltage, and a 10nA beam current. To test internal consistency and inter-laboratory comparison of the microprobe data for quality control, four glass standards: Lipari Obsidian (a secondary standard for all elements), Orthoclase Glass (for calibration of K and for blank correction), NKT (for calibration of the Ti, Fe, Mg Ca, and Na), and BHVO (to calibrate Si and Al) were extensively utilized. Additionally, $Mn_2SiO_4$, Apatite, and Sodalite were utilized for calibration of Mn, P, and Cl respectively. BSE imagery (Back-scattered electrons) of individual shards, as seen in *Figures 1 and 2*, illustrated the crystal content in each glass shard.

In order to minimize and compensate for sodium loss in the samples, the beam diameters were adjusted and relatively short analysis times (8 seconds for Si and Al; 30 seconds with TDI for Na) were utilized. In rhyolitic glasses, including those collected in the Nathrop field area, alkali element migration (sodium loss) can occur when $Na^+$ atoms, and to a less extent $K^+$ atoms, interact with an electron beam. This process is characterized by a physical migration of the alkali elements out of the excitation volume from the beam, which results in an approximately exponential decline in sodium X-ray counts over the time it is exposed and a resulting increase in silicon and aluminum X-ray counts (Kuehn et al, 2011). Additionally, TDI (time dependent intensity) correction was used for Na for all analyses in order to limit sodium loss. Individual glass shards were analyzed within each sample using the Automation feature of Probe for EMPA (produced by Probe Software, Inc.), with a defocused electron beam ranging from 8-4 microns. The basaltic samples from Dotsero Volcano were crystal-rich and therefore required a smaller beam (~4 microns) than the rhyolitic Nathrop samples which contained fewer crystals. To minimize

sodium loss in the more susceptible rhyolitic glasses, larger beam diameters (6-8 microns) were required for the Nathrop Volcanics.

## RESULTS AND DISCUSSION

### Dotsero Volcano

The tephra samples collected from the Dotsero Volcano revealed that there is only one, chemically distinct population of basaltic tephra represented at the site, most likely from the most recent eruption 4,200 years ago. *Table 1* shows the chemical signature of the recent Nathrop eruption, along with the Nathrop Volcanics. The analyzed samples from Dotsero Volcano contained both crystal rich and crystal poor grains, as seen in the bask-scatter electron images in *Figure 4*. The data, although uniformly basaltic and plotting in a relatively tight cluster when charted, contained a considerable amount of scatter as a result of the large crystal content inside the matrix of the tephra shards. The samples contained both large crystals that were in the magma prior to eruption and smaller microcrysts which formed during the eruptive event, many of which were less than 1 micron in size. Microcrysts in particular were often inadvertently included in analysis spots, and the glass chemistry may have experienced a fractionation effect in some areas as crystals grew in the matrix. The resulting glass chemistry in Dotsero samples is scattered primarily as a result of crystals, and chemically distinct populations are difficult to identify.

Crystallization of the Dotsero tephra, particularly the microcryst concentration, occurred during the eruptive event as a result of rapid rates of crystallization. The crystal content in the shards increased with closer proximity to the source vent, indicating a higher rate of crystallization and slower cooling rate than the fallout at larger distances. This can be connected to the comparatively smaller grain sizes, larger surface area and increased amount of time airborne for the fallout grains which result in faster crystallization. A second population may be represented in the samples, but the abundant crystallization creates problems with correlation because of the comparatively large scatter in the data. However, the relatively crystal poor grains in the Dotsero samples have allowed for a relatively accurate data set that reveal at least one chemically distinct population. *Figure 5* demonstrates this spread in the data that resulted from the large crystal content of the samples.

**Nathrop Volcanics**

The Nathrop Volcanics were relatively crystal-poor and unweathered, allowing for accurate analysis of the tephra shards that were collected. As illustrated in *Table 1*, the Nathrop Volcanics contained two slightly different distinct felsic populations which were produced by different volcanic events. The tephra shards (*Figure 6*) contained few crystals, and the variation between shards of different populations was not immediately distinguishable in terms of grain morphology. *Figure* 7 illustrates the different chemical populations represented in the samples. The field area contains two separate volcanoes, so future research could be conducted to determine whether the two eruptive units originated from the same vent and magma chamber, a different magma chamber within the field site, or from a volcanic area outside of the field site. A study of cores taken along the Arkansas River, which flows along the western side of the field area, might also provide a record of past pyroclastics preserved in the valley below the fluvial sediments seen at the surface.

*Alkali Exchange ($Na_2O/K_2O$) in Nathrop Volcanics*

Although the shards in the Nathrop Volcanics may not have underwent extensive weathering, evidence of post-eruption hydration is recorded in the chemical signature of several of the grains (*Figure 8)*. In glass shards, water can enter into the matrix through a process of exchanging sodium for potassium (Brown and Nash, 2014). Because hydration of volcanic glass can result in Na loss and correlating K gain, these elements have been examined both in comparison to each other and other major elements. Some of the grains from each Nathrop sample had experienced more hydration and ion exchange than others, which is probably a result of the availability of openings in the glass structure itself since fractured glass encouraging higher levels of hydration (Jezek, 1978).

Based on the sodium and potassium comparisons of *Figure 8*, the Nathrop Volcanics is likely to have been exposed to water. This process of hydration could have occurred soon after the eruption if the pyroclastic flows were thick enough to maintain their heat, as a result of reheating the tephra when a new lava flow was emplaced on top of the layers, or as a mechanism of weathering in the field area. On average, the affected samples experienced a loss of 20% of their sodium atoms in exchange for a gain of

20% of potassium atoms, which can be seen in the plots of *Figure 8.* In contrast, there is consistency in the concentration of the other analyzed elements. Almost all of the tephra samples collected from the field area had experienced some varying degree of ion exchange, and the relative constancy of hydration could have been a direct result of the field area, Brown's Canyon, being carved by water.

## CONCLUSION

To reprise, for this study the geochemical signatures of the Nathrop Volcanic Units and the Dotsero Volcano, Colorado, were analyzed using electron microprobe analysis in order to determine the chemical signatures of the represented eruptive units. This was achieved by collecting pumice samples from tuff layers at the Nathrop Field site and scoria and ash from the Dotsero cinder cones, which were process to concentrate glass in the samples. Both the Nathrop and the Dotsero units were analyzed for eleven major and minor elements: $SiO_2$, $TiO_2$, $Al_2O_3$, FeO, MgO, MnO, CaO, $Na_2O$, $K_2O$, $P_2O_3$, and ClO.

The Dotsero Volcanics samples that were studied contained a single magma composition, the most recent eruption, which had experienced significant crystallization during the volcanic event. The tephra shards represented an increase in crystallization at closer proximity to the volcanic vent, which indicates rapid crystallization and relatively slow cooling at the vent, but also created scatter in the data as a result of microcrysts in the analyzed glass. This creates difficulties in accurately determining the chemical signature of a tephra layer.

The Nathrop Volcanics, in contrast, consisted of two relatively crystal-free eruptive units which were chemically distinguishable. These units, although similar in chemistry, are distinctly different in a few elements (Fe and Ca) and contain relatively little scatter in the data. Alteration is represented in the samples as hydration through ion exchange. In most of the samples, some of the grains have experienced a swap of Na for K in their glass matrix while other tephra shards remain unaltered. This process occurs when water enters into a glass matrix.

TABLES AND FIGURES

Table 1: Geochemical signature of the Dotsero and Nathrop Volcanics

| | Sample | SiO2 | TiO2 | Al2O3 | FeO | MnO | MgO | CaO | Na2O | K2O | P2O5 | Cl | Total | H2O diff | *n* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NATHROP VOLCANICS | | | | | | | | | | | | | | | |
| FIRST POPULATION | Average | 76.85 | 0.08 | 12.91 | 0.52 | 0.10 | 0.03 | 0.44 | 3.78 | 5.24 | 0.00 | 0.07 | 100.00 | 4.25 | 76 |
| | StDev | 0.34 | 0.01 | 0.22 | 0.04 | 0.02 | 0.01 | 0.03 | 0.59 | 0.62 | 0.02 | 0.01 | 0.00 | 0.90 | |
| SECOND POPULATION | Average | 76.89 | 0.08 | 13.03 | 0.22 | 0.11 | 0.01 | 0.27 | 3.47 | 5.86 | 0.02 | 0.06 | 100.00 | 4.04 | 16 |
| | StDev | 0.41 | 0.02 | 0.43 | 0.09 | 0.03 | 0.03 | 0.06 | 0.44 | 0.54 | 0.04 | 0.03 | 0.00 | 1.17 | |
| DOTSERO VOLCANO | | | | | | | | | | | | | | | |
| | Average | 51.69 | 1.84 | 16.82 | 9.36 | 0.23 | 2.89 | 6.61 | 4.39 | 4.82 | 1.04 | 0.43 | 100.00 | 1.54 | 85 |
| | StDev | 0.72 | 0.10 | 0.42 | 0.69 | 0.02 | 0.44 | 1.08 | 0.69 | 0.69 | 0.11 | 0.51 | 0.00 | 0.67 | |

**Table** 1 contains the chemical signature of the three eruptive units represented in the analyzed samples based on the major elements Si, Ti, Al, Fe, Mn, Mg, Ca, K, P, and Cl. The *n* column represents the number of analyses run on tephra grains from each eruptive unit. The Nathrop Volcanics contain two felsic compositional units with similar chemistries and relatively high water content in the matrix. The two units are distinguishable primarily based on the concentrations of Fe and Ca. The Dotsero Volcano consists of a single basaltic composition.

Figure 1: Overview Map of Field Areas

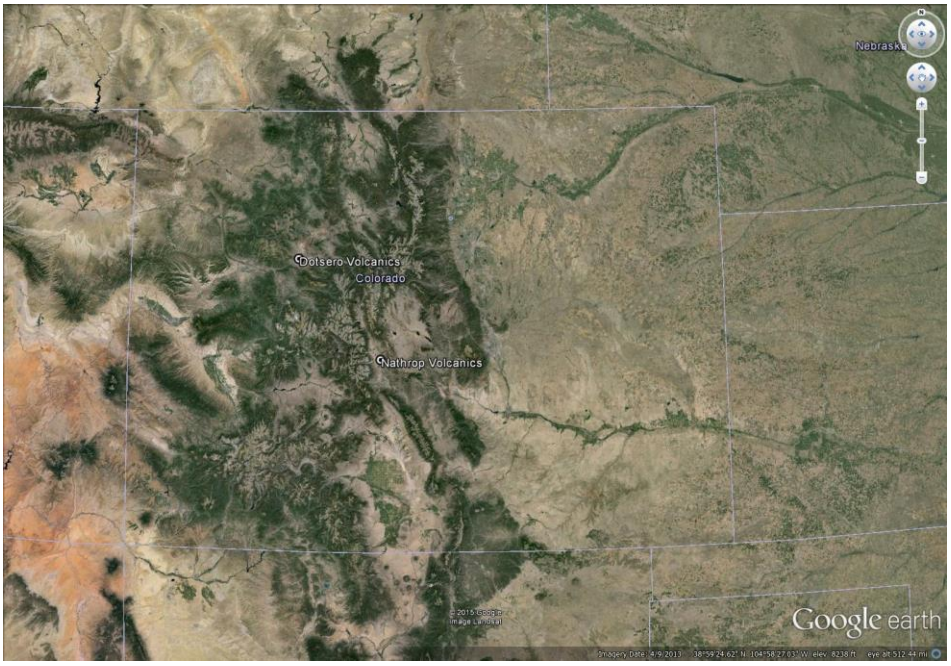



**Figure 1,** produced using Google earth, illustrates the field areas on a regional scale. Both field sites are located in central Colorado, where extensional rifting of the continental crust is occurring.

Figure 2: Dotsero Area Map


**Figure 2**, an area map of Dotsero Volcano produced with Google earth, is a regional map of the field area. The map illustrates the location of the samples which were taken from the area. Sample Site 1 is near the peak of one of the cinder cones and above the Dotsero Crater. Sample Site 2 is about 1/3 of a mile south from the peak of the cinder cone.

Figure 3: Nathrop Map

**Figure 3,** also from Google earth, details the Nathrop field area. The samples were taken from pyroclastic flows throughout the valley between the Sugarloaf Mountain and Ruby Mountain Volcanoes. Both volcanoes are rhyolitic lava domes which contributed to the flows in the field area.

Figure 4: BSE Imagery of tephra shards from Dotsero Volcano

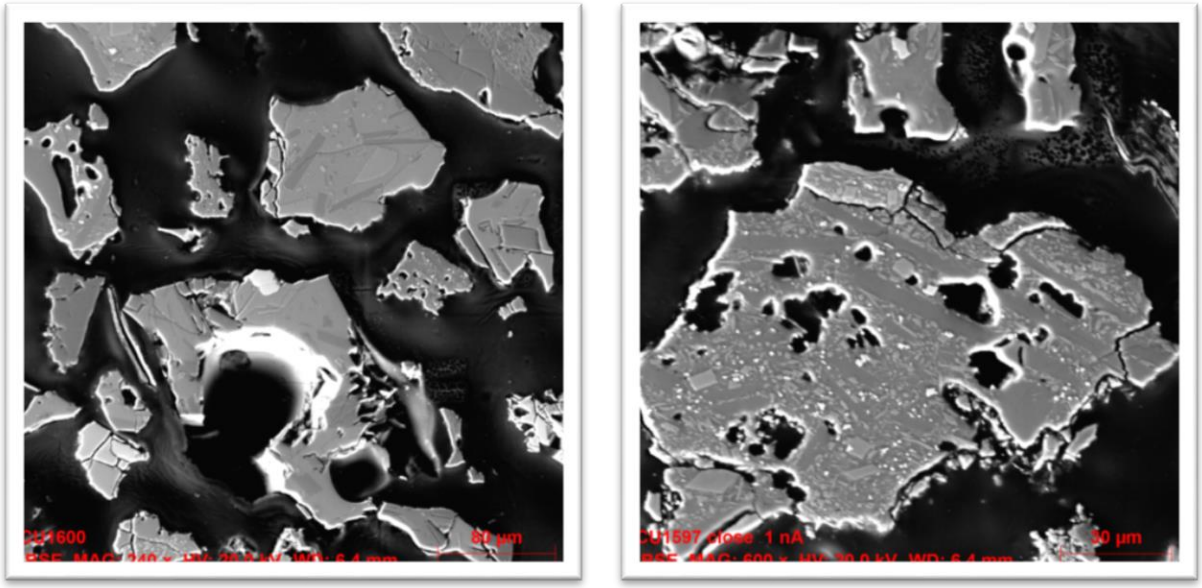


**Figure 4** illustrates the BSE (backscatter electron) imagery of several tephra shards from the Dotsero Volcano. This site contained glass which had experienced extensive crystalization during the cooling process of the magma while the eruption occurred. The samples contained both crystal rich (right) and relatively crystal poor (left) tephra samples.

Figure 5: Dotsero volcanic glass geochemistry

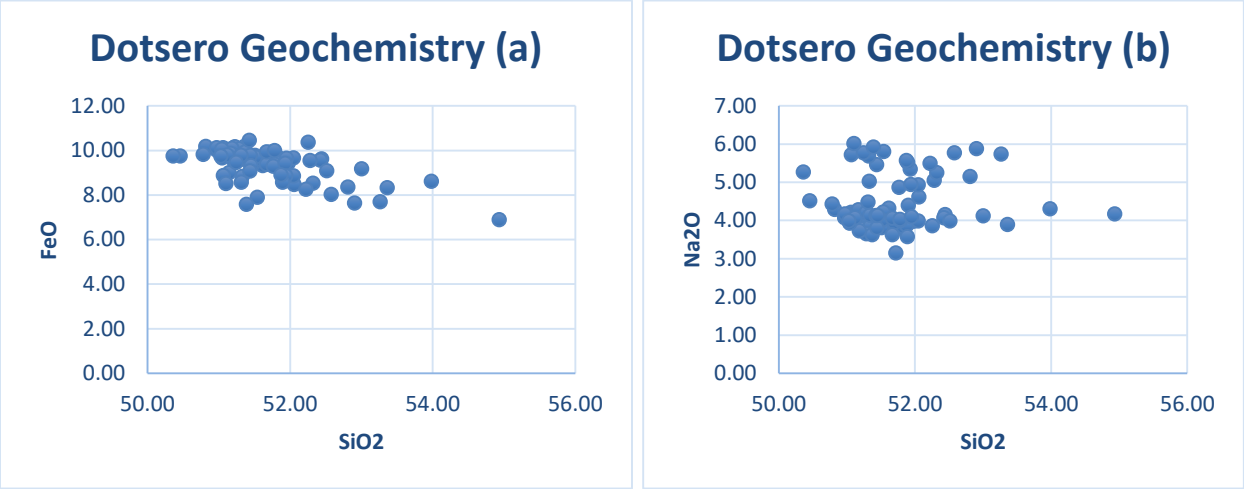



**Figure 5,** illustrates the geochemical distribution of the analyzed grains from the Dotsero Volcano. There appears to be only one population, the most recent eruption, represented in the tephra shards. This was determined based on the single cluster illustrated in the data. Iron (a) and sodium (b) were plotted against $SiO_2$ in order to illustrate the relatively tight distribution of the unit. The crystal-rich grains created scatter in the distribution while the crystal-poor samples plotted more consistently. When plotted against with silicon and sodium, a possible second population is also seen that may have resulted from either the scatter or a possible second compositional unit.

Figure 6: BSE Imagery of tephra shards from the Nathrop Volcanics

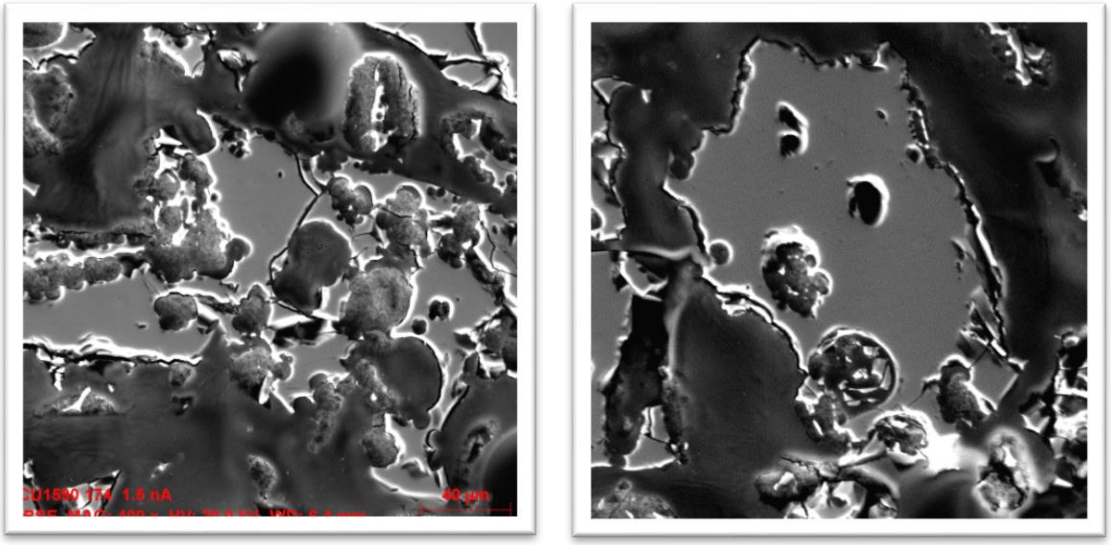
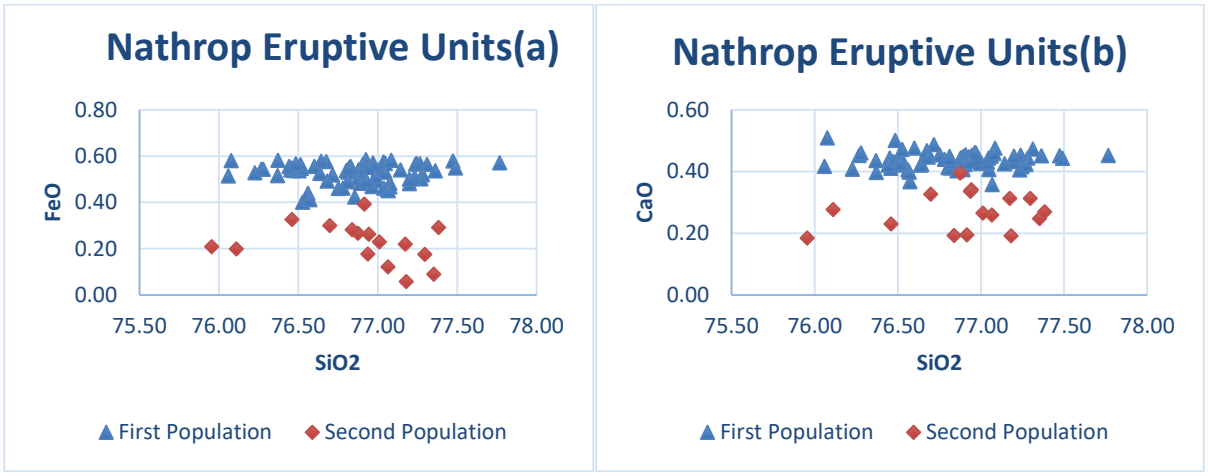


**Figure 6** demonstrates the tephra shards from the Nathrop Volcano pumice. These samples are relatively crystal-poor, indicating that they did not undergo rapid crystallization during the event and have not experienced much post-eruptive devitrification. Although there are two different eruptive units represented chemically, no visible difference was noticed between the grains.

Figure 7: Nathrop volcanic glass geochemistry




Similar to Figure 5, **Figure 7** demonstrates the chemistry of the two separate eruptive units preserved in the pumice clasts in Brown's Canyon, specifically when plotting iron (a) and calcium (b) against silica. The relative lack of crystals in the samples allowed for more accurate analysis of the tephra grains. Different populations plot together in clusters, illustrating the chemical variation between the two populations. The distinction between the populations was less clear on other elements, but lower concentrations of Fe and Ca were consistent in the second population when compared to the first population.

Figure 8: Nathrop volcanic glass geochemistry: Alkali Exchange

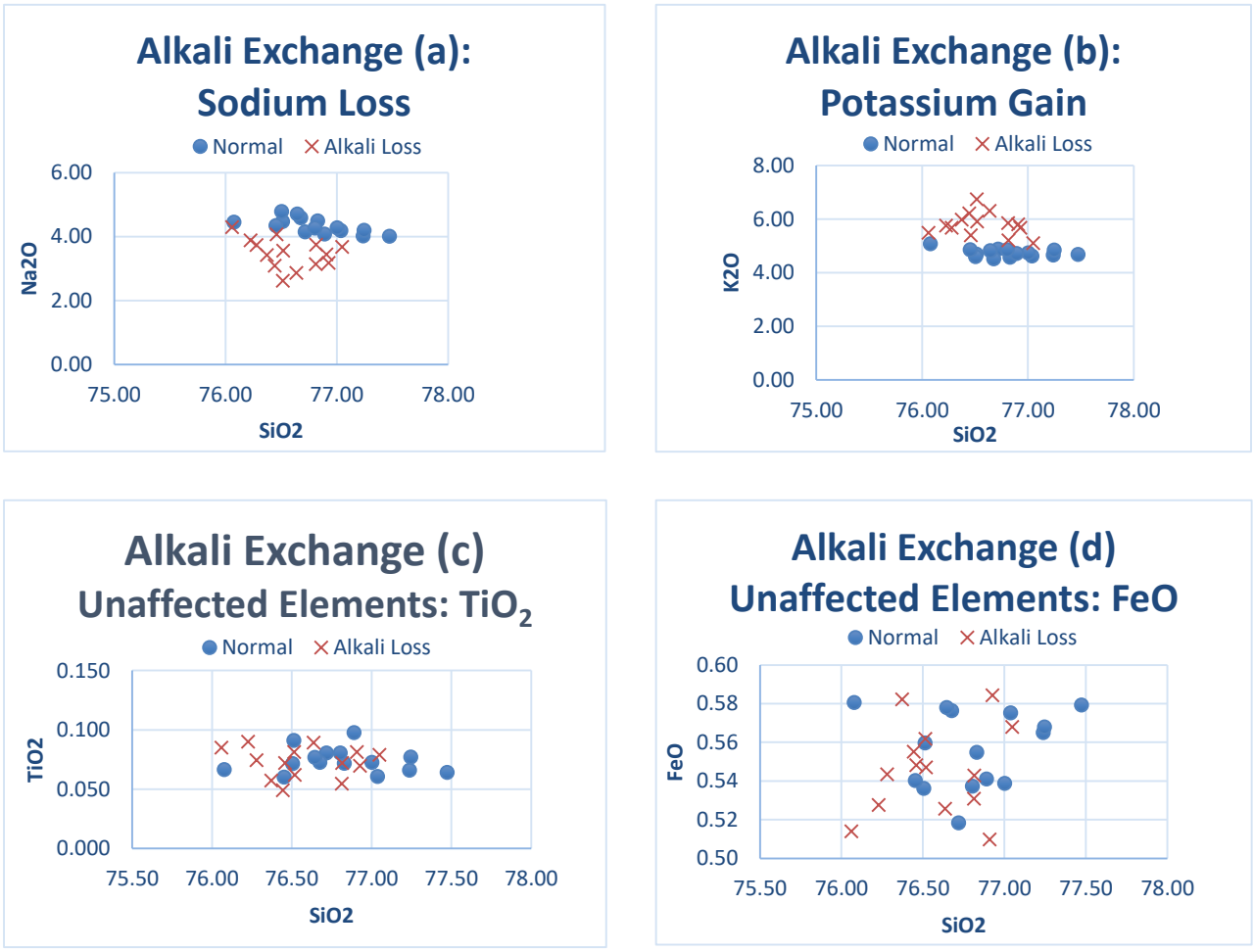



**Figure 8** demonstrates the alkali exchance observed in most of the Nathrop samples using a single sample for consistency of the data. These points were analysed from the same unit, with points consistently represented in each population, and illustrate the exchance of sodium (a) for potassium (b) in the matrix of the glass. Individual analyses illustrate the process in some grains, the "alkali loss" population while the control, or "normal" population were analysed from other grains within the same sample which appear to have been less affected . On average, the affected samples lost about 20% of their sodium atoms in exchange for an additional 20% of potassium atoms. This process is only represented in the sodium and potassium, and all other elements are unaffected, as indicated in the titanium (c) and iron (d) to silica plots.

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Exploring Casino-Style Blackjack using the Monte Carlo Tree Search Method

by Jonathan Collins

## Abstract

Monte Carlo Tree Search (MCTS) is an algorithm that enabled improvements in game playing to be made in games with large and often complex game states, such as Go. The algorithm is frequently used to study perfect information games, allowing the algorithm to be optimized to such games using variance pruning techniques. This paper explores the usefulness of MCTS in the hidden information game, blackjack, by comparing it to the performance of a well-known approach to solving the game space, basic strategy, when both strategies are applied with basic casino-style rules such as varying numbers of decks as well as automated shuffling. This paper finds that the MCTS agent was able to perform nearly as well as the basic strategy agents and may be able to match performance in future work.

## Background

When playing games, human players are able to use intuition to quickly process information while a computer player must observe and consider all available moves before calculating its choice. The most common approach is to provide the machine with a set of heuristics, rules to govern decisions, and filter moves based on the rules chosen. This method does not scale well, requiring a factorial amount of resources in some games and systems. Another drawback is that this naive approach is not flexible, requiring heuristics hand-tailored for the game, and in some cases, even the moves available or the states of the game itself. These critical issues of the naive approach prompted games to adapt the Monte Carlo Tree Search, a search algorithm that builds trees based on move selection in order to more efficiently discover better lines of play, improving the quality of artificial intelligence in machine players.

### Monte Carlo Tree Search

The Monte Carlo Tree Search (MCTS) algorithm uses some form of randomization to decide which move to make within a list of available moves [1]. At first, these moves may be decided entirely at random but can be weighted over time to influence how the algorithm decides which moves are more valuable[1]. Exploration occurs when the algorithm branches wide, attempting moves that may be suboptimal to explore lines of play which may turn out the optimal line. Exploitation occurs when the algorithm chooses actions that are currently known to be good lines of play. The MCTS algorithm attempts to balance exploration and exploitation so that the computer player can consider a wide variety of moves and determine which ones are the best actions to take in a given situation [1].

The MCTS algorithm first considers all available actions then chooses at random one of these actions using an algorithm that balances exploration and exploitation. Then, the player

makes that move and a copy of the game state is made. The copy is then played out in some number of simulations until the game ends in a win, a loss, or a tie and then determines a value as to how much this terminating state is worth [1]. The copy is then traveled in reverse, propagating backwards by rewarding the actions taken along the way with the determined value [2]. Eventually this rewinds to the original game state, where the next action will be determined, only each subsequent action may be weighted based on the success during the simulations. Tree branches that report more frequent wins are more likely to be taken, while tree branches with high amounts of losses are less likely to be taken. One weakness of this algorithm is that the optimal set of moves may be found in a tree branch that first requires making suboptimal plays. The randomization for MCTS can be truly naive, picking at random every time, or more commonly uses another algorithm called Upper Confidence Tree (UCT), which is an algorithm that balances exploration and exploitation during randomization so that the MCTS can attempt to find optimal moves, even in suboptimal branches[2].

The MCTS algorithm has been used to improve game playing AI for perfect information games (games where all information is known to all players) such as Go [2], real time games such as Ms. Pacman [3], and has allowed research for imperfect games (games with hidden or derived information) such as Texas Hold'em poker [4] and Magic: The Gathering [5] to take a new direction in AI advancement. For Chess and Go, the MCTS allowed AI players to challenge, and in some cases exceed, expert human player skill, especially when the MCTS algorithm combined expert heuristics to filter known lines of play. For Ms. Pacman, the MCTS would allow an AI controlled player to learn and adapt to ghosts that have perfect game information by using the algorithm to engage online learning (learning based on constantly updating game states) allowing the AI controlled player to adapt to strategies for each level of skill difficulty[3].

In some Texas Hold'em variants, the MCTS algorithm was able to learn to match efficiency with other known algorithms. While MCTS did not necessarily play as effective as the other algorithms against an individual opponent, it was the only online learner that played at comparable levels of skill and research may be expanded such that the Monte Carlo learner may adapt to a table of players as opposed to one opponent, with the goal of being able to adapt play style to be able to learn and play competitively at any table [4]. In the case of Magic: The Gathering, the game itself involves deep lines of play based largely on both game states as well as large amounts of hidden and derived information. MCTS has been able to learn the basics of combat strategy within the game, a task that's challenging to accomplish without perfect information [5]. The MCTS algorithm is easily adaptable across many different styles of games and is able to model information in perfect and imperfect games, offline and online learners, as well as real-time and sequential games, making the algorithm a natural research topic for games and systems.

There are multiple ways to implement the Monte Carlo pattern but all of them share a general flow [6]. First, a copy of the current game state is made and then used as the root state for decisions. A root node is made to reflect this state, and then populates this new node with a list or array of available moves that have not yet been considered. A move is picked by some randomization, pointing back to the move-node of the prior move, and then the first copy makes a second copy of the game state, makes the selected move (if it's a leaf node) and plays the game out until the game would terminate[3]. Once the game terminates, it returns a reward value based on the outcome [6][3]. For most games, the basic reward is 1.0 for a win, 0.5 for a draw, and 0.0 for a loss, but can be changed as needed. Once this reward is determined, the algorithm then increments two values in the node, one that keeps track of the total times the games has visited,

and one that keeps track of the reward value[3]. For example, a node visited would have its total visits increased by 1, regardless of outcomes, and the reward value can be increased by 0/.5/1.0 based on outcome. Then the algorithm recurses back to the move-node that lead to the chosen leaf node, and updates both visited and rewards like the leaf node did. MCTS will recurse back to the leaf node, updating the original sequence of actions [3], then dispose of the second copy. This process will repeat for some number of iterations, representing a number of simulations [6][3]. Once the simulations have concluded then first copy will evaluate all of its original list of available moves and chose the one with the highest win percentage. It then returns this move to the original game state, which then makes the chosen move, repeating the entire process until the actual game is completed [6].

While the basic algorithm is simple in concept, added complexity can yield improvements in performance, both in terms of speed and accuracy. The Upper Confidence Bounds algorithm, UCB1, helps improve the randomization of choosing moves in MCTS. UCB1 moves MCTS away from choosing purely at random (the naive approach) and towards randomization that weights the best known move more heavily than others [7]. UCB1 chooses the best known option roughly 50% of the time, while choosing other options, evenly, the remaining 50% of the time [7]. This allows for a better balance between exploration and exploitation. Further improving upon UCB1 is the UCB_Tuned algorithm, which offers two changes of note [3]. The first change is that UCB_Tuned doesn't use just the win ratio like UCB1, but combines it with an additional component that allows "explored" moves that are yielding winning sequences back to back to rise quicker to be chosen for exploitation, while moves that lose more frequently rise slower[3][7]. Second, this modification allows for a second component to be added to impact node decisions. These modifications range from tree pruning

[8] to using heuristics or "Best-of-N" modifications [9].

Prior to MCTS, the game Hex used a pruning algorithm for creating minimax trees, Alpha-Beta, that can outperform MCTS but has a drawback in that it requires strong evaluation functions of the game in question in order to be efficient, and even then, it's not better in all cases[8]. MCTS is an algorithm that scales with "Best-of-N" heuristics, which aim to eliminate illegal moves and game states from being considered, or outright bad moves [9]. This domain knowledge is not required for the MCTS to work, making MCTS a flexible algorithm [8], but providing such heuristics allows MCTS to use hardware more efficiently and a beneficial side effect of "Best-of-N" heuristics is that they scale well with hardware power [9]. As hardware grows more powerful, further research could show MCTS to be the more powerful game AI algorithm over the traditional Alpha-Beta pruning Comparing MCTS to Alpha-Beta has shown that both game-move heuristics and "Best-of-N" heuristics have improved the rate at which MCTS beats Alpha-Beta, from 19% to 28% in 3 second tests; from 29% to 37% in 10 second tests; and from 22% to 32% in 30 second tests [9]. Monte Carlo also improves against Alpha-Beta with higher time limit rounds, up to a critical point where MCTS can but does not necessarily yield better accuracy against itself.

Parallel processing has also been used to improve MCTS, especially when compared to Alpha-Beta pruning. MCTS won and increased 35% of the time against Alpha-Beta on a single core processor, but increasingly won with more cores, eventually reaching a 75% increased win rate on 8 cores of processing power [9]. This is likely due to how each algorithm uses mutex locks. Alpha-Beta must engage locks at nearly every step of the algorithm, which can lead to cores waiting in queue to obtain a lock, while MCTS only needs to engage locks on a node by node basis, and could potentially be growing different areas of the tree at once due to

randomization [9]. For example, if the MCTS algorithm is evaluating "Move A" on one thread, then a second thread is evaluating "Move B", then it's possible that neither thread is engaging in conflicting areas of the tree and can likely just grab locks immediately with little to no competition. This variation is also referred to as "Ensemble UTC" when using concurrency to search several independent trees at once [5]. This yields yet another area of future research because parallel computing is still in its infancy, and efficiency in parallel computing times should only serve to benefit the parallel MCTS. Parallelization and "Best-of-N" improvements both scale well with hardware increases and are both being researched for improvement in efficiency and breakthroughs on any of these fronts could propel the MCTS algorithm's efficiency and so further research into any of these areas would likely benefit MCTS as well[5].

Other modifications to the MCTS include treating imperfect information games as perfect information games when modeling as the method can yield results similar to expectations [5]. MCTS agents playing perfect information variants of imperfect information games have been able to learn the games with great efficiency as well as to expand research into multiplayer variations [5]. One side effect to this, however, is that different states may hold different moves necessary to win or gain advantage in situations where the correct move may exist differently between a perfect information and imperfect information model [5]. When MCTS was applied to Ms. Pacman in real time, it was discovered that different decisions lead to different game states, so different MCTS agents may play worse against stronger agents, or better against weaker agents than would be expected of an identical game state, based on how the game arrived at the state[3]. Research of MTCS in the card game Magic: The Gathering (MTG) has shown promising results for imperfect information games. Since MTG uses a customizable deck of cards, players make decisions based off both public information (the primary game state) as well

as hidden information (player hands), and because the game rules have great depth and actions can be made during multiple points within a turn in some cases, and some actions may even be taken during opponent's turns, MCTS research on this game may be able to push MCTS harder than the game Go, which as combinatorically large tree branching[5].

Many of these modifications were tested with the MTG MCTS Agents and compared with rules-based agents created to test against human players. Using a strong-rules player, reinforced with heuristics given by competitive player knowledge, a weak-rules player, which used the basic heuristics, and a random player, the strong rules player would compete against humans playing at a competitive level with win rates of 37.5% to 46.6%, playing second and first respectively [5]. The Monte Carlo agent was able to best the strong-rules agent in the majority of games played, using a basic representation of game interaction. Even a weak-rules variant MCTS agent was able to outperform a strong-rules player [5]. Once again, larger simulations do not necessarily yield the best move, but definitely helps up to some critical point and naive randomization proved to be very weak[5]. Poker is another hidden information game that used counterfactual regret minimization (CFR), a method to calculate strategy profiles to use MCTS to produce strong players, despite hidden information [5].

Genetic programming has also been researched for MCTS improvements. Genetic programming is any algorithm that develops solutions to problems via natural selection. Genetic programming works by randomly generating child trees which attempt to solve the task at hand [10]. Then it breeds the best children, using them as parents for the next generation of children, repeating the cycle some number of times until a time limit or number of simulations has been reached [10]. The MCTS algorithm was combined with a genetic programming algorithm in Ms. Pacman, providing a real time environment for these algorithms to explore. Results showed that

choosing the training environment (a given stage of the game) largely impacts the outcome of genetic programming, especially when the real game environment is used [10]. Ms. Pacman requires a game tree that accounts for simultaneous moves and must consider her own moves against both the best moves of the enemy ghosts as well as the moves the ghosts actually take. Experiments led to an agent that was created by using genetic programming on various subtrees and then recombining these trees, proving superior and quicker than the standard genetic programming algorithms [10]. The MCTS in the experiments used a split reward system that gave half of the reward based on the game score earned during the current simulation and the other half awarded based on whether or not the pacman agent survived the simulation of Ms. Pacman [10]. Originally the experiments performed playouts with a random agent that was guided loosely by heuristics. The random agent was replaced with a genetic agent that would evolve after each playout and then readjust its play behavior based on game states. As Ms. Pacman plays in real time, the MCTS needs to be able to perform numerous simulations in a smaller than usual time frame, often 40ms to 60 ms, and as a result the experiments used a maximum tree depth to reduce calculation times. Shorter simulations also showed to be more accurate, as did larger numbers of simulations, which works well because the goal of lower calculation times naturally achieves shorter and more numerous simulations in some cases. Ideally the experiment should strive for 25,000 evaluations per round, but due to various inefficiencies, it yielded only 5000 evaluations, leaving significant room for future improvement [10].

The MCTS algorithm builds large trees in order to determine best moves and since tree pruning has been successful with its predecessor researchers turned to decaying simulation strategies. Old information is normally kept between moves, allowing a given strategy to be

reinforced, but strong move information may become outdated as the game progresses [11]. Strategies that track statistics data over multiple moves may benefit from decay more than UTC algorithms. One decay strategy, N-gram selection, tracks move sequences in addition to single move. The N-gram selection technique, or NST, keeps track of sequences between multiple players and averages the rewards earned by individual nodes to score the sequences, which are tracked by their respective player agents [11]. One decay factor is applied after an actual move is made, while a second factor is applied after an arbitrary number of rollout simulations are tried, while a third decay strategy can be applied after each simulation and affects only sequences that were played in the current round[11]. Results showed that games where move quality depends on game phases and states are more likely to improve with decay factors. In most cases, a decay value of 0, which resets moves and reward values between simulations, showed similar or better performance improvement than using no decay factor at all[11]. Single player games benefit little, if at all, from decay strategies [11]. Decay strategies worked best when selection of the best strategy relies on recent move history and game states [11].

The UTC methods commonly found in MCTS can also be improved through tree pruning. Three UCT pruning methods, two of which are domain independent, requiring no formal knowledge of what the algorithm is being applied to, as well as one domain dependent method, which requires more detailed information unique to the application[12]. Absolute pruning trims decision nodes that are not the most traveled, resulting in performance roughly equal to the original UTC method [12]. Relative pruning trims all decision nodes on a branch that result in only losses, as long as one node in the branch has some number of wins; this method performs mildly better [12]. Relative pruning, however, cannot be applied in all experiments. Lastly, territorial pruning assigns values to board positions based on which player is

most likely to benefit from the move. This approach improved MCTS in Go, but requires knowledge of the game and may be challenging to implement in other applications [12].

While the MCTS offers ways to improve the quality of the algorithm, it's equally important to consider future applications of what the algorithm can achieve in order to guide future work.

For example, MCTS agents can play Go at an expert level on a 9x9 board and can also play at a seasoned level on a 19x19 board, but the best Go research programs are weak in local move situations [13]. Although attempts to address this with parallel computing offer improvement, this improvement doesn't scale well with games like Go, but researchers predict that even one or two major breakthroughs in algorithm research could offer significant improvements in general game playing [13]. These breakthroughs will likely appear from the MCTS being combined with other algorithms. If MCTS can improve the quality of local searches then the MCTS can improve in both speed and accuracy [13]. The publicity of the MCTS breakthrough in the Go problem has promoted funding in the field of power-plant management [13]. MCTS may be extended to allow power-plants to manage energy more efficiently, sometimes with ecological and economic benefits [13] and such research may yet expand the number of fields that are able to apply the MCTS to improve systems.

Computer games could create dynamic stories for characters that change on multiple playthroughs and these games could then contain dynamic content books [14]. Dynamic storytelling could use MCTS to account for multiple actors taking a variety of actions across many locations and formulate believable stories [14]. In some cases, databases have been used to help agents generate story plots dynamically [14]. Some research has allowed dynamic storytelling for individual characters that still fits within the larger story domain. Interactive

narrative generation has been used in a framework that acts as a tool for authors to modify both dynamic and automatic stories [14]. Experiments are conducted with a "believability" metric that rewards action paths that make sense, such as detectives being more likely to arrest a murderer after observing murdered actors and obtaining clues about the scenes and uses this metric within a story domain consisting of actors, items, and places [14]. Items give actors additional actions to take, while actors can either pickup items or move to new places as default actions [14]. Actions are marked as more believable or less believable based on secondary criteria, such as an angry actor being more likely to attack another actor, while a calm actor is much less likely to commit the same action [14]. MCTS first adds moves to a tree as usual except then evaluates the believability factor of each move as that move is added to the search tree [14]. Rollouts then create a series of random actions until all story goals are met, which will often be believable unless the only action set that satisfies all goals can only be met with a set of unbelievable actions. A history table weights the actions of the initial story state and then tracks these weights to improve early rollouts and combines heuristics to improve the believability factor[14]. Future work in this area may include exploring other believability metrics or to allow an author the ability to control elements such as pacing and timing of the climax of the story [14].

Operating room simulators used to train operating room staff have been improved by using MCTS to improve the AI player that controls non-player characters so that the AI player plays more accurately like a human player [15]. Experiments allowed the MCTS algorithm to only evaluate authorized actions and evaluation of the final game states [15]. Nodes used during experiments represent the states of the environment, with the actions taken being represented by the travel between nodes [15]. Decaying rewards encourage lines of play that reward the shortest plans of action. Mandatory nodes have fixed reward values and do not get awarded during back

propagation, allowing the MCTS to frequently pick required nodes [15]. Non-player characters are also given instructions anytime they are awaiting commands, and these combined restrictions have even allowed an AI to correct human players that attempt to deviate from reasonable and expected lines of play [15].

Paraphrase generation is any algorithm that takes a given source sentence and converts this sentence into a new one with similar meaning [16]. In general, the paraphrase generation process is similar to the language translation problem, where the source and target language is the same [16]. Usually this translation requires decoding, although paraphrase generation may be able to use the MCTS to avoid this [16]. Paraphrase generation can include automatic summary, aiming to create the shortest paraphrase possible [16]. A scoring function is applied to transformation actions, where states are modeled as a sentence with a set of possible actions [16]. These states can then be added to the MCTS algorithm, although currently the algorithm generates ill-formed sentences approximately 37% of the time. Adding a linguistic knowledge-based analyzer could further reduce the rate of awkward paraphrases [16], improving the utility and capabilities of paraphrase generators.

In general, the Monte Carlo Tree Search algorithm is flexible and can assist in modeling a variety of problems, including both perfect and hidden information systems. This paper aims to expand the knowledge of the MCTS algorithm in casino-style Blackjack, a hidden information game with more depth than traditional Blackjack.

## Blackjack Rules

Blackjack is effectively a two player, hidden-information game between a player and a dealer. While multiple players may play at a table, players do not compete or interact among one another thus the game's interactions are directly between that of the player and the dealer. The

goal of the game is for the player to create a hand that beats the dealer's hand while not busting her own hand by going over 21[17].

A round of Blackjack is relatively straightforward to play. First, a player places a bet and then a dealer deals that player two face up cards, and deals herself one face up card as well as one face down card. Then, the player has the ability to act to modify her hand. Cards are valued by their face value, with kings, queens, and jacks being worth 10, and aces being worth 1 or 11. Aces are treated as 11s unless the hand value would exceed 21, in which case they are automatically worth 1. It's possible to have the first ace in a hand count as 11, with subsequent aces counting as 1 each.

In this experiment the player will have the ability to "hit", "stay", "double down", or "split", based on the rules of the game for that hand. When a player hits, she is dealt another face up card and a player may hit as many times as she desires, or until the hand busts by going over 21[17]. When a player stays, she ends her turn and awaits the dealer's actions to decide the round. A player may choose to double down if they have taken no other actions in their initial hand for the round by placing a bet equal to the original bet. Once the subsequent bet is made, the player is then dealt her card but then her turn ends. This action allows the player an element of skill in order to increase her winnings. Lastly, a player may split a hand that contains two identical number or face cards by placing a subsequent bet equal to the initial bet. For example, if the player has a hand containing two kings, she may split the hand, while a hand of one king and one queen will not be split for this experiment, although occasionally some casinos allow for this modification. Splitting allows the player the potential to play two hands in an attempt to win additional money. The dealer will separate the two cards from the original hand into two separate hands, then the player makes decisions for her first hand, and then her second. For this

experiment, the player cannot double down after splitting, nor can she split again, although rarely these options may be considered in some casinos.

Once the player has finished making actions for all of her hands in a turn, play then turns to the dealer, who will act according to the casino rules [17]. "Soft 17" dealers will hit on all hands with a total value lower than 17, and stay on 17 to 21[17]. This is the most common type of dealer, however, a second dealer was almost as common, "Hard 17." A Hard 17 dealer will hit on all values below 17, but if the dealer has a total hand value of 17 to 21 and the hand is counting an ace as an eleven instead of a one, the dealer must hit [17].

Once the dealer finishes her turn, all cards are revealed and the players then compare their hands. A player automatically loses any hand that busts. When a dealer busts, players that haven't busted automatically win. If the dealer's initial hand value is 21, the dealer has a blackjack and will automatically win unless the player also has a starting hand value of 21. A blackjack will beat all non-blackjack hands, even if the hand values are tied. If neither player has a blackjack and no players are busted, then the hand with the highest value wins, and at this point if there are any ties, the player will "push" the hand. When a player wins, they will receive an amount of money matching their bet plus their bet, while a player that pushes will only receive their bet. In the case of blackjack, players will win additional money. In some casinos, players may spend money to purchase insurance to help mitigate the risk of a dealer having 21, however, this is not modeled in the experiment because insurance is not a common enough option to apply generically.

**Previous Research**

MCTS has been applied to a basic version of blackjack where the player is capable of hitting and staying, but not doubling or splitting. Vaidyanathan found that the MCTS agent could

almost play as well as an expert agent under these circumstances, and suggested that future research into the subject would include the ability to double and split [17]. The thesis used array matrices in order to track success with the hit/stay model [17]. This approach would allow the simulations to run more quickly, but also makes modeling the effects of doubling and splitting harder [17].

**Method**

Blackjack Simulations

The simulator will playout and record the results for some number of rounds of blackjack. In each round, if the player has enough money to cover the bet amount, the player will be dealt a hand of two cards while the dealer will be dealt once card representing their face up card with the dealer receiving their "face down" card immediately after a player acts.

Once the initial cards of the round are dealt, the player will first check to see what available moves she has, then makes a decision as to which move to make, makes the move, then her turn is over. The dealer receives her face down card, then goes through roughly the same steps as the player except that the dealer does not need to check available moves as dealers only ever have the default moves, hit and stay, available to them. The simulation will use a tree of depth one to model the actions in a hand as, apart from hitting and splitting, the stay and double actions will only use one layer of depth. To resolve the issue of subsequent decisions on hits and splits, the initial decision will be made using the MCTS, while subsequent decisions will hit until the hand busts or reaches 17 to 21, which models after the Soft 17 dealer.

When a player is dealt her initial hand in the round, the hand is assigned a value of 1. Splitting a hand will divvy the hand up into two new hands, subsequently splitting the hand value evenly between the newly split cards. When considering a split, it is possible to win both hand,

lose both hands, or win and lose hands. Once the player and the dealer have finished play, the hands are compared and the player is awarded accordingly. Each winning hand will reward the player with a win rate for the round, equal to the amount of the winning hand. In the case of a split, it becomes possible to win .5 points if the player wins one hand but loses the other. This weight is used to reflect the nature of the value in splits, especially when a betting model is used. The blackjack simulation will gather information based on win rates and the money a player ends up with at the end of a simulation, and will compare a "random" player that acts as an inexperienced player, a "basic strategy" player which acts as an expert heuristics player and serves as the control, and a "Monte Carlo" player which will allow for testing of the MCTS algorithm to compare its performance to an expert player. A card counting player will not be used because the simulations will be operating under the assumption that a card shuffler is being used after every round, as this is becoming a large and growing trend in casinos to eliminate card counting, which cannot operate on such a system effectively.

After all rounds have been played in the simulation the results for the player's win rate percentage, ending bankroll of the player, and the time required for the simulation are recorded in text files. The simulation will be strictly between the player and the dealer for simplicity, although adding multiple players should have no effect on the results [17].

**Player Types**

Random Agent

The random agent will select moves randomly from the moves available and then make them. This emulates a novice player who may not be familiar with the rules of the game, or any strategy used to improve her success.

Basic Strategy Agent

Basic strategy in blackjack is the culmination of trial and error blended with mathematical probabilities designed to solve the game on a hand by hand case [17]. This simulation will use the basic strategy listed in [17] that optimizes the agent against a Hard 17 dealer. Ideally this agent will play better against Hard 17 dealers, though the difference in play against a Soft 17 dealer is relatively minor at best. The following represents the basic strategy used in general as well as for splitting hands:

| Hard Total | Dealer's Score | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Player's Total | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | A |
| 17 to 20 | S | S | S | S | S | S | S | S | S | S |
| 16 | S | S | S | S | S | H | H | H | H | H |
| 15 | S | S | S | S | S | H | H | H | H | H |
| 14 | S | S | S | S | S | H | H | H | H | H |
| 13 | S | S | S | S | S | H | H | H | H | H |
| 12 | H | H | S | S | S | H | H | H | H | H |
| 11 | D | D | D | D | D | D | D | D | D | H |
| 10 | D | D | D | D | D | D | D | D | H | H |
| 9 | H | D | D | D | D | H | H | H | H | H |
| 5 to 8 | H | H | H | H | H | H | H | H | H | H |

| Pairs | Dealer's Score | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Player's Total | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | A |
| A,A | Sp | Sp | Sp | Sp | Sp | Sp | Sp | Sp | Sp | Sp |
| 10,10 | S | S | S | S | S | S | S | S | S | S |
| 9,9 | Sp | Sp | Sp | Sp | Sp | S | Sp | Sp | S | S |
| 8,8 | Sp | Sp | Sp | Sp | Sp | Sp | Sp | Sp | Sp | Sp |
| 7,7 | Sp | Sp | Sp | Sp | Sp | Sp | H | H | H | H |
| 6,6 | Sp | Sp | Sp | Sp | Sp | H | H | H | H | H |
| 5,5 | D | D | D | D | D | D | D | D | H | H |
| 4,4 | H | H | H | Sp | Sp | H | H | H | H | H |
| 3,3 | Sp | Sp | Sp | Sp | Sp | Sp | H | H | H | H |
| 2,2 | Sp | Sp | Sp | Sp | Sp | Sp | H | H | H | H |

Figure 1

The above tables in Figure 1 list the player's hand on the left and compares it to the dealer's face up card listed on the top, and then chooses to either hit "H", stay "S", double "D", or split the hand "Sp" based on how the player's hand relates to the dealer's face up card. For example, if a player has a hand of 10 and 10, then the player should always stay as the chances of winning this one hand are often greater than if the hand would be split and risking two mediocre hands that may not both win. Alternatively, a player holding a hand with a pair of 9's would split unless the dealer's face up card was a 7, 10, or an A, in which case the dealer may have blackjack if her upcard is either a 10 or an A, and an upcard of 7 could represent a strong hand that's likely to beat both hands after a split.

Monte Carlo Agent

The MCTS agent makes decisions by simulating the current hand of blackjack some number of times and then selects the action that leads to more winning states. It does this by first making a copy of itself, the dealer, and the deck(s) of cards being used, as well as nodes for each of the HIT, STAY, DOUBLE, and SPLIT actions that are available in the hand. When an action is played, the Monte Carlo simulation will increase the count of the number of times the action has been selected, and if the action wins, will increase the win rate of that action equal to the value of all winning hands. In the case of splits, this means that winning two hands is superior to winning one hand, which is superior to winning zero hands.

A Monte Carlo sim first plays each available action exactly once and records the win rate and times played. Then, the simulation chooses between these actions randomly for the remainder of the Monte Carlo sim, using the UCB approach by weighting the winning action to be selected 50% of the time while the non-winning actions share evenly the remaining 50%. This allows a balance between retesting options that were not winning often early on, while allowing

a winning action to be selected more provided it remains a winning action. After this is finished, the winning action node is selected and its action is returned back to the agent which will then select this action and play it against the dealer, and repeats this until the hand is completed.

**Research Questions**

1. How does the number of Monte Carlo simulations effect the win rate of the MCTS agent?
2. Is there a number of MCTS sims among the four trial variables that is more efficient than others?
3. How does the number of rounds of blackjack impact the win rates of all agents?
4. Is there a number of blackjack rounds among the four trial variables that is more efficient than the others?
5. How do the agents' win rates compare to each other in the blackjack trials?
6. How do the ending bankrolls of the agents compare to one another assuming an efficient number of MCTS simulations as well as rounds of blackjack can be found when altering the flat bid amount?
7. How does the number of decks effect the ending bankroll of agents?

**Simulations**

RQ1 and RQ2

Experiments to discover the effects of win rates based on the number of Monte Carlo simulations requires isolation of other variables and as such the testing was performed under two conditions. The first condition was against a Soft 17 dealer with 1000 blackjack simulations and 1 deck. The second was against a Hard 17 dealer with 1000 blackjack simulations and 1 deck. This number of blackjack simulations represents a large enough sample size such that the data is

accurate while the number of decks was selected as 1 to observe if there was much variance between Monte Carlo simulations. If there is a high variance then it becomes necessary to perform multiple trials with differing deck numbers as well as varying Monte Carlo simulations, while little to no variance would allow the experiment to later test the number of decks as an isolated and independent variable. Simulations would play against both dealer types in order to observe whether or not the MCTS agent played better against one over the other. This experiment would test these conditions with 50, 100, 500, and 1000 Monte Carlo simulations. One hundred data points were collected for each simulation, for a total of 100,000 rounds of blackjack played per data set.

Based on the data collected for this experiment there were no meaningfully significant changes in win rates versus either Hard or Soft dealers across the above values for Monte Carlo simulations. The minimum win rates across all trials showed no significant changes between the numbers of simulations nor between dealer types. The maximum win rate for both Soft and hard dealers was insignificant after accounting for outliers. This experiment shows that a large number of Monte Carlo simulations is not necessary in casino-style blackjack, and that since blackjack has a small number of decision points then using the 50 Monte Carlo simulations provides approximately equal accuracy to using 1000 but without the extra memory overhead.

RQ3, RQ4 and RQ5

Testing the influence that the number of blackjack rounds had on an agent's win rate was performed with the Monte Carlo agent using the 50 simulations model for 100 data points of blackjack simulations. The number of blackjack trials tested were 250, 500, 1000 and 2000 trials. These trials were performed with one deck to isolate the impact of blackjack trials on win rate. As there was no meaningfully significant variance between the Monte Carlo hard/soft agents,

only the hard agent was used for the blackjack trials. During the trials, there were no significant differences between the Random hard/soft agents, so only the hard agent was used for comparisons. There were no significant differences between the Basic hard/soft agents with the exception that the soft agent possessed larger standard deviations at smaller numbers of trials but somewhat tighter deviations at larger numbers of trials. The differences in standard deviations is likely due to two outlier win rates observed during data collection, although they appear to have no significant impact on win rates.

Between all variations in the number of trials for a given agent, all agents followed similar patterns, namely that win rates were not impacted significantly based on the difference in number of trials. Simulations with 250 trials held drastically higher variance across all agents while that variance fell sharply at 500 trial simulations. Beyond 500 trials, however, the standard deviation would lower but contribute no further impact on the average win rate.

Random agents were able to attain approximately a 40.6% win rate. The Basic agents performed the best with an approximately 60.5% win rate, while the Monte Carlo agents were close behind with an approximate 58.5% win rate, a difference of around 2%. At 500+ trials however, the Monte Carlo method had a lower standard deviation suggesting that the agent would perform at this win rate more consistently compared to the Basic agent. It's important to note that for these simulations win rate refers to the total number of round wins, with split hand rewarding portions of a round's value. This metric is used to measure and compare the Basic strategy and Monte Carlo agents more readily, and these values will be higher than the average win rates across all hands as a whole.

RQ6

Flat bid simulations were observed using 500 blackjack trials and 50 Monte Carlo

simulations as those were found to be the best test numbers for the variables based on the prior tests performed. Both the Monte Carlo Hard and Basic Hard were chosen for this because they played similarly enough to their soft counterparts, and these agents would start flat bid rounds with $10,000 and would always make the maximum bid available. The value of the flat bid was $5, $10, $50, and $100 amounts.

Among the flat bid variables, the Basic Hard agent performed better in almost all areas. In each comparison, the Basic Hard agent would have a higher average winnings than the Monte Carlo Hard agent did. Across the bid range, the Basic Hard agent would hold maximum winnings and spreads that were approximately linear based on the bid amount. This pattern of maximum winnings and spreads makes sense considering that the Basic strategy does not deviate play style based on the bid amount while it maintains a fairly consistent win rate percentage. Consistent play with scaling bid amounts makes sense that the maximum winnings would also scale accordingly. The Monte Carlo agent also held near-linear maximum winnings in proportion to the bid amount, however, differed in spread on the $50 and $100 simulations. The spread in this simulation represents the level of fluctuation in the simulation, with a tighter spread being more probable to arrive at the average. While the Basic Hard agent did have a higher spread than the Monte Carlo agent in these categories, the Basic agent still maintained higher average winnings. The Monte Carlo agent was less likely to lose a large amount of money, however, the Basic agent, while riskier due to larger variance, offers a higher potential payout.

RQ7

Simulations to discover the impact the number of decks have in casino blackjack on the agents were observed as an extension of the flat bid simulations, but using $100 as the flat bid value. Data was collected using 1, 2, 4, and 8 decks comparing the spreads and averages of the

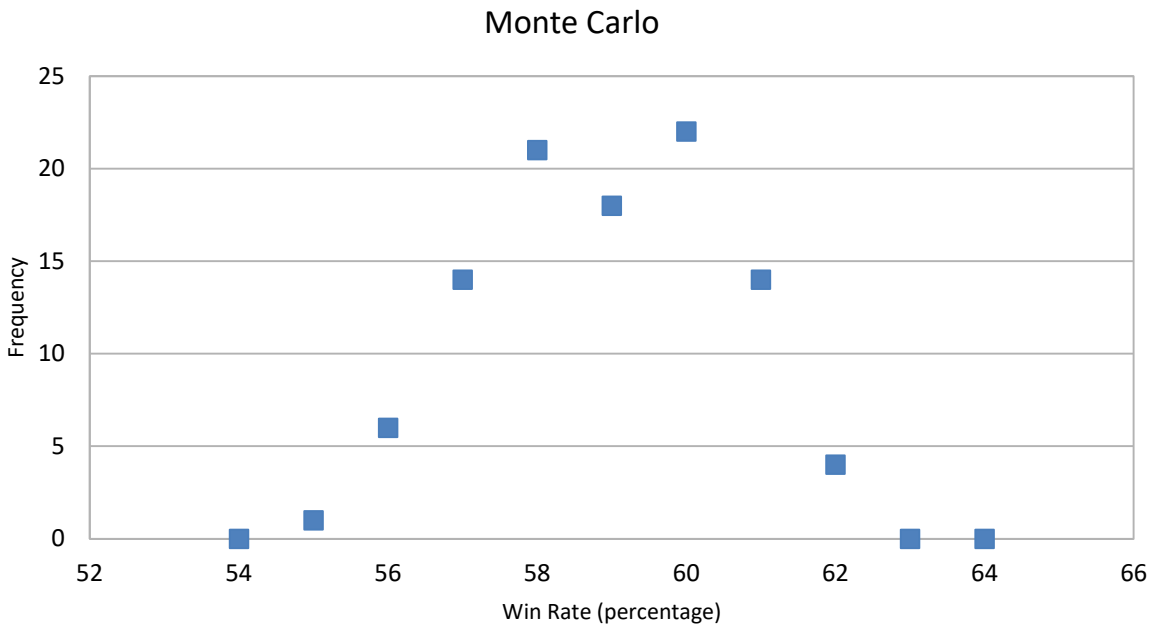
simulations using both the Basic Hard and Monte Carlo hard agents as was used in the flat bid trials.

The number of decks held almost no impact on the Basic Hard agent with the exception of going from 4 to 8 decks, in which case the agent gained roughly 2.3% more average bankroll when winning. The Basic Hard agent outperformed the Monte Carlo Hard agent in each case, however, the Monte Carlo agent also had a notable 25.3% increase to winning bankroll average between 4 and 8 decks, but between 1 to 2 and 2 to 4 decks there was little growth.

**Conclusion and Future Work**

The Monte Carlo agent is able to win just under the frequency of basic strategy agents, although basic strategy agents performed better in both flat bid simulations as well as simulations to observe the influence of the number of decks used, these simulations demonstrates that an agent could perform fairly well when not provided an explicit set of instructions. Future research in applications for this algorithm would be that modifying or playing similar games to blackjack could yield improvements if the random sampling methods can be improved and the research in this paper can be found at https://github.com/zolphinus/CasinoMonteCarloBlackJack. One advantage the algorithm has is that if the simulation rules were to be changed into a new blackjack variant, the Monte Carlo algorithm should be able to adapt easily while it would be inconvenient to redefine a system similar to basic strategy. For current iterations of blackjack the basic strategy is more efficient in implementation than Monte Carlo tree search at this time, however, the numbers are close enough that the right vein of research could challenge this assessment.

Appendix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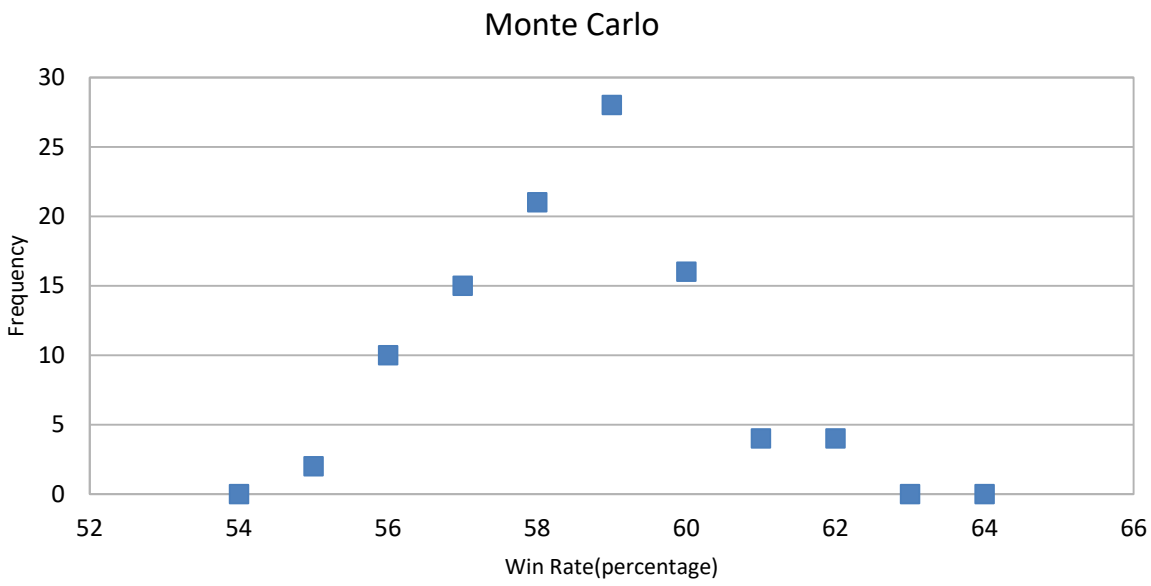
Win Rate (percentage)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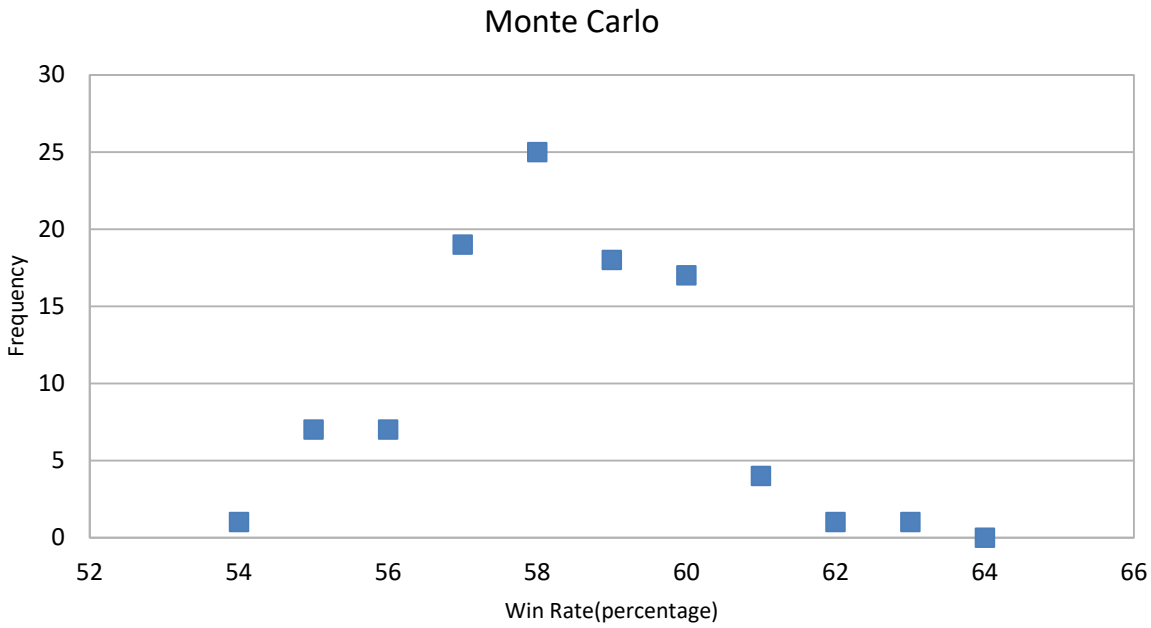
Win Rate(percentage)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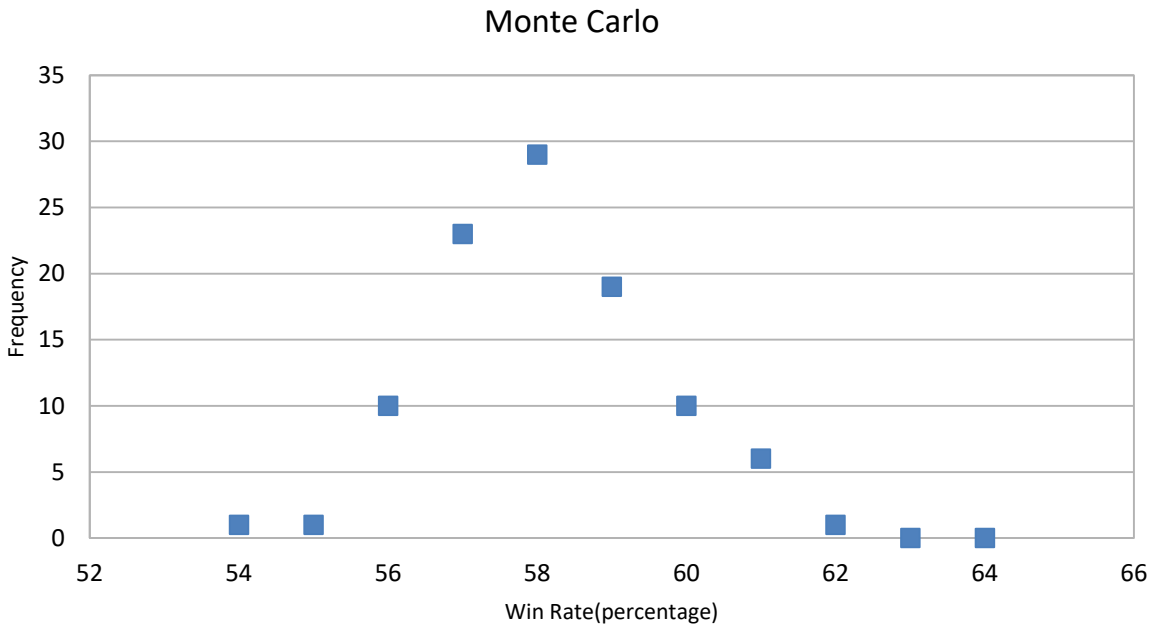
Win Rate(percentage)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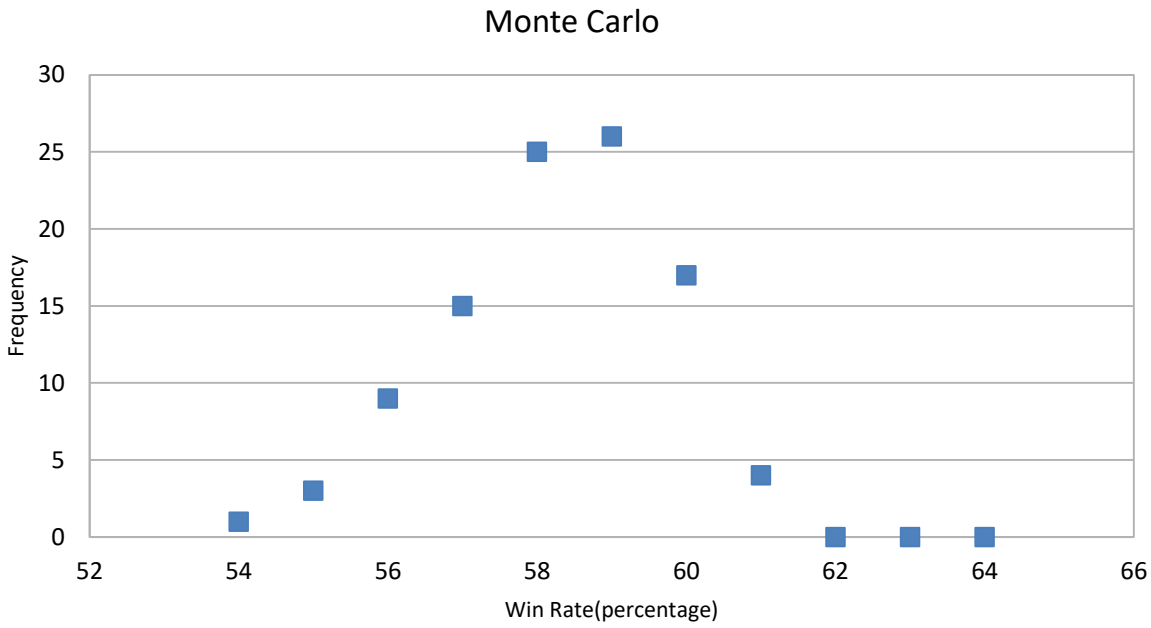
Win Rate(percentage)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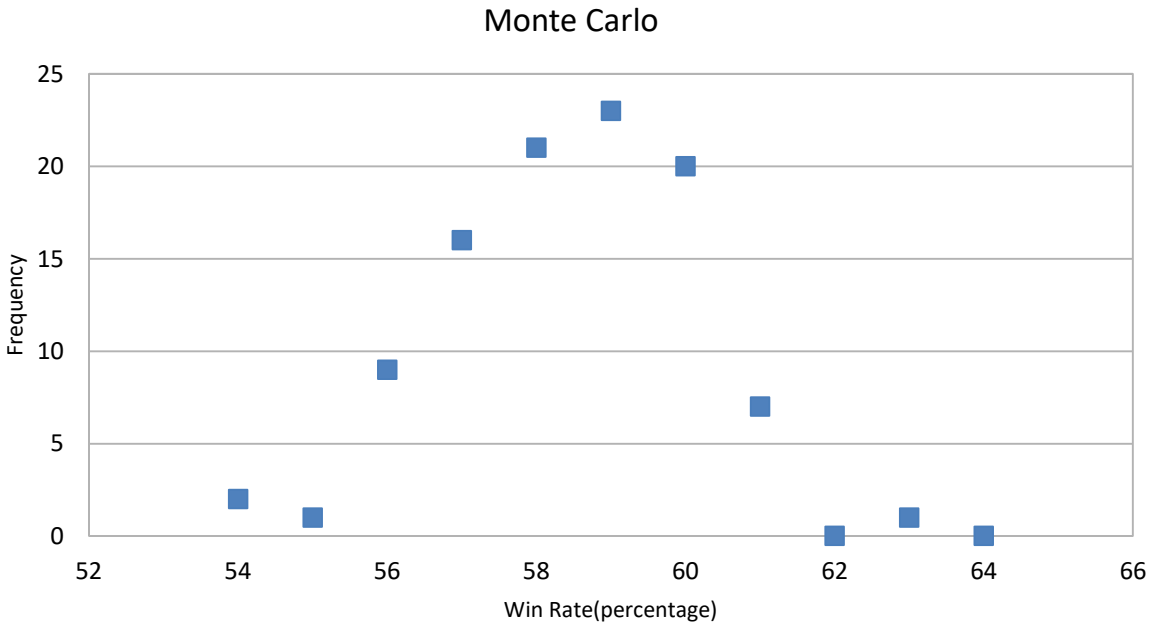
Win Rate(percentage)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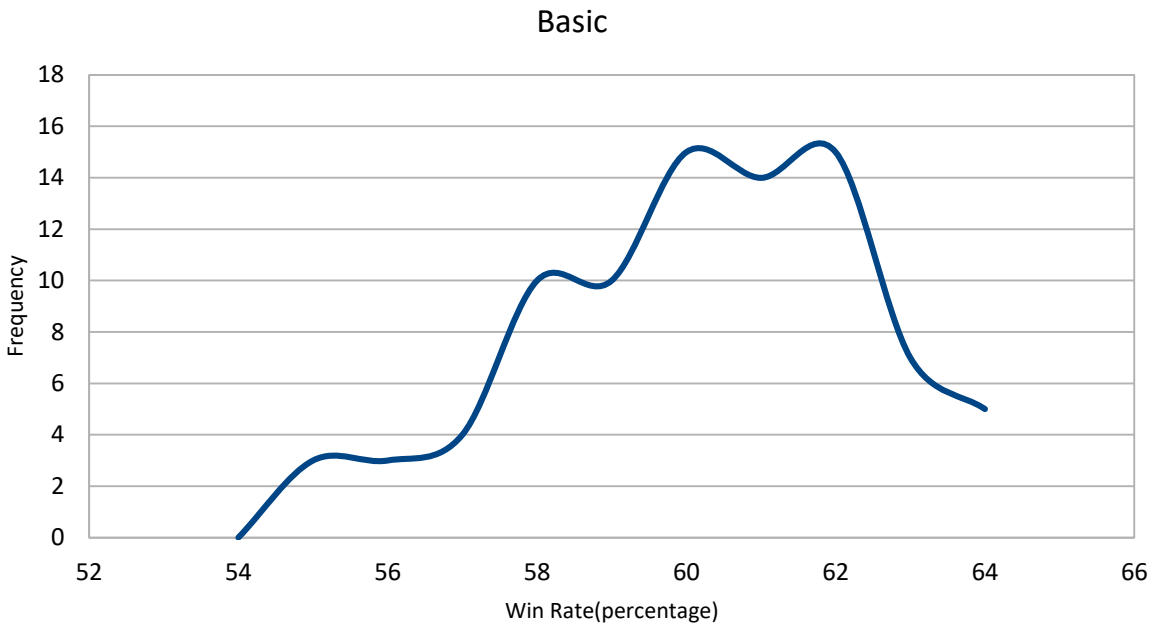
Win Rate(percentage)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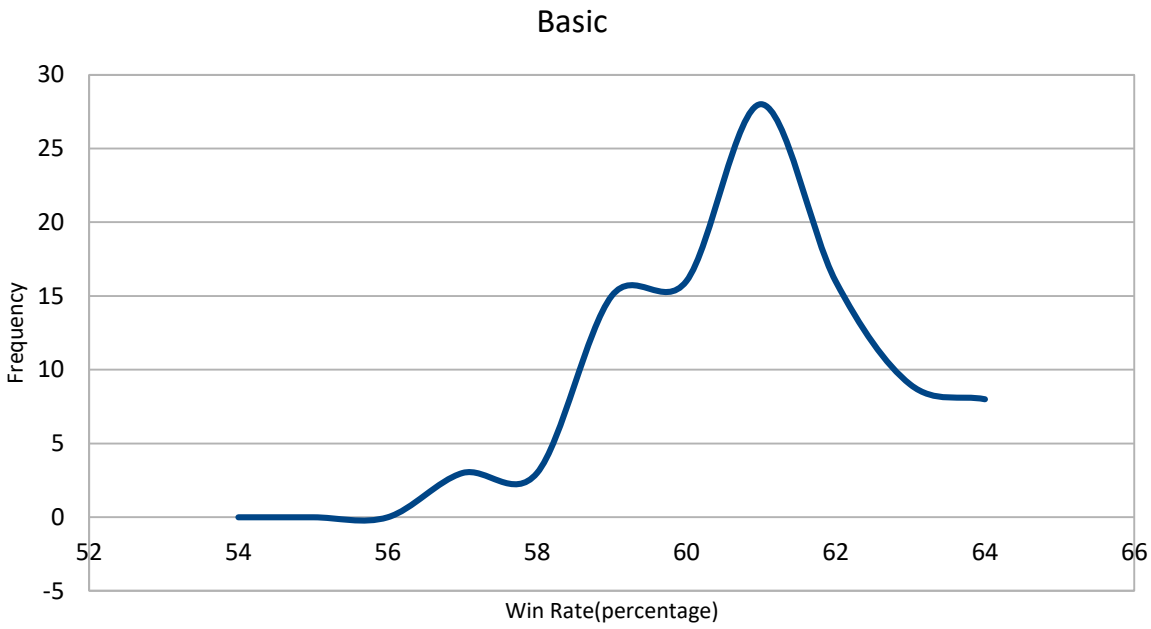
Win Rate(percentage)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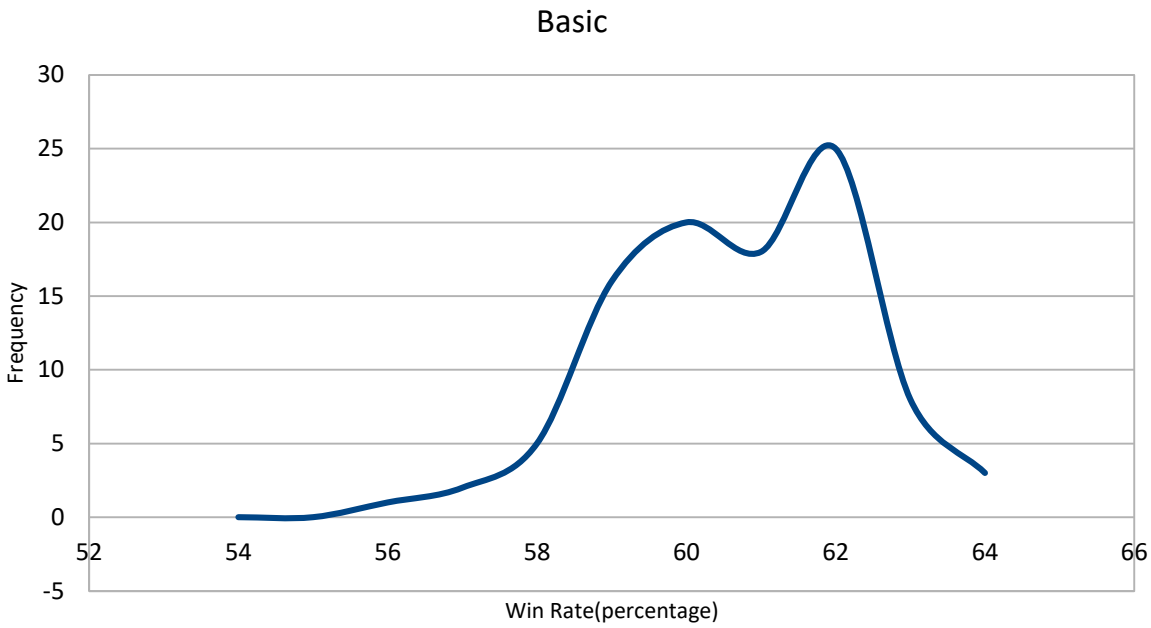
Win Rate(percentage)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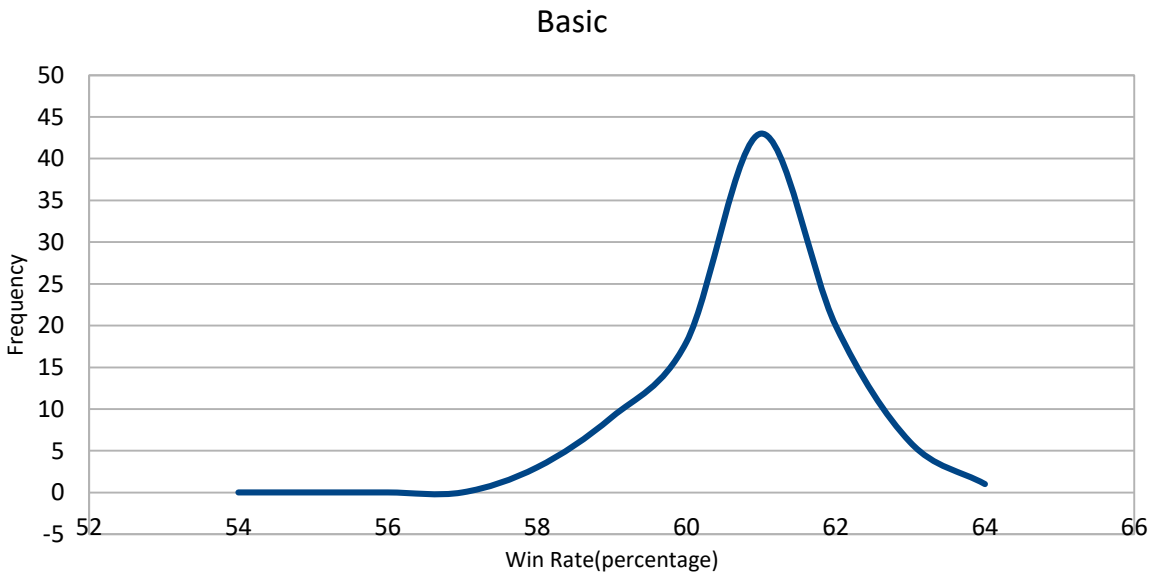
Win Rate(percentage)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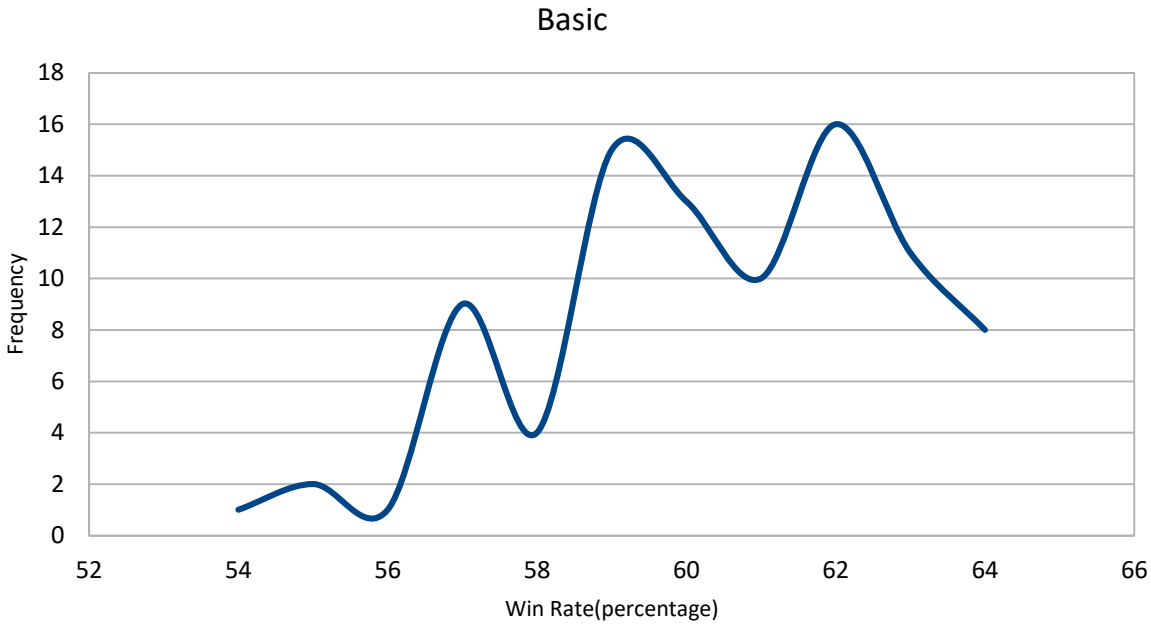
Win Rate(percentage)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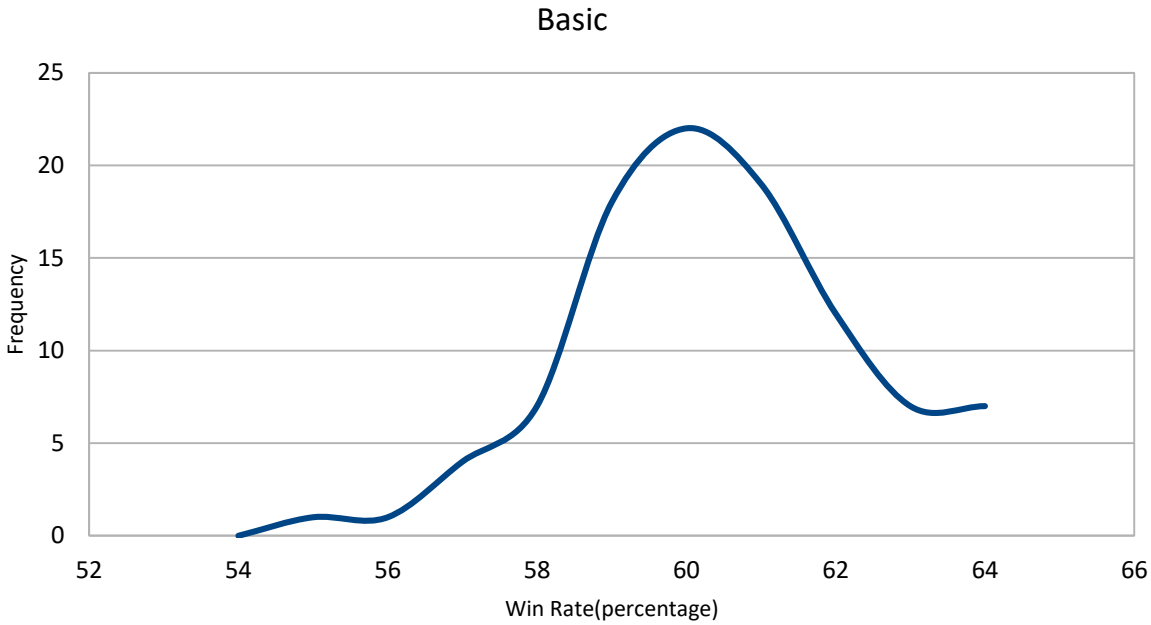
Win Rate(percentage)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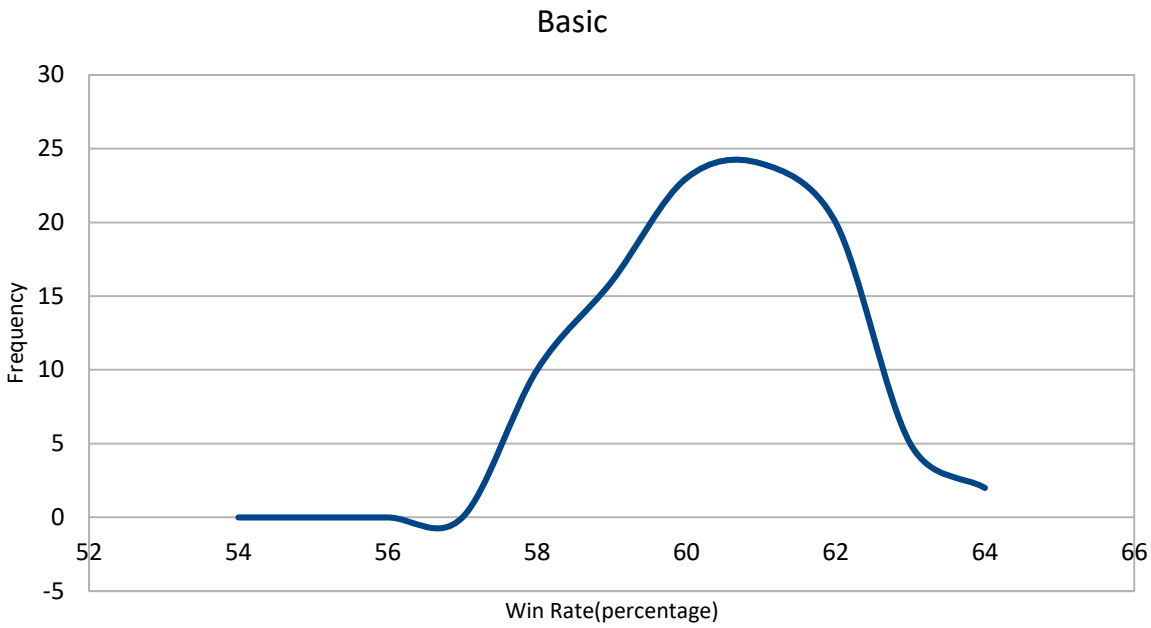
Win Rate(percentage)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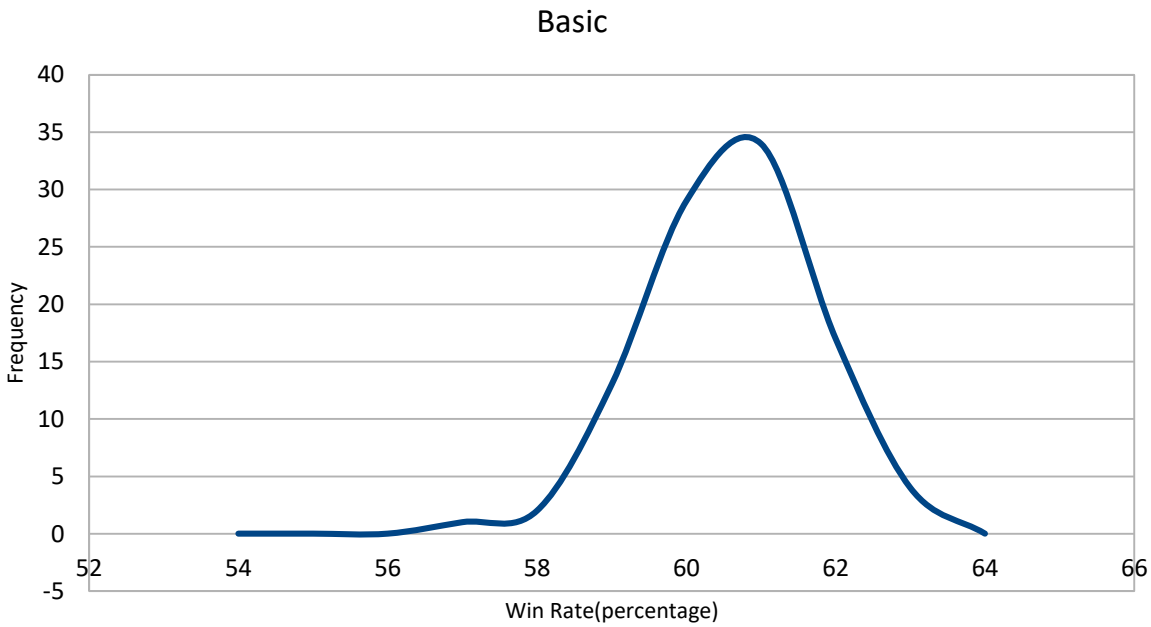
Win Rate(percentage)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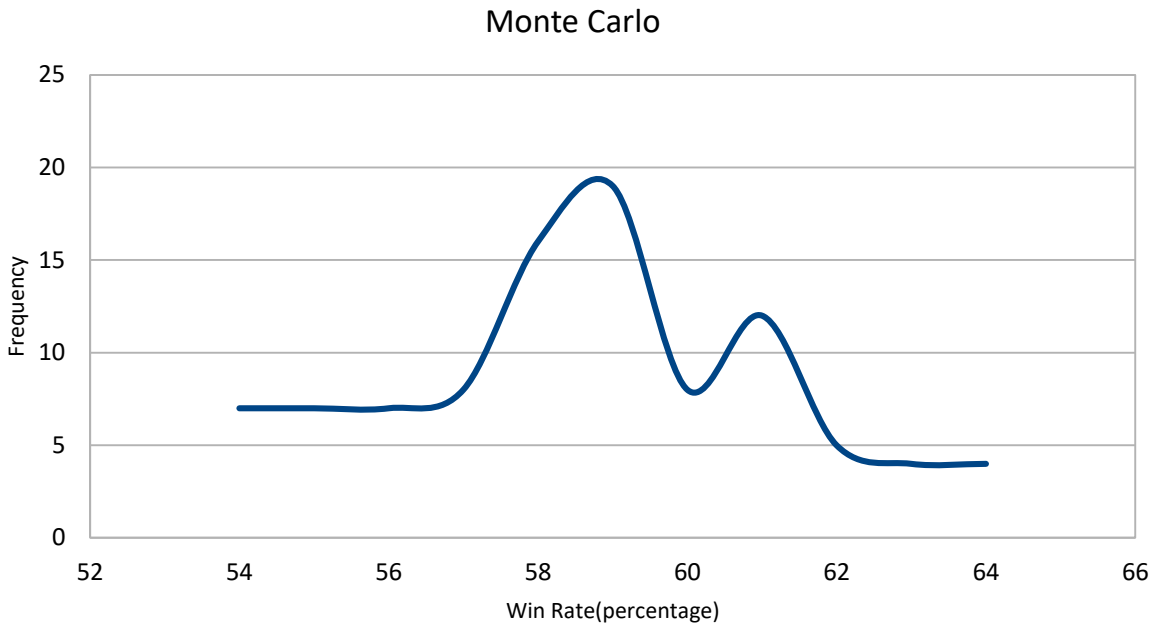
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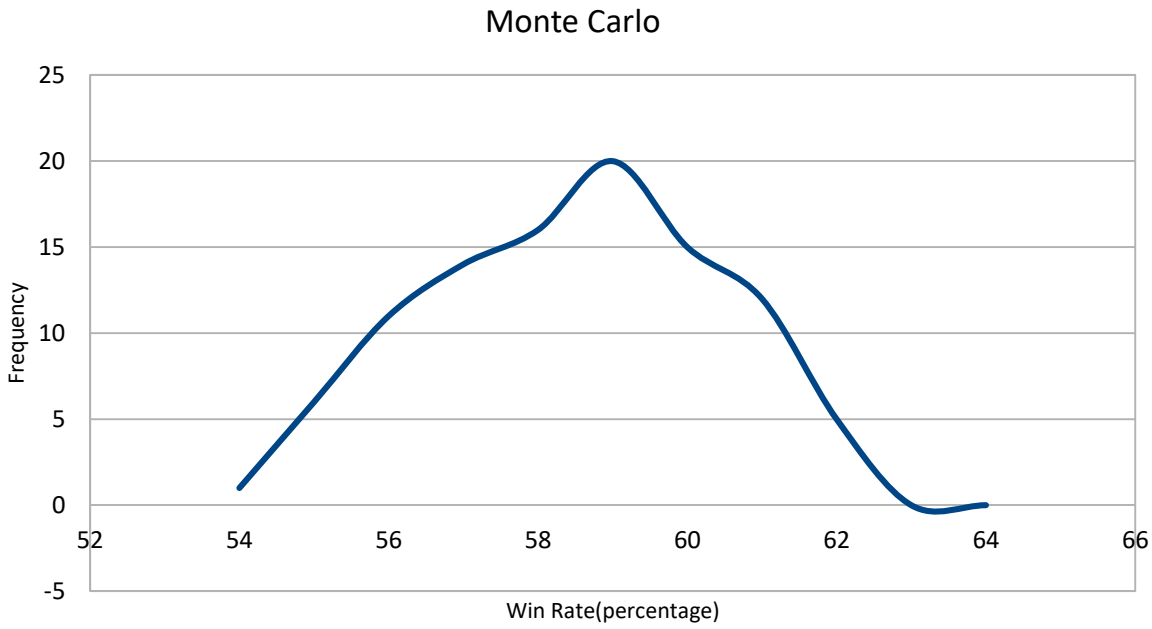
Win Rate(percentage)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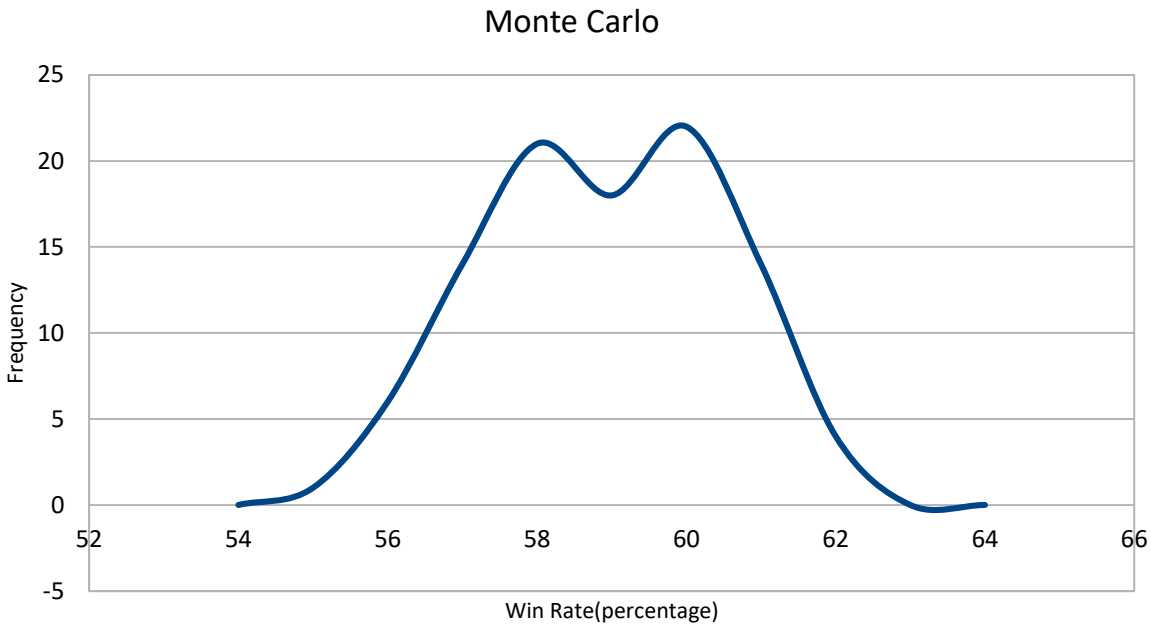
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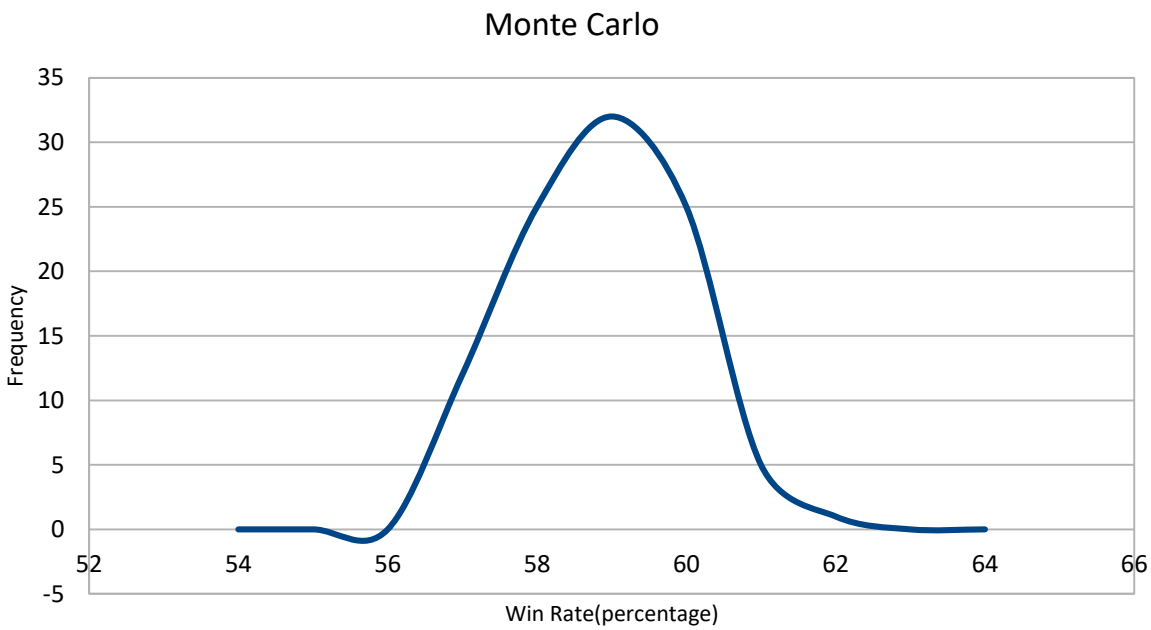
Win Rate(percentage)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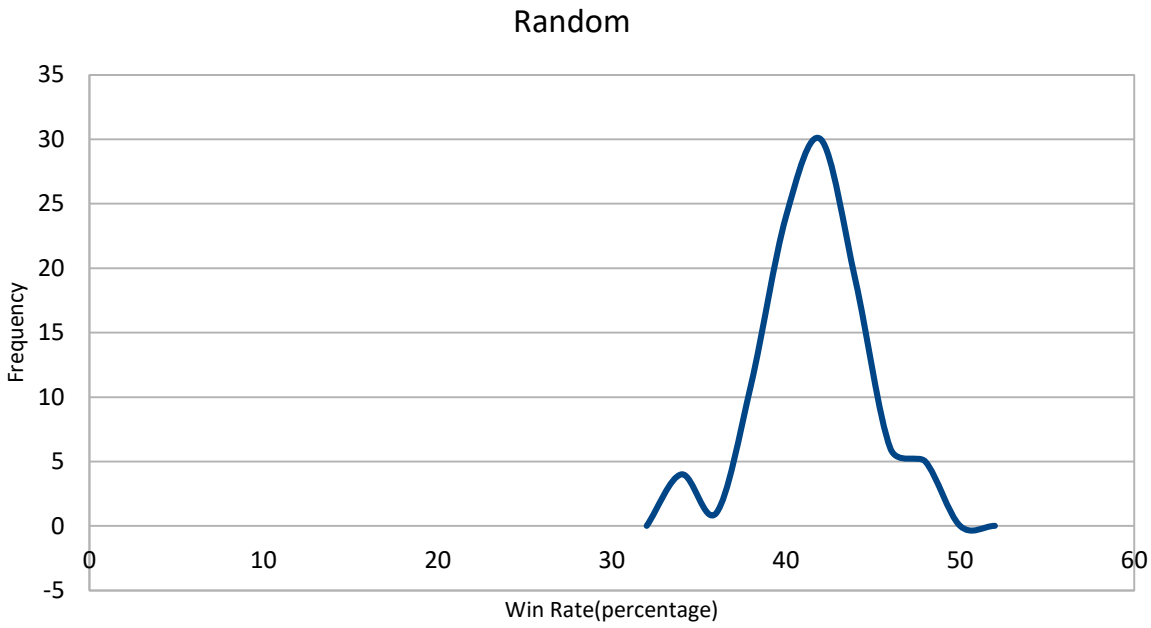
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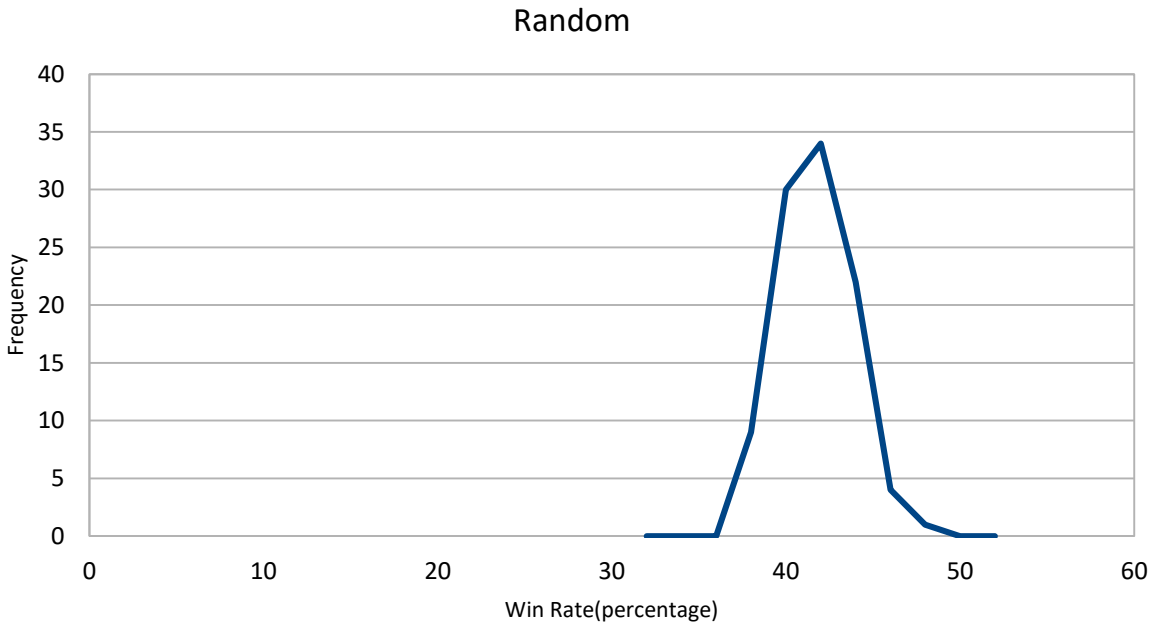
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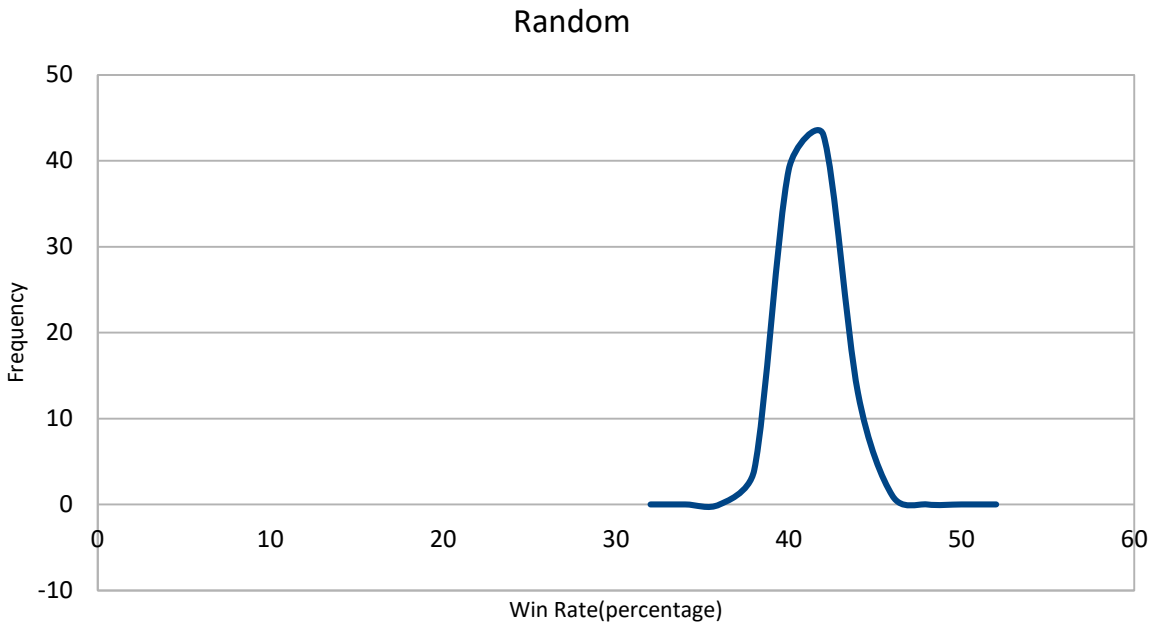
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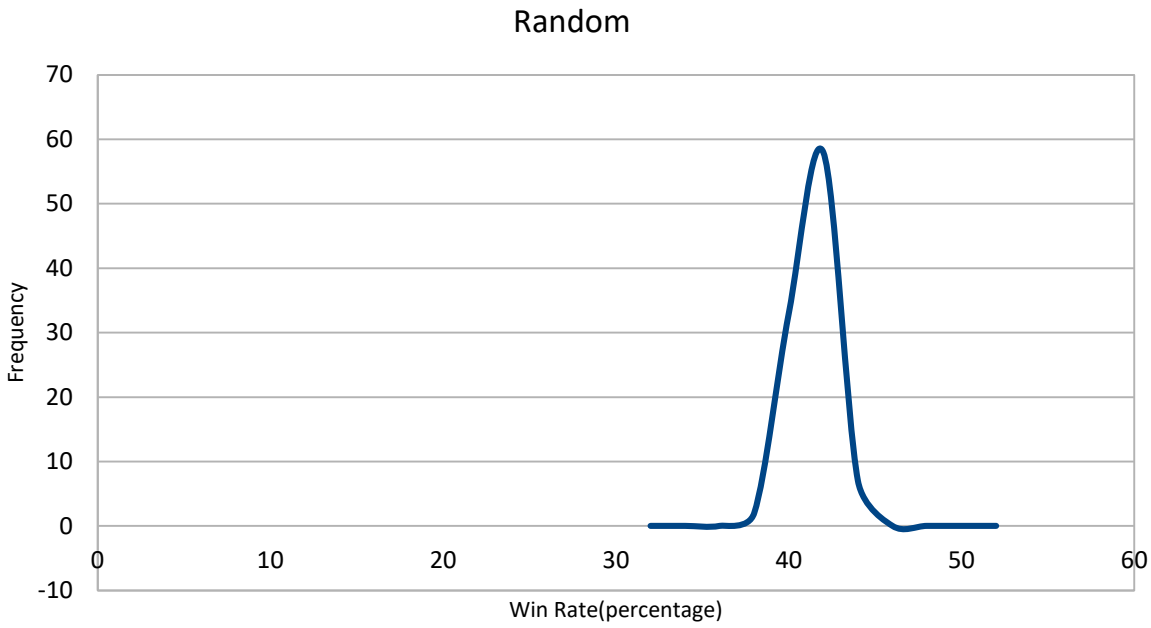
Win Rate(percentage)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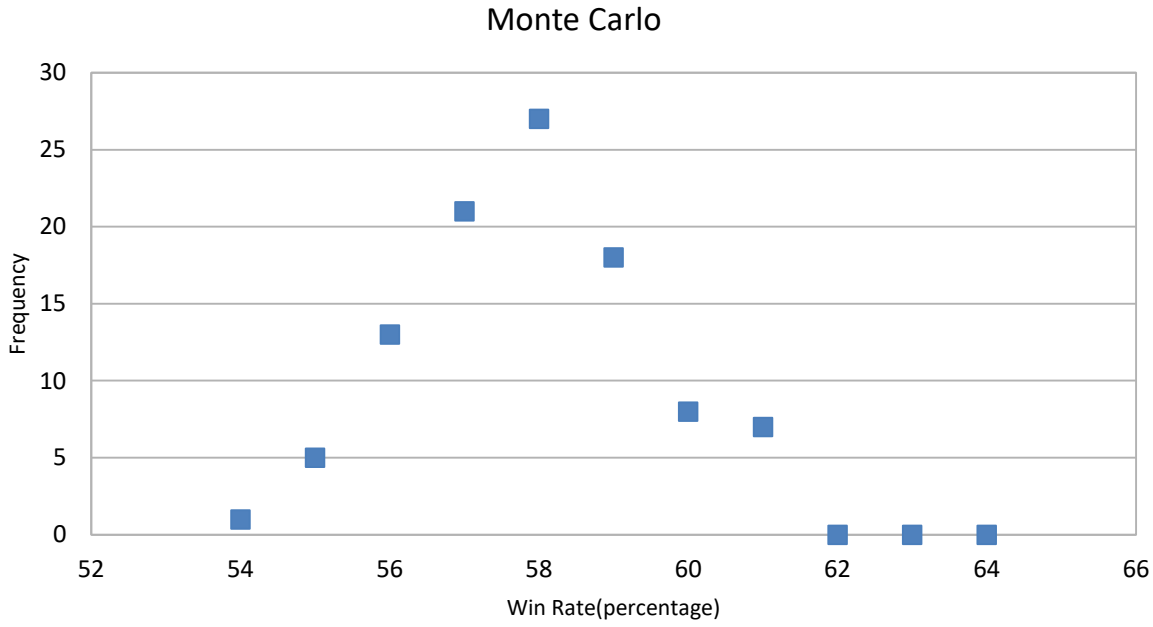
Win Rate(percentage)


Monte Carlo
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Win Rate(percentage)

| | | | MONEY | TRIAL | | | |
|---|---|---|---|---|---|---|---|
| | Bid | Min | Max | Avg | Std. Dev. | High Spread | Low Spread |
| Basic Hard | 5 | 10415 | 10972 | 10627.05 | 118.05 | 344.95 | -212.05 |
| | 10 | 10700 | 11845 | 11315.3 | 241.51 | 529.7 | -615.3 |
| | 50 | 13775 | 19425 | 16472.5 | 1218.53 | 2952.5 | -2697.5 |
| | 100 | 16100 | 28800 | 22793.5 | 2397.1 | 6006.5 | -6693.5 |
| | | | | | | | |
| Monte Carlo | 5 | 10057 | 10665 | 10343.69 | 126.74 | 321.31 | -286.69 |
| | 10 | 10100 | 11210 | 10703.55 | 242.91 | 506.45 | -603.55 |
| | 50 | 10200 | 16050 | 13568.75 | 1105.07 | 2481.25 | -3368.75 |
| | 100 | 12400 | 21400 | 16997 | 2029.15 | 4403 | -4597 |

| | | | DECK | TRIAL | | | |
|---|---|---|---|---|---|---|---|
| | Decks | Min | Max | Avg | Std. Dev. | High Spread | Low Spread |
| Basic Hard | 1 | 16100 | 28800 | 22793.5 | 2397.1 | 6006.5 | -6693.5 |
| | 2 | 16550 | 30000 | 22880.5 | 2311.28 | 7119.5 | -6330.5 |
| | 4 | 17350 | 28500 | 22460 | 2236.63 | 6040 | -5110 |
| | 8 | 17550 | 29600 | 23517.5 | 2616.83 | 6082.5 | -5967.5 |
| | | | | | | | |
| Monte Carlo | 1 | 12400 | 21400 | 16997 | 2029.15 | 4403 | -4597 |
| | 2 | 10900 | 24750 | 17091 | 2244.87 | 7659 | -6191 |
| | 4 | 11450 | 21200 | 16869 | 2191.09 | 4331 | -5419 |
| | 8 | 15250 | 27850 | 21424.5 | 3577.91 | 6425.5 | -6174.5 |

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Mutation and Cloning of p53 to Inhibit p53/MDM2 Interaction

Joshua Ennis

McNair Research, Dr. David Chambers

Concord University, Athens, WV

## Abstract

P53 binds to MDM2 promoting apoptosis of cancer cells. The interaction between p53 includes a hydrophobic face of an alpha helix. Interference with this hydrophobicity could lead to inhibition of the interaction between p53 and MDM2. The purpose of this experiment was to mutate certain amino acids in the p53 structure less hydrophobic and/or hydrophilic residues. Mutations were produced using PCR and cloned into the wild-type p53 background. The constructed plasmids will be used in transfection studies to assess any change in apoptosis due to the mutated p53 proteins.

## Introduction

P53 is a protein that induces apoptosis in cells by target gene regulation, and transcription-independent signaling.[7] p53 is located in all areas of the cell, and it has been noted that it can now be found in the mitochondria where it can translocate and carry out permeabilization.[7] P53 plays a key role in the regulation of complex intracellular networks. It does this by allowing the cell to maintain its genomic integrity and homeostasis. P53 helps the cell to modify gene expressions in response to stresses that the cell experiences like DNA damage, metabolic stress, and oncogene activation.[1] When p53 is in its tetramerized form, which means it has four domains of approximately 393 domains each[6], it acts as a transcriptional factor and regulates the expression of genes that are involved in cellular events like the cell cycle, apoptosis, DNA repair, and angiogenesis. A wide range of cellular stresses leads to a stable p53 protein. The protein is activated mainly through phosphorylation, de-phosphorylation, acetylation, glycosylation, and sumolation.[5] One of the most known functions for inactivated p53 is in the use of controlling the cell cycle and preventing it from dividing too many cells that could cause a tumor.[6] It does this by being a transcription factor in the cell cycle. The human p53 protein consists of 5 domains: transactivation domain, proline rich domain, core sequence-specific DNA-binding domain, tetramerization domain, and the C-terminal regulatory domain.[1] P53 also has two family members that are p63 and p73 that share a similar sequence homology with p53. P53 is inactive in unstressed mammalian cells and is maintained at low levels by continuous ubiquitylation and degradation by a proteosome. When cellular stress occurs, the p53

ubiquitylation is suppressed and p53 is stabilized and begins to accumulate in the nucleus. In the nucleus, p53 starts to repress the transcription of downstream target genes. It has often been questioned which of the roles that p53 hold is the most crucial. Several studies have been conducted and every experiment has found a different conclusion of which role is most crucial. From these results, it has been concluded that the p53 action is context dependent. [5] This means that p53 can be used for several different roles depending on the environment that it is currently in.

The p53 pathway is considered to play a major role in human tumors. When p53 is mutated from its original wild type, the protein's function changes and it ends up helping in the creation of tumors which then lead to cancer. More than 50% of human cancers contain a p53 mutation, and over 90% of these mutations occur in solid tumors.[1] About 80% of the mutations of p53 are missense that results in a single amino acid being changed in the DNA binding domain.[5] There are three common types of mutations of the protein that cause cancer. The three types of sequence alterations or mutations are familial cancers, common polymorphisms, and somatic mutations. The mutations of this protein are mostly missense mutations which means that the mutations inactivate the ability of p53 to control the growth of malignant cells, and to stimulate the transcription of the promoters containing the sequences for the cells.[3] A study done by Frebourg et al. showed that when p53 mutant proteins are mixed with the p53 wild type proteins in a cell, the some of the p53 mutants are able to inactivate the wild type p53s and convert them into mutants that can cause cancer. The mutant p53 can decrease the binding to DNA and the activity of transcription of the wild type p53s.[3] A mutation of the wild type can also lead to a p53 that is considered to be a germ-line protein. These proteins are most commonly

found in patients that have familial cancers or multiple primary cancers. They exert a dominant negative effect and they provide an increased cancer risk.[3]

P53 can bind to another protein called MDM2 to start the process of transactivation. MDM2 is a negative regulator of p53, and is responsible for regulating the levels of p53 ubiquitinization and nuclear export of p53 to the cytosol for degradation.[4] MDM2 keeps p53 at low levels and helps maintain a cell from undergoing apoptosis. When p53 is activated, MDM2 dissociates from p53 by phosphorylation or acetylation of amino acids in the TAD of p53.[8] After this p53 begins the transactivation process. MDM2 and p53 binds between p53's TAD and the binding domain for p53 on MDM2. There are more than 100 amino acids that are in the binding domain of MDM2, and these amino acids form a cleft that is essential to the binding of p53. The p53 TAD domain has 3 hydrophobic amino acids, which are Phe19, Leu22, and Trp23, that end up binding in the MDM2 domain.[2] The binding between p53 and MDM2 is a stable bond. If during this process, MDM2 is over expressed then problems can occur. One major problem that can occur is that p53 becomes suppressed even when the function of MDM2 has been triggered. When this happens the cell becomes cancerous.[4] According to Chene, research with the p53/MDM2 interaction has been focused on disrupting the bond between p53 and MDM2 in specific cancers. By doing this, p53 would be freed from the bond and could cause apoptosis to occur to kill the cancerous cells that it helped create with the MDM2 interaction.

Past experiments on p53 has shown that there are several mutations that can occur to the wild-type protein, and that the mutant proteins are the ones that cause malignant tumors to form. It has also been shown that some mutant p53s can cause wild type proteins to stop functioning and convert into mutant p53s. P53 could be used in cancer prevention and tumor suppression.

There has not been any research accomplished that proves that p53 can be used as a tumor suppressor.

## Procedures

PCR was performed using a Go Taq Green Master Mix. The forward primer that was used was P53 BamHI and the reverse primers that were used Alanine, Glycine, Proline, Arginine, and Aspartate/Glutamate/Aspartate. The cut sites were BamHI and Kpn I. Agarose gels of 1.5% were prepared with 1X TAE and run at 100V. The product was then ligated into a p53-KPN plasmid and transformed into E. coli cells. Overnights were created, and then PCR was run to confirm the presence of the inserts.

## Results and Discussion

Mutation of p53 was desired to observe if the interaction between the mutated p53 species and the MDM2 molecule was inhibited. PCR was run to mutate the p53 wild type with the 5 different amino acid subunits. To determine if the PCR was successful, an agarose gel was run. 200 base pair PCR products were observed suggesting PCR mutagenesis was likely successful.

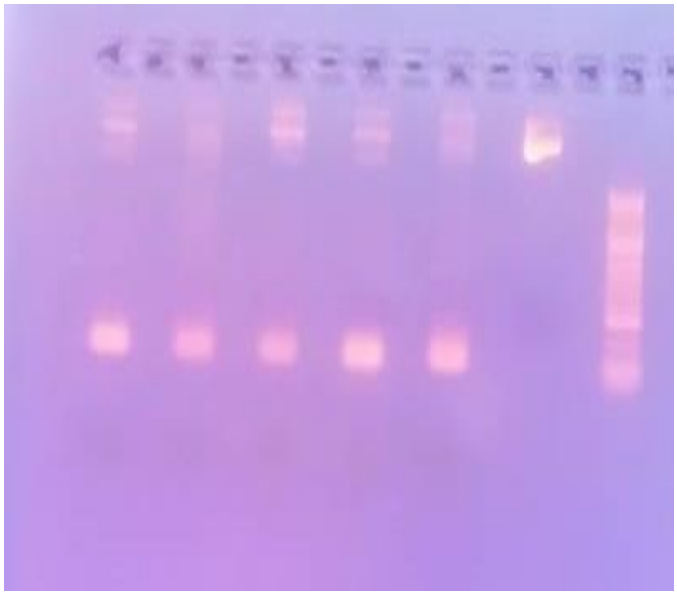

Figure 1. PCR products for each mutation were successful. 200 base pair bands are observed in each PCR reaction, indicating PCR product were obtained. Lanes are marked with mutation: Alanine (A), Glycine (G), Proline (P), Arginine (R), and Aspartate/Glutamate/Aspartate (DED).

The agarose gel indicated that the correct p53 mutagenesis products were obtained. To retain the PCR product, each 200 base pair product was TA cloned. To confirm that the mutant p53 products were present in the TA clone colonies, PCR was performed on plasmid isolated from colonies. An agarose gel was then run to confirm that the inserts were present.

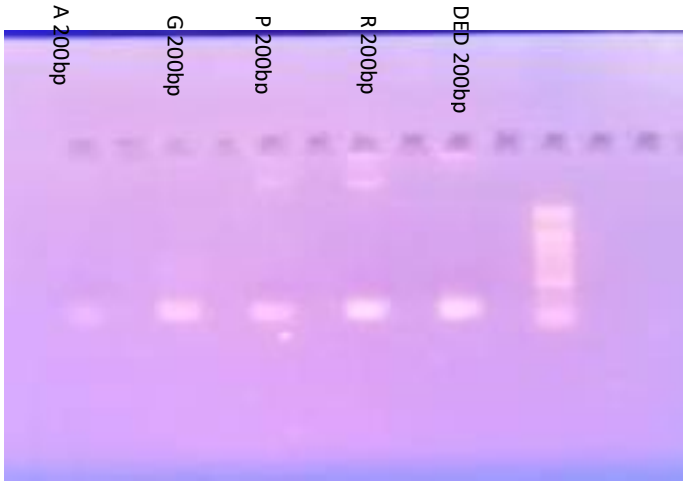

Figure 2. PCR products for each TA clone were successful. 200 base pair bands are observed in each PCR reaction, indicating isolated plasmids contain insert. Lanes are marked with mutation: Alanine (A), Glycine (G), Proline (P), Arginine (R), and Aspartate/Glutamate/Aspartate (DED).

After the conclusion that the TA cloning was successful, the TA clones were digested with BamHI and Kpn I, then ligation of the mutated p53 domains were performed. The mutated domains were ligated into a similarly digested p53-KPN plasmid. After ligation, the plasmids were then transformed into E. coli bacterial cells. Colonies were obtained and overnights were grown for evaluation. Two of the bacterial overnights did not result in any growth. The two overnights were the Arginine (R) and the Proline-1 (P-1) tubes. The bacteria from the overnights were then purified and PCR was performed to determined in the insert was present. An agarose gel was run in order to observe that the inserts were present in the p53-Kpn plasmid.

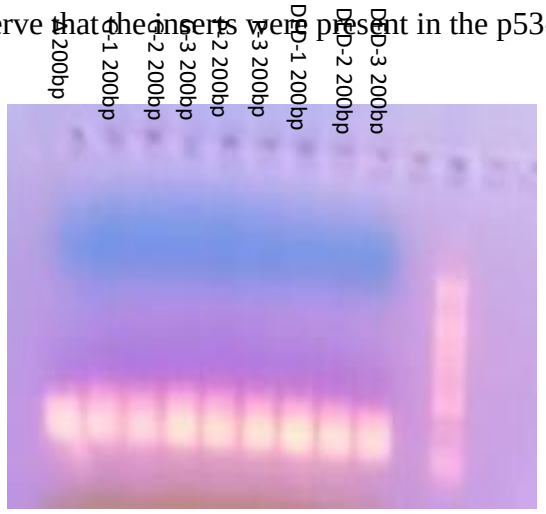


Figure 3: PCR products for A, G, P, DED constructs indicate presence of insert. 200 base pair bands are observed in each PCR reaction, indicating PCR product were obtained. Lanes are marked with mutation: Alanine (A), Glycine (G), Proline (P), and Aspartate/Glutamate/Aspartate (DED).

## Conclusion

Analysis of the initial DNA electrophoresis results indicated that the PCR product satisfied our intentions. This allowed for the continuation of following procedures needed for ligation and transformation of the p53 mutated domains into the full length p53 plasmid. The size of the mutated p53 domains were approximately 200 bases. The mutations that were conducted was with the amino acids alanine, glycine, proline, arginine, and aspartate/glutamate/aspartate. Using PCR, it was concluded that the mutations were successfully inserted into the TA clones, and were able to be ligated into the p53-KPN plasmid and transformed. After tansformation, PCR was again used to confirm that the mutations were successfully inserted into the plasmid in E. coli cells. It was concluded that mutated p53 domains were inserted into the plasmids successfully. Future research involves getting the mutated p53 plasmids sequenced and then inserting to plasmid into CHOKY mouse cells to observe if the p53 plasmid is inhibited from binding to MDM2 during an invasion of tumors in the cells.

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Race, Gender, and Sexuality Representation in Contemporary Video Games

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## Introduction

The video game industry is a relatively new form of media. Among other forms of media, television, music, cinema, this industry occupies an interesting space due both its nature and how the academic community has critical analyzed its cultural significance. It is an interactive form of media that has become common place in the contemporary household. Video games, as a unique medium, allow for the consumers to interact within preset narratives, some that permit high levels of variance in the player's experience and others that only allow for minimal player input in the narrative.

As with all forms of media, it is important to be academically critical of video games. Other formats have a long history of academic research and analysis regarding their content and consequences. However video game research mostly focused on violent content and influence on violent behaviors. Contemporary researchers are beginning to branch out on video game research, and this research is meant to contribute to this growing body of academic inquiry. This research is focused on race, gender, and sexuality representation in contemporary video games.

When researching the effects of video games on players, it is important to remember what this entertainment format is at its core, a form of media. Media includes many forms of information transmission such as literature, cinema, television, radio, and many others. The focus of this research is to examine the representations in video games, as its own distinct media format. By analyzing how LGBTA, gender, and racial groups are depicted in game narratives this research will provide some leverage as critical constructive criticism of video game narratives. Player input and attitudes towards the topic of representation in video games were also gathered through interviews and surveys. These attitudes are taken into account when

addressing the possible consequences that limited-diverse representation-how it affects consumer perceptions of their own identity, how that identity is meant to be interpreted, and how much value the culture places on their identity.

## Literature Review

First, let's address the importance that media has as an agent of socialization. Agents of socialization exist as those bodies or institutions within a culture that instill norms and values onto the individuals of that culture and society (Conley, 2011). Common examples of agents of socialization are school, family, peers, laws, and other levels of macro and micro institutions. All of these have influence on how an individual constructs norms and identity. Among these institutions, the media exists as a body that is constantly reinterpreting and reproducing ideas and values in numerous instances for public consumption (Ore, 2000). This project brings together Socialization Theory with Social Learning Theory, which highlights the importance of observation in social interactions, experiences, and outside media influences an individual's learning (Bandura, 2011). Just by observing one instance of a television program, one individual could infer many cultural practices, norms, values, and attitudes based on the behaviors within the televised narrative and the dynamics presented. According to Denzin (2001)," A majority of Americans know and understand the American racial order through mass media. Accordingly, those who control the media…shape and define a society's discourses about race and race relations." Denzin's quote offers a premise for the continued literature addressed in this project and as a core component in the motivation for conducting this research, examining how identity is presented in the media and how the culture at large interprets this.

### *General Media Representation*

Before reviewing any literature focusing on video games, it is important to review broader, more researched media formats on their performance in demographic representation. A review of the literature focusing on other popular media formats offers an insight into the culture and business environment that video games are produced within.

Film is one of the most analyzed media formats in its history with regard to demographic representation. Being one of the older of the media formats, it rightfully receives analysis and has the attention of academics whom have identified the trends of high lighting and empowering the heterosexual white man. For many familiar with sociological research, it is not an uncommon theme of history for empowering this demographic to correspond with the exclusion and dis-empowerment of most others in various degrees. The white heterosexual male in film and cinema has been celebrated countless times in award ceremonies and has dominated the percentages of industry praise and regard with other demographics in film (Rehling, 2009). This may seem like a relic of the sexist ideology of the past, but this trend exists widely today. For example, research shows no change in women's speaking roles in cinema in the past century (Smith, Choueiti, & Pieper. 2014). Woman are also portrayed less often than men, sexualized more often, and confined to strict definitions of conventional physical attractiveness (Smith, Choueiti, Scofield, & Pieper, 2013).

Academics and critics focus on the importance of racial representations in media as well. In an extensive literature review compiled by Brooks & Hébert (2006), has identified a large body of literature focusing on how the media frames non-white men and women of various races. Citing many authors whom point out the various negative stereotypical and sexually objectified depictions that are rampant for minority groups (Africa American men and women, Latino men and women, Asians, and Native Americans). Sexuality in movies has seen the same pattern of

disempowerment and objectification as well. Lesbians have their identities objectified for the heterosexual male gaze (Jenkins, 2005) (Diamond, 2005). Further into the analysis of LGBT identities, transgender characters in film are often used as either objects of fear, sympathy, or ridicule, dissociating the representation in media with the audience identity (Miller, 2012).

Television is not exempt either from scholarly analysis of its messages and presented images of race, gender, and sexuality. In television, the ideology behind many of the themes and images presented stem from a business perspective (Dines & Humez, 2003). Images and themes in television, including television commercials, focus on appealing to the largest audience possible to generate ratings and appeal. Poor representation of non-white-cisgender-heterosexual-men has been a common occurrence in television. Narrative innovation is at times, considered too risky of a venture for many producers, and thus they fall back on stereotypes that have demonstrated success in the past (Butsch, 2003). In advertisements, women are generally portrayed in stereotyped fashions such as the bitch, attractive whore, or the unattainable dream for the heterosexual male-gaze (Messner & Montez de Oca, 2005). A comprehensive analysis of speaking roles of women in prime-time television (both programs and advertisements) also reveals that women are still under-represented, side-lined, and sexualized (Smith, Choueiti, Prescott, & Piper, 2010).

Research has suggested that current trends in commercial advertising are beginning to reflect more diverse representations of African Americans, but many other racial depictions have yet to improve or have gotten worse in some cases (Mastro & Stern, 2003). Canadian television has been recently under scholarly scrutiny as having a strong negative association with indigenous people and other non-white races (Henry & Tator, 2009). Transgender identities have

been seeing some contemporary characters that fall into positive light, with the LGBT movement making some movement into the televised area (Kahn, 2014).

*Video Games and Representation*

Based on a review of more traditional media formats, it is possible to develop an understanding of the social and business context in which video games are developed. No piece of media is established in a vacuum, and a broad understanding of the media environment in a given culture offers valuable insight into predicting the messages and images present in future pieces of media. The previously cited literature (Mastro & Stern 2003, Henry & Tator , Kahan 2014 etc) revealed that much of traditional media tends to over represent white, cis-male, heterosexual, and it is predicted that the literature on video games and their representations will follow a similar trend.

Beginning the conversation on gender representation in video games has been difficult in some cases. The popular belief is that video games are a male-centric media for a primarily male audience (Romell). Some criticism against equal gender representation in video games is that it is simply marketing, targeting and appealing to the media's primary demographic. This idea however is not supported, according to the Entertainment Software Association. As video games have become of the most successful mediums in terms of industry size and reaching a wide audience. In 2014, the Entertainment Software Association released demographic information on American video game players. The gender divide of video game players falls almost evenly with 48% of American game players being female, leaving the 52% to be male (Entertainment Software Association, 2014). This report also notes that women 18 or older hold a significantly greater portion of the American video game player population than boys ages 18 or younger. The

Pew Internet research center also provides racial demographics of adult video game players, with 51% of all Black (Non-Hispanic) adults and 61% of Hispanic (English-speaking) adults being video game consumers (Lenhart, Jones, & MacGil, 2007). To assume that the typical video game player would be a white male is a difficult claim to support.

Games were originally assumed to market to be marketable only to young, cis-male consumers, and for some time there was a gender imbalance in researched video game player demographics. However this imbalance is gradually shrinking, with research suggesting a 55% male to 45% female (Romell). This research also shows data of previous years where the male-to-female ratio was strikingly unbalanced, with men dominating the consumer market for this media. This would also explain the tradition of this media catering to the male experience. In 2009, research revealed that there was a strikingly obvious gender imbalance between males and female character in video games, with male characters being four times more likely to appear then female characters (Williams, Martins, Consalvo, &Ivory, 2009). In an analysis of video game focused magazines, many depictions of female characters fall within objectification or side-lining for a male lead (Fisher, 2015). Burges et al. (2007) conducted a wide reaching analysis of 225 console game covers in 2007. Of their findings, men were more likely to be featured on covers then women, and in less objectified. Women in their findings were also more frequently paired with violence and 'sexiness' and with men paired with violence and masculinity. Without addressing the content research of these games, their marketing and cover images seem to depict a gender-bias in favor of men.

Some researchers on gender representation in video games claim that the representations of women are in a breach of regulations against violence towards women, as trends of objectification tied heavily with violence (Gutiérrez, 2014). Over the years there has been

repeated instances of sexualization, underrepresentation, and disempowerment (Rajkowska, 2014). However, other research has suggested that there is an equal amount of male and female appearance, but female characters are portrayed sexually with emphasis on female features and primarily whiteness (Jansz & Martis, 2007).

Other research has focused on the narrative role of female characters as being either the main character or a side character. In these findings that suggest main characters are often given more realistic depictions in terms of personality and role in the narrative, while side-characters lack this luxury (Rajkowska, 2014). One contemporary analysis of game narratives, Friedberg (2015) found that men are overrepresented in popular games, with their narratives commonly aligning with male power-fantasies of using violence to reach a resolution, often after of the male protagonist losing a component of their life (in some cases a female character). Friedberg additionally finds that women are used as plot devices, and with less emphasis shown on sexualization (still with a common theme of physical attractiveness) than earlier studies. In terms of female protagonists, this author claims that there has been improvement in depictions of female characters, but these stories often fall into male power fantasies.

Racial representations in video games have also seen their fair share of academic research. Stereotypes of race have been in media for ages, with video game media formats also producing these images. Whites, as with many other media types, are overrepresented in video games and all other racial categories are under-represented (Williams, Martins, Consalvo, &Ivory, 2009). Again with magazine images as well, Whites are more likely to be represented positively and represented in less-violent roles then other minorities in video game advertisements (Burgess, M. C., Dill, K. E., Stermer, S. P., Burgess, S. R., & Brown, B. P. 2011). In 2001 a content analysis of the top selling video games revealed that there were no

Latina or male Native American characters, with many of the heroes being white while African Americans and Latinos were often athletes and Asian/Pacific Islanders were usually wrestlers or fighters (Glaubke, Miller, Parker, & Espejo, 2001). Additional research reveals that many non-white races are often depicted stereotypically in video games (Dill, Gentile, Ritcher, & Dill, 2005). These characters can also be seen as a form of virtual blackface, allowing white players to adopt masculine athletic bodies of other races without having to interact with the social context of that race (Leonard, 2004). An additional practice employed in video games featuring urban settings is a practice of creating "exotic" environments with many black and brown bodies throughout it, with these environments being sold for there "difference" (Everett & Watkinds, 2008).

*The Effects of Representations*

Moving away from focused media narrative, media representations have real world consequences and can influence on behavior. For example, health psychologists have cited media representations of illness and disease as having three major characteristics: they impact individuals' understandings of health and illness, create and reproduce meanings and influence attitudes, and act as a guide to mediate behavior (Lyons, 2000). It is a simple mental exercise to replace the heath related terms with group identity labels. Further, these hyper-sexual and narrow bodily representations of women serve as references for body image management in women, resulting in eating disorders and health issues (Stice & Shaw, 1994). Sexual behavior can also be influenced by media exposure and representations, as exposure to sexually oriented genres have been found to create greater acceptance of stereotypical and casual sexual attitudes as well as, sexual pluralism (Ward, 2003).

When discussing the importance of healthy representations in the media, it is often a counter argument to inquire if this does generate noticeable after effects or consequences. The media acts as an agent of socialization so that we learn the norms and behaviors appropriate for those norms (New Charter University). Tukachinsky (2015) offers a meta-analysis of the research on the effects on media representations and stresses that these representations have both positive and negative consequences on the psychology of the groups they represent, affecting their self-consciousness and harming their collective self-esteem. The interactive nature of video games thus allows the audience to interact with group representations, allowing for more immersion into the normalization of these representations, whether good or bad. With black bodies and avatars often used as "minority others" for the white heroic characters to plow through, could this not have some effect on views of differing racial groups and the policies surrounding them? Addressing the violent nature of this media, much of the literature on violence rarely touches on the subjects of stereotypes and labelling as David Leonard discusses in their research that video games can exist as "construction sites and vehicles…, as a space through which we learn about race, which has consequences within and beyond virtual space reality… the space where we use and abuse race in avoidance of the real world" (2009). This scholar offers an important position, that this violent media can be used as a vehicle for exploring thought, group injustices present in this media thus can be disastrous to the real world assumptions. Abrams et al. (2003) provide a theoretical approach to understanding how the power of representation in their approach on group vitality. They examine cultivation theory in their article, and state that these representations re-instate a lesser status and lower the groups' assessment of themselves, but adds on that groups have the power to view media that does contain representations of their group.

Stereotypical representations can be quite negative to players and consumers of these video game narratives. Vincent Cicchirillo (2014) found in their experimental design that players experienced higher rates of identification with characters that shared their racial identity. In the same vein, Grace Yang et al. (2014) tested violent and stereotypical racial avatars on player association of violent behaviors and implicit attitudes. They found that playing a game as a violent Black avatar led players to have stronger negative attitudes towards Blacks, associated more negative words and weapons on the implicit attitudes test.

The goal of this research is to analyze the top selling video game of the 2015 Fall and Summer season and understand their representations of gender, sexuality, and race. Additionally, consumer/player stances and perspectives on the issue on video game representation have been collected in order to asses who is viewing these games, how they are related their identity, and if representation has any impact on in consumer behavior. This research aims to offer a kind of health diagnosis of the current video game industry on its upfront and most publically viewed form. While there do exist video games with positive and varied representations of characters, this research does not aim to discredit those. This research is focused on what is presented currently at the top of the video game industry, and possibly why it's there when taking into account representation and character narratives.

## Procedure

### Methods

This research uses three different methodologies to generate both qualitative and quantitative data. The quantitative data is gathered through the use of survey and content

analyses. Qualitative data is generated through semi-structured interviews. Survey and interview data overlap on specific variables they measure, but asses some unique variables.

The survey was conducted online, hosted on a polling website called Qualtrics. It was distributed through class mailing lists for introductory and intermediate courses in the social sciences (Sociology, Psychology, Geology, and English). Additionally, social networking was employed further the distribution on websites such as Facebook and Tumblr.

The interview was semi-structured, with key questions for participants to respond to regarding their thoughts on how well they're represented and their thoughts on their representations that do exist. It was ultimately coordinated as an open discussion based on the question prompts. Each interview was recorded and later transcribed for analysis. All participants are made aware of this recording through the use of the informed consent form.

The content analyses worked in two parts. First, a custom rubric was developed and reviewed by the faculty mentor, but did not have any prior testing or academic review. The custom rubric is broken into four sections, bare minimal, total presence throughout the piece, dynamics of X character (where the piece must provide three non-white-cisgender-heterosexual male characters), and dynamics of X character in relation to the whole piece (using the same three characters of the previous sections). Each section has their own amount of points, and each title is compared to how many points out of 100% (a theoretical score for a game with perfect representation). To help validate some of its data, the Bechdel Test (Bechdel, 1985), the Vito Rusoo (GLAAD, 2014), and Representation test (The Representation Project, 2014) were used in conjunction with the custom rubric to help validate and revise its data. Both the Bechdel and the Vito Rusoo measure bare-minimal levels of representation of women and LGBT (respectfully),

but the mirror each other in asking only three questions (Is there a character that is (Female/LGBT), Do they talk to another (Female/LGBT) character, and Is it about something other than (Man/Heterosexual)). The Representation test is a 20 item check list that provides a letter grade based on the scores that each checkable item is worth. The titles selected for this method were the top ten sellers of the Fall 2015 season based on ranking on (http://www.vgchartz.com/). However, many titles within this list lack narrative or are based on real world people (Sports games). The research focuses primarily on fictional narratives, and thus simply replaced such titles with the next top seller on the list and that meet the research requirements. The following game were selected for the content analysis: Call of Duty: Advanced Warfare, Grand Theft Auto 5, Destiny, Watch Dogs, Dying Light, Far Cry 4, Pokémon Omega Ruby and Alpha Sapphire, Assassin's Creed: Unity, and Bloodbourne.

An additional note on the content analysis rubric however. In many game titles, there is an increasing trend to allow for main character/player controller character customization. Ultimately however, games tend to be written in to provide the same narrative/player experience regardless of what customizations the player enacts on their character. Gender is often regarded simply in terms of pronoun alteration when referring to the main character. For the purposes of the content analysis, custom built characters are treated as not meeting any qualifications for any criteria, existing separate from any race, gender, or sexual identity.

Due to the cost for directly experiencing many of these games (purchasing copies as well as the appropriate consoles to properly play them), free-access play-through recordings were used to remedy this. Many of these play-throughs come with uploader commentary, but this commentary is relatively meaningless when analyzing the content of the games through these videos.

## Participants

Course mailing lists were used to spread information of this research among Sociology, Psychology, Literature, and Geology courses. To gather participants for the survey and the interview, extra credit was offered for certain courses. This method for recruitment was used primarily for the interview process but early survey data was generated through this method. Some participants were recruited through in class-visitation and announcements, again offering extra-credit for participation. Additionally, participants were recruited by using snowballing and social media. This became the more prominent method for recruiting non-white-heterosexual-cis-men.

The average age of the respondents to the survey was 23.85 (n==148 responses). The survey participants had an issue of variety. Of the 153 responses, 85% of respondents were White/Caucasian, 49% of the respondents were Heterosexual, and 59% of all respondents were cisgender females. This research focuses on the experiences of underrepresented groups and while it is a good representation of the cisgender female's experience (as they are under or poorly represented), it is difficult to generalize this data to other populations. See Figure 1 for the gender of respondents, Figure 2 for the Race of respondents, and Figure 3 for the Sexuality of Respondents.

The interview had a small sample size of 8 participants. Of these eight, half were white, cisgender, and heterosexual. The average age was 20.13 (n=8). Racially, six were white, with one black and one Native American. Half were heterosexual, with one homosexual, two bisexuals, and one asexual. Seven were cisgender, with one trans-male participant. These participants were recruited through mix methods of snow balling, in class announcements, and

student e-mail lists. Because of this sampling, the results for these participants will be separated into Group A (white, heterosexual, cisgender males) compared to Group B (non-white, heterosexual, cisgender males).

**Materials**

*The Survey*. A twenty six survey hosted freely on Qualtrics.

*The Interview.* Standard equipment for the interviews were informed consent paperwork, the researcher's personal computer for recording purposes, and a digital copy of the interview. The interview consists 16 question/prompts, with various sub prompts attached to questions for conversation encouragement or additional probing.

*The Content Analysis.* The Bechdel test, Vito Russo, and Representation.org tests are all free content analysis rubrics available online. The custom rubric consists four sections; Most Visible Presence, Total Presence throughout the Entire Piece, Dynamics of Character X, and Dynamics of Character X in Relation to the Whole Piece.

## Results

*The Survey*

It is important to note that due to the small sample sizes present in this survey, statistical testing cannot be accurately conducted. These results are presentations on the end scores and trends observed via Qualtrics' analysis/results program.

For the survey, due to the over-representation overly represented demographics, groups questions such as *How often do you see your (race, gender, sexuality) in video games* were cross tabulated with the identifier questions (*What is your race, gender, sexuality*?). For gender

visibility, only Cisgenders responded to viewing their identity in the video games, while trans and non-binary responded that they saw no examples of their gender identity in video games (See Figure 4.) On race, a similar trend followed in that White/Caucasian respondents responded with viewing their identity quite often while Black, Latino, Asian, and Middle Eastern respondents replied with seeing their identity only sometimes, rarely, or never (See Figures 5-7). For sexuality the pattern continues in that Heterosexual respondents saying they are visible, while all non-heterosexual respondents responded with hardly seeing their identity (See Figure 6).

On regarding how well demographics are represented, a similar trend occurred. These questions were "(Demographic) characters are represented in video games fairly and accurately" and placed on a Strongly Agree to Strongly Disagree scale with "I have never seen a character that meets this criteria" as an additional option. For Asian characters from all respondents, 1% responded with strongly agree and 11% responded with agree. Neither agree nor disagree made up 29% of responses, with the remaining 32% being disagree and 21% being strongly disagree (See Figure 7). For Black characters; 3% said Strongly Agree, 9% Agreed, 29% Neither Agreed nor Disagreed, 37% Disagreed, 22% Strongly Disagreed, and 1% had never seen a Black character in video games (See Figure 8). On Middle Eastern characters: 2% Strongly Agreed, 5% Agreed, 21% Neither agreed nor disagreed, 21% Disagreed, 36% Strongly disagreed, and 16% had never seen a Middle Eastern character in video games (See Figure 9). For women; 3% Strongly Agreed, 5% Agreed, 28% Neither agreed nor disagreed, 36% Disagreed, 28% Strongly disagreed, and 1% stated they had never seen women characters in video games (See Figure 10). When self-identifier questions (What is your race/gender/sexuality?) are cross tabulated with these questions on how well a demographic is represented, there is a trend for all demographics

with responses leaning towards the Disagreement responses through all of these questions (See Figure 11).

In terms of stereotypes present in video games, this result is generated by cross tabulations of the identifier questions along with a question on what stereotypes each of these identities see. Due to nature of the question and this cross tabulation, intersectionality cannot be addressed in this analysis, over represented groups (Cisgender Male, Heterosexual, and White) will not be presented in this analysis due to the inability to remove these identities as separate to other underrepresented identities that participants may hold. The categories that respondents can identify are; Token Representative, Objectified, Stereotyped, In need of rescue, Protagonist, Antagonist, Mostly Supporting roles, Mostly Subordinate roles, Enemy or Nameless Hostile, or Other. The highest response regardless of any identity were Stereotyped and Mostly Supporting Roles. Of the Cisgender Female responses, the highest responses were; Objectification (16.54%), Stereotyped (17.31%), In need of rescue (15.38%), and Mostly Supporting roles (16.92%). Of Transgender men, the highest responses were; Token Representation (33.33%) and Stereotyped (33.33%). Non-binary responses had the highest response of Token Representation (17.19%). Black responses stated that the largest trends they observed were Token Representation (23.53%) and Stereotyped (23.53%). Latino responses had the highest responses of Stereotyped (26.09%). Asian responses stated that the highest trend they noticed were; Objectification (22.22%), Stereotyped (22.22%), and Mostly Supporting roles (22.22%). Homosexual respondents stated that they viewed mostly Stereotyped (25.93%). Bisexual respondents had the highest response of Mostly Supporting roles. Pansexual respondents had the highest response of Stereotyped (18.92%). Asexual responses had the highest response of Mostly Supporting roles (21.13%).

For the question on sharing a character sharing demographics being a deciding factor in purchasing a title, the only demographic that responded heavily towards Agreement at 80% was Black. All other demographics had either insignificant differences between Agreement or Disagreement or only had sizeable amounts of responses in Indifference/Neither agree nor disagree (See Figure X).

Character preference based on sharing demographics trended towards Indifference (Neither agree nor disagree, 40%) and Agreement (54%) (See Figure X). The demographics that had the highest score of indifference against other responses were; Cisgender males (53.13%) and Other-which is primarily composed of gag responses and other queer identities not listed- (57.14%) and the Not-Listed racial category (50%). All other identity categories tended towards agreement. For the follow up question on which dynamic of identity (race, gender, or sexuality) respondents had preference for, the highest response was for Gender (46%) with Sexuality being the second highest (18%). Additionally, a character sharing a demographic with a respondent was reported to not be a deciding factor on participants choosing to purchase a title (See Figure X).

*The Interviews*

During Group A's interviews, there was a constant theme of both awareness for the issue of representation as well as little to say on the topic. When inquired on how their in-power identity and how it is represented, many of these participants easily responded that they were represented properly in video games. They do agree that they are often the main character, hold some form of significance to the plot, are visible, and do not fall under negative stereotypes.

"*Umm…I would say I see (my identity) very often sense most characters are predetermined…I see this character on Call of Duty all the time online…(Characters that share my identity) are shown pretty good and not under any particular bad way. I do think there's enough white-male characters. I guess it is important to see my identity, but for mine not particularly."-Jacob: White, Heterosexual, Cisgender Male*

Group B demonstrated a different trend trend from Group A. Only 1 participant of this group stated that they felt their demographic was represented properly (however only providing one example of their non-heterosexual identity being represented positively). Common themes of Group B were disempowerment, objectification, stereotyping, lower-narrative significance, and absence of representation.

In general, the female identifying participants, expressed experiences of objectification and a desire for legitimate main character status. Their interviews expressed concerns with objectification in terms of attire, bodily language, and plot relevance. Some did find identification with these characters however, in that they saw little female representation and took what they could get.

*"I know that these women are dressed in scantly ways for no real practical value, but I still love them just because they're there and are fighting bad asses….But I still want more women main characters, not another white, thirty-something, brown haired man. I like this, but at the same time I am sometimes afraid of revealing my gender to other players because I don't want to be harassed." –Tamarra: Native American, Bisexual, Cisgender Female.*

In non-heterosexual participants, there was a large trend of not experiencing representation. The Bisexual participant brought in indicated a desire that their identity needs validation in the media and not vilification. The homosexual participant focused solely on one example of their sexual identity, stating that they view them as positive and full rounded as a character based on this one sole representation. With regard to the Asexual participant, they stated that they saw no representation of their identity. One participant identified on the bisexual-asexual spectrum, and brought in a discussion on how they lacked representation on both spectrums. When presenting their interview trends, they precariously exist between variables/values. However, their interview stated that they felt little to no representation of their sexual identity.

> *"I see NOTHING for the Asexual spectrum, and it sucks! I know that there are some fan interpretations, but there is nothing explicit! I went through such an experience to feel validated in my sexual identity, it would mean a world to some people just to have a small amount of representation." Anna: White, Asexual, Cisgender Female.*

The trans identifying participant of this research brought in the lack of representation that their identity faces. When asked on how to improve their representations, their quick response was a call to begin having representation. This is not talking in terms of trans-male or trans-female representation, but in general trans-identity having any visibility in the media.

The Black respondent discussed of side-lining and the lack of variability of black characters. Their roles consisting of lower levels of plot power and with little variability in terms of who the character is and their plot role and significance. The Native American interviewee also discussed such themes but also expressed feelings of invisibility of their identity. Again, the

key theme of their interviews in regards to race is a need for more variety in what narratives and roles characters of their race have available to them.

> *"I'm just tired of seeing the same thing. I want more diverse and exciting characters that look like me." Mike: Black, Heterosexual, Cisgender Male.*

*The Content Analyses*

No title passed the Vito Russo, nor was there any game that passed any question of the Vito Russoo on LGBT+ representation.

For the Bechdel test, the only titles that fully passed were Destiny, Far Cry 4, Pokémon Omega Ruby and Alpha Sapphire. Titles that were one question away from passing were Assassin's Creed Unity (Two women do not talk to each about something other than a man), Dying Light (same reason as Assassin's Creed Unity), and Grand Theft Auto V (see the previous two).

For the Representation.org test, the final grades/scores are as followed; Call of Duty: Advanced Warfare scored a F (5 points), Grand Theft Auto V scored a C (11 points), Destiny scored a C (11 points), Watch Dogs scored a D (6 points), Dying Light scored a D (8 points), Far Cry 4 scored a B (12 points), Pokémon Omega Ruby and Alpha Sapphire scored B (16 points), Assassin's Creed Unity scored a F (4 points),

For the custom rubric, all games passed the basic visibility measure of the first page. For the Total Presence Throughout the Entire Piece, the average score of all titles was 59.67%. All titles were able to provide at least three Non-white-cisgender-heterosexual-males for analysis.

The average score of these individual character analyzes was 48.74%. Finally the average score for all these characters analysis in relation to the whole piece was 84.76%.

## Discussion

This research offered many perspectives on the relationship of representation in the video game industry. A dynamic that was identified was the consistent trends in the Content Analysis and the Survey and Interview data. Both reflect common themes of over-representation of the White, Cisgender, Heterosexual Man, and overtly positive representation of this demographic as well. All other demographics along the gender, sexuality, and racial spectrums saw lesser amounts of visibility and were represented in less important roles (if they were represented at all).

This project was not without limitations in all dynamics of the three-way methodology. The sample size and composition for the online survey are heavily skewed towards one demographic, even when accounting for intersectionality. A larger and more varied sample size may have shown different data. The interviews themselves were especially limited in their scope as well due. An explanation for this however may lie within the geographical region where this study was conducted, rural southern American campus. Regarding the content analysis, many of the titles presented custom character creation, invalidating them automatically from the main character portion of the custom test. While this was a hard set rule to focus on the actually crafted narratives, over half of the titles could have passed the Bechdel test due to custom character gender assignment.

Trends and patterns did emerge from this research however. These trends seem to reflect current and past literature on the state of representation of demographics in both video game

specific and traditional media. Like cinema, television, and the music industry, the video game industry favors images of the white, cisgender, heterosexual, male. This research is situated within the theories that claim that culture influences learned behaviors. Agents of socialization also present patterns of conditioning and learning models. Conforming to images and narratives that are produced through agents of socialization are judged positively (Grusec, 2005). As one views themselves against media narratives, they compare their own behavior against what is "typical". Bandura's social learning theory brings in the learning through example or modelling (Bandura, 1971). When taking these two approaches combined with Skinnerian Operant Conditioning (Skinner, 1963), the modelling of behavior and mimicking behavior provides positive reinforcement, strengthening the likelihood that the behavior will persist. The common example of this is female representation in media and learning sexual and body management behavior. How does this interactive form of media entertainment contribute to learning ideals and values? The messages present seem to support the high status of white-cisgender-heterosexual-male, while all other demographics are marginalized. This type of media narrative can contribute to overt and covert behaviors practiced by the populace that consumes this media.

How we shape our understanding and treatment of marginalized demographics also comes from how we are exposed to these demographics. Dominant cultural messages can be coded into pieces of media by those with the power to produce media, but these coded messages can be decoded by the consumer of this media, and these messages and narratives contribute or reinforce existing ideals present in the culture (Dines & Humez, 2002). These messages and narratives become the normalized, and contribute to the greater cultural norms and narratives on how to interpret identity. While it is possible to resist these narratives and presentations of identity, groups with whom the narrative supports or don't affect do adopt the media messages as

the norm. Again, how does this research apply to this literature? The narrative of one specific demographic being normal or in constant power. This can also be seen as what the culture wants to produce. Establishing a cause and effect circular cycle of establishing group power and dominance.

This research examined what narratives and representations are present in a contemporary and highly popular media format. It has identified trends that favor only a limited demographic and provides lower levels of significance other demographics. Games also have natural reward schedules built into them by design to reward players for certain behaviors and to encourage play. When this is applied to media, what are the potential consequences when that media presents limited, and negative representations?

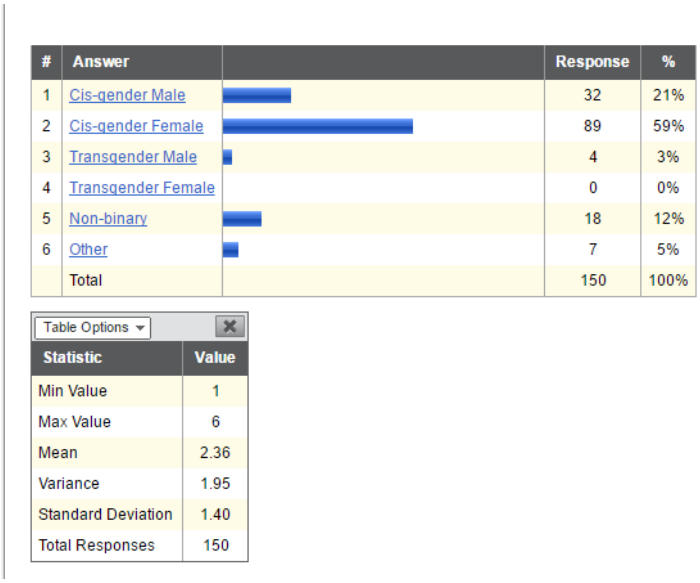
## Conclusion

Media can be both a reflection of a culture and an influence on culture. As groups compete for control and power, and shape what media is more readily available for public consumption, the narrative that defines cultural norms becomes shifting. What media provides to the academic community is a summary of what norms and dynamics exist in a culture. This research aims to include the video game industry in the broader discussion of culture and media, while also bringing into the conversation the effects that representation has on members of demographics within the general population. While the sample size and sample diversity were prominent issues in this research, the trends and patterns identified by non-white-cisgender-heterosexual-male participants does align with past research in more traditional media formats. This research found that the video game industry has a trend of favoring the white-cisgender-heterosexual male. Additionally, contemporary video games seem to have subpar amounts of

representation of all other demographics. These other non-white-cisgender-heterosexual-men also report trends of being lesser narrative actors. Future research would aim towards a larger and more diverse sample. This would aid to strengthen the generalizability of this research as well as allowing for statistical testing to allow for tests of significance.

# Appendix

*Figure 1: Gender Demographics of Survey Participants*

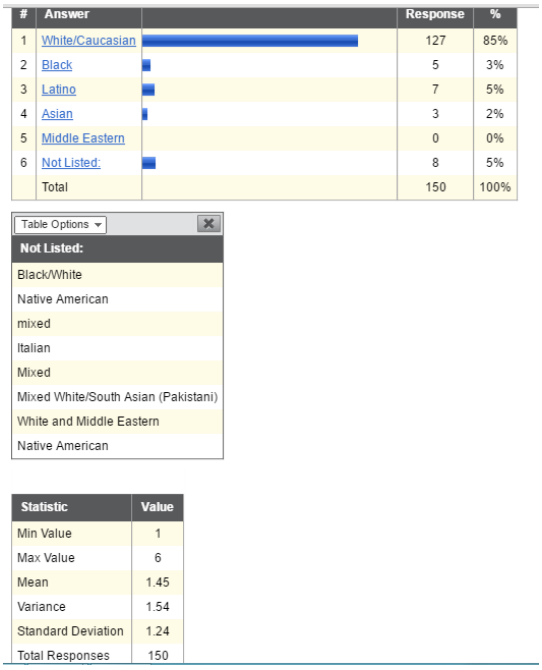


| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | Cis-gender Male | | 32 | 21% |
| 2 | Cis-gender Female | | 89 | 59% |
| 3 | Transgender Male | | 4 | 3% |
| 4 | Transgender Female | | 0 | 0% |
| 5 | Non-binary | | 18 | 12% |
| 6 | Other | | 7 | 5% |
| | Total | | 150 | 100% |

Table Options

| Statistic | Value |
|---|---|
| Min Value | 1 |
| Max Value | 6 |
| Mean | 2.36 |
| Variance | 1.95 |
| Standard Deviation | 1.40 |
| Total Responses | 150 |

*Figure 2: Race of Survey Respondents*



| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | White/Caucasian | | 127 | 85% |
| 2 | Black | | 5 | 3% |
| 3 | Latino | | 7 | 5% |
| 4 | Asian | | 3 | 2% |
| 5 | Middle Eastern | | 0 | 0% |
| 6 | Not Listed: | | 8 | 5% |
| | Total | | 150 | 100% |

Table Options

| Not Listed: |
|---|
| Black/White |
| Native American |
| mixed |
| Italian |
| Mixed |
| Mixed White/South Asian (Pakistani) |
| White and Middle Eastern |
| Native American |

| Statistic | Value |
|---|---|
| Min Value | 1 |
| Max Value | 6 |
| Mean | 1.45 |
| Variance | 1.54 |
| Standard Deviation | 1.24 |
| Total Responses | 150 |

*Figure 3: Sexuality of Survey Respondents*

| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | Heterosexual | | 73 | 49% |
| 2 | Homosexual | | 7 | 5% |
| 3 | Bisexual | | 28 | 19% |
| 4 | Pansexual | | 9 | 6% |
| 5 | Asesexual | | 21 | 14% |
| 6 | Not Listed: | | 12 | 8% |
| | Total | | 150 | 100% |

| Not Listed: |
|---|
| Queer |
| ace-spectrum bisexual |
| moneysexual |
| Asexual and panromantic! |
| Quoisexual |
| Demi-homosexual |
| none |
| Queer |
| Grey-Asexual, Demisexual |
| Demisexual |
| Questioning |
| Demisexual |

| Statistic | Value |
|---|---|
| Min Value | 1 |
| Max Value | 6 |
| Mean | 2.56 |
| Variance | 3.16 |
| Standard Deviation | 1.78 |
| Total Responses | 150 |

*Figure 4: Survey data Cisgender Women are represented accurately or fairly.*

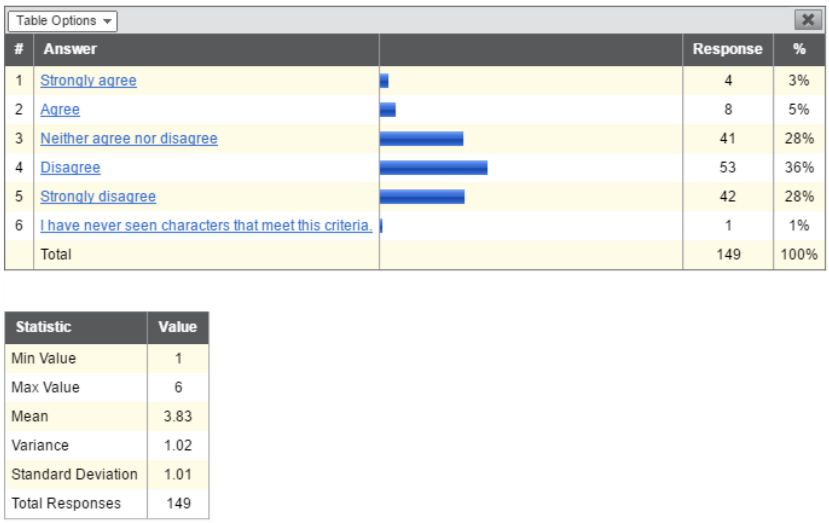


Table Options

| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | Strongly agree | | 4 | 3% |
| 2 | Agree | | 8 | 5% |
| 3 | Neither agree nor disagree | | 41 | 28% |
| 4 | Disagree | | 53 | 36% |
| 5 | Strongly disagree | | 42 | 28% |
| 6 | I have never seen characters that meet this criteria. | | 1 | 1% |
| | Total | | 149 | 100% |

| Statistic | Value |
|---|---|
| Min Value | 1 |
| Max Value | 6 |
| Mean | 3.83 |
| Variance | 1.02 |
| Standard Deviation | 1.01 |
| Total Responses | 149 |

*Figure 5: Survey data: Transgender characters are represented accurately and fairly.*

14. Transgender and Non-binary gender characters in video games are represented accurately and fairly.

| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | Strongly Agree | | 0 | 0% |
| 2 | Agree | | 5 | 3% |
| 3 | Neither agree nor disagree | | 25 | 17% |
| 4 | Disagree | | 16 | 11% |
| 5 | Strongly disagree | | 46 | 31% |
| 6 | I have never seen a character that meets these criteria. | | 57 | 38% |
| | Total | | 149 | 100% |

Table Options

| Statistic | Value |
|---|---|
| Min Value | 2 |
| Max Value | 6 |
| Mean | 4.84 |
| Variance | 1.45 |
| Standard Deviation | 1.20 |
| Total Responses | 149 |

*Figure 6-8: Racial demographics are represented fairly and accurately.*

11. Asian characters in video games are represented fairly and accurately.

| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | Strongly agree | | 2 | 1% |
| 2 | Agree | | 16 | 11% |
| 3 | Neither agree nor disagree | | 43 | 29% |
| 4 | Disagree | | 48 | 32% |
| 5 | Strongly disagree | | 31 | 21% |
| 6 | I have never seen characters that meet this criteria. | | 9 | 6% |
| | Total | | 149 | 100% |

Table Options

| Statistic | Value |
|---|---|
| Min Value | 1 |
| Max Value | 6 |
| Mean | 3.79 |
| Variance | 1.25 |
| Standard Deviation | 1.12 |
| Total Responses | 149 |

10. Black characters in video games are represented fairly and accurately.

Table Options

| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | Strongly agree | | 4 | 3% |
| 2 | Agree | | 13 | 9% |
| 3 | Neither agree nor disagree | | 43 | 29% |
| 4 | Disagree | | 55 | 37% |
| 5 | Strongly disagree | | 33 | 22% |
| 6 | I have never seen characters that meet this criteria. | | 1 | 1% |
| | Total | | 149 | 100% |

| Statistic | Value |
|---|---|
| Min Value | 1 |
| Max Value | 6 |
| Mean | 3.69 |
| Variance | 1.04 |
| Standard Deviation | 1.02 |
| Total Responses | 149 |

12. Middle Eastern characters in video games are represented accurately and fairly.

| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | Strongly Agree | | 3 | 2% |
| 2 | Agree | | 7 | 5% |
| 3 | Neither agree nor disagree | | 31 | 21% |
| 4 | Disagree | | 31 | 21% |
| 5 | Strongly disagree | | 53 | 36% |
| 6 | I have never seen a character that meets this criteria. | | 24 | 16% |
| | Total | | 149 | 100% |

| Statistic | Value |
|---|---|
| Min Value | 1 |
| Max Value | 6 |
| Mean | 4.32 |
| Variance | 1.49 |
| Standard Deviation | 1.22 |
| Total Responses | 149 |

*Figure 9: Survey data-Non-heterosexual characters are represented accurately and fairly.*

13. LGB+ (Sexual spectrum, not gender) characters in video games are represented accurately and fairly.

| # | Answer | | Response | % |
|---|---|---|---|---|
| 1 | Strongly Agree |  | 2 | 1% |
| 2 | Agree |  | 9 | 6% |
| 3 | Neither agree nor disagree |  | 34 | 23% |
| 4 | Disagree |  | 47 | 32% |
| 5 | Strongly disagree |  | 29 | 20% |
| 6 | I have never seen a character that meets this criteria. |  | 27 | 18% |
| | Total | | 148 | 100% |

| Statistic | Value |
|---|---|
| Min Value | 1 |
| Max Value | 6 |
| Mean | 4.17 |
| Variance | 1.50 |
| Standard Deviation | 1.23 |
| Total Responses | 148 |

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# The State of Diversity on WVSU's Campus through the Eyes of Its Students

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McNair Scholars Program

Fall 2015/Spring 2016

## INTRODUCTION

Diversity in a university describes the presence of people on a campus who differ in terms of race, culture, ethnicity, religion, socioeconomic status, sexual orientation and ability. It also means the presence of people with diverse opinions, political views, and academic passions. However, a true, comprehensive definition of diversity should also include ways in which a diverse population engages with and explores its differences (Weinland, 2012).

"WVSU addresses diversity at prominent administrative levels that include the president and vice presidents and throughout all facets of the campus community. Article II of the Affirmative Action Policy states that WVSU is an Equal Opportunity/Affirmative Action institution that does not discriminate against any person because of race, religion, color, national origin, ancestry, sex, age, marital status, or disability. In 1983, the University amended this policy to include activities related to the management of its educational, employment, financial business and other affairs." (WVSU Purpose Statement)

Having a diverse population of students is important to the growth and wellbeing of a university as well, because it allows students to have a better understanding and appreciation of different cultural differences and similarities among one another. The purpose of this study is to discover students' attitudes toward diversity on campus.

My research questions I will answer with my research are as follows:

1. **What are students' attitudes toward diversity on campus?**

2. **Do the programs offered on campus satisfy the level of diversity the students desire?**

# LITERATURE REVIEW

## Historically Black College Universities

Because WVSU is a historically black college university (HBCU), I found it important to research the background of HBCUs. In an article that was published in the Encyclopedia of Diversity in Education, (Gasman, 2012) defines HBCUs as, "Institutions created under the laws of segregation and prior to 1964 with the express purpose of educating African Americans" (P. 1070). There were a few Black colleges prior to the Civil War, but the focus of educating African Americans did not come until after the war. More than 4 million formerly enslaved people were taught by the federal government through the Freedman's Bureau, and many northern church missionaries. These White missionaries founded many of the Black colleges, such as Fisk University in Nashville, Tennessee and Spelman College in Atlanta, Georgia. However, Black denominations also founded their own colleges, such as Morris Brown in Georgia, Paull Quinn in Texas and Allen University in South Carolina (p.1070).

In 1890, the Morrill Act stipulated that the states practicing segregation in their public colleges and universities would forfeit federal funding unless they established agricultural and mechanical institutions for the Black population. Despite these measures, the government only funded the Black colleges a fraction of what was being given to White colleges. The only reason the money was given was out of Christian benevolence and control. Philanthropists provided financial support for Black colleges up until the late 1930s, and the United Negro College Fund (UNCF) was founded in 1944 by Frederick D. Patterson, President of Tuskegee Institute, and 29 other HBCU presidents (p. 1071). These colleges and universities remained segregated until Brown vs. Board of Education took place in 1954 (p. 1071).

"Many Black colleges suffered from 'brain drain' as predominately White institutions in the North and some in the South made efforts to attract the top 10% of their students to their institutions once racial diversity became valued within higher education"(1072). In 1965, the Higher Education Act defined a Black college as "any college or university that was established prior to 1964, whose principal mission was, and is, the education of black Americans." The recognition of the uniqueness of Black colleges led to an increase in funding for the institutions. Later on in 1980, President Carter instilled Executive Order 12232, which established a national program to alleviate the effects of discriminatory treatment and to strengthen and expand Black colleges to provide quality education. Since that time, every U.S. president has provided funding to Black colleges through this program.

According to (Gasman,2012), African Americans who attend Black colleges have higher levels of self-esteem and find their educational experience more nurturing than those who attended predominately White colleges. Graduates of Black colleges are more likely to continue their education and pursue graduate degrees than those who attend predominately White colleges (p. 1072). This is why the institution and wellbeing of these colleges are maintained in order to support Black students and help give them the opportunity to succeed and better themselves in a comfortable, quality environment that allows them to celebrate their heritage.

**The Effects of Diversity in the Classroom**

One of the places diversity is most important is among students in the classroom. This relates to my research because diversity in classes in general gives students a better insight to the world around them and an overall deeper learning experience. (Tsetsura, 2011) wrote that the relation between multidimensional diversity and the benefits of global public relations education

was discussed. She speaks of how diversity is a much broader spectrum than many people realize, and gives examples and statistics that help support the need for global public relations education and interaction.

"I believe one way for our students to learn about global public relations is to understand their own background and identity. If we start from a premise that students can learn from one another, we can enrich our class discussions and find fresh ways to demonstrate how diversity influences global public relations in ways we have not previously considered" (Tsetsura, 2011). She also explains that all humans are diverse in their own ways and should be treated with respect in order to form positive relationships.

Multidimensional diversity is not limited to someone's race, gender or ethnicity, but their social status, level of global awareness, past and present experiences, exposure to various cultures, ability and desire to assimilate, etc. "Understanding multiple dimensions of diversity can bring us closer to our students who, as a group, sometimes can seem quite homogenous at first" (Tsetsura, 2011). Addressing multiple dimensions of diversity can also help future practitioners to better understand their roles as strategic communicators.

**The Social and Historical Development of Racially Diverse Students**

In my research, I will be looking at the different issues for racially diverse students at WVSU and their particular environments and experiences as a racially diverse student body. Racial discrimination has always been an issue in the United States. (Shang, 2008), describes social and historical developments coinciding with the emergence of increasing numbers of biracial and multicultural college students. The chapter covers how social and political developments have an impact on how colleges and universities serve the mixed-race population.

He explains the ways that the characteristics of current students and their precollege socialization about racial issues are important in the development of services and approaches for serving multiracial and biracial students among all other students as well. Shang mentions how the progress made in the civil rights era is at best "stalled" because there are still numerous signs of racial injustice even after the turn of the 21st century. He states, "How biracial or multiracial students feel about themselves and how they interpret their treatment by others is complicated not only by the nation's current debate about responding to historical wrongs based on race, but also by the nation's ambivalence about mixed-race people" (Shang, 2008).

The Higher Education Research Institute found in 2001 that of entering freshmen responding to a survey, only slightly more than one-third rated the objectivity of helping to promote racial understanding as "essential" or "very important," which has declined from its peak of 46.4 percent in 1992. As more diverse students come to college from more segregated backgrounds, students may need more social support and opportunities to explore personal backgrounds. The delivery of these services, or opportunities, must be developed taking into consideration how contemporary college students access higher education in addition to their demographic characteristics. The basic point the author conveys in this article is that diversity is not about the needs of one group competing with another for resources. It is rather about purposeful and effective ways to support all students' educational development and achievement. It is a crucial component of the mission and purpose of the institution to position itself in a way that will allow full participation for all students regardless of the economic, social and civic domains of a diverse society.

## How Diversity Makes Well Rounded Students

One of the main reasons I am researching the diversity at State is because students who are exposed to diverse environments in a school setting, are able to carry themselves better around people who are different. It gives them a level of respect for people of different cultures, ethnicities, beliefs, etc. and allows them to shift their perspective to a more understanding point of view, which is valuable when entering the workforce. (Bowman, 2013) discusses a university's role in preparing well rounded students who are culturally aware and have better shaped civic outcomes.

The authors describe the growing research showing that students' views, attitudes, and university diversity experiences promoting preparation for a global society, but highlight the fact that little research is available outside of American contexts. The study presented in this article displayed data collected at an Australian university to examine whether students' views and attitudes towards diversity, and their university diversity experiences, aided the development of key attributes needed to function effectively in a global society, specifically positive intergroup attitudes and civic engagement. The findings demonstrated that students who participate in institutionally structured diversity engagements and interact with diverse peers are associated with improved intergroup attitudes and civic engagement outcomes. The findings also revealed that poor quality engagement with diverse peers are negatively associated with gains in these outcomes. These findings are consistent regardless of students' pre-university experience with diversity and their openness to diversity.

## Cultural Difference and Graduate Supervision

(Grant, 2011), shows the relation between cultural difference and graduate supervision. I found this to be relevant to my research because many of the graduate students at State are of diverse cultural backgrounds, and I wanted to observe a study that related to the situation of diverse graduate students and the relation with their advisors and university experiences. Since the year 2000, there has been an increasing number of culturally diverse international research students seeking advanced levels of education (p. 1). This often brings them to the United States because of the plethora opportunities and access to this education.

Grant writes about the idea of culture itself as, "Vast and complexly layered with political and practical aspects" (p. 2). In the context of higher education pedagogies, culture can refer to ethnicity, discipline, profession, industry and workplace. The author mentions that "In contemporary neo-liberal formulations of supervision, little of the complexity of either supervision or culture is recognized […] in some disciplines, especially those that construct knowledge as objective, asking what role culture might play in supervision is a puzzling question. Yet, as this special issue of Innovations in Teaching and Education International (IETI) demonstrates, supervision is a pedagogy in which our raced, classed and gendered bodies are present. Culture, in all of its varied guises impacts there. When we supervise across ethnic cultures, supervision becomes a pedagogical site of rich possibility as well as, at times, a place of puzzling and confronting complexity" (p. 3). The main point of this article is of this to provide readers with deeper insights into the complexities associated with supervision across cultures and the nature of the relationship between supervision and culture in general.

**Suicide in Racially Diverse Students**

The mental and physical health of students is a priority at WVSU. By ensuring that students of all races have access to the resources they need on campus, it may prevent a student from committing suicide. (Brownson, 2014) explains the issue of suicidal and help-seeking behaviors of students of color on college campuses is addressed on the basis of results from a national survey of college student mental health. The results suggest significant differences in the expression of suicidal thoughts and behavior across racial and ethnic groups and different experiences in their referral for, and utilization of, professional help.

Suicide is the third most prevalent cause of death for youth between the ages of 18 and 24 years, and is believed to be the second leading cause of death for college students (p. 3). In addition to death by suicide, suicidal thinking and behavior is a serious public health concern among college students. Over 50% of college undergraduates have had some type of suicidal thought in their lives, with 18% having seriously considered a suicide attempt (p. 5). Despite the increasing diversity in higher education, there is a plethora of data about the correlation between racial/ethnic minorities and suicidal thoughts and behavior, help-seeking behavior, and best practices in suicide prevention and intervention.

Although some studies have focused on suicide prevalence in people of color, the research is often related to adults or adolescents as opposed to college students. The study conducted in the article found that Alaska Native/American Indian, Asian American, and multiracial/multiethnic students all had significantly more distressed thinking or suicidal thoughts than other students in the sample. These results suggest that colleges and universities need to increase their efforts in mental health promotion with these students and perhaps consider whether the typical means of

reaching them are culturally relevant for these particular groups. Whether these students feel more alienation, racism or academic pressure, it is necessary to explore the appropriate support structures to meet their needs. Caucasian/White students were advised to seek help from the first person they told at statistically significantly higher rates than all other racial and ethnic groups (p. 7). Creating more culturally appropriate ways of providing service on college campuses would most likely decrease the number of suicidal racially diverse students.

**Linear Relationship between Diversity Interactions and Student Outcome**

I chose to research this article because it displayed a direct linear relationship between diversity and student outcomes and was based off a quantitative study, closely related to the research I will be conducting. (Bowman, 2013), tells of the level that constitutes a sufficient level of diversity on college campuses is proven through quantitative research. He explains how previous research on the educational benefits of diversity has examined the linear relationship between diversity interactions and student outcomes.

The study presented in the article used a sample of 8,615 first-year undergraduates at 49 colleges and universities. The results indicate that rare or moderate diversity interactions are associated with virtually no growth (and sometimes even slight declines) in leadership skills, psychological well-being, and intellectual engagement, whereas very frequent diversity interactions are associated with considerable growth. The results are similar regardless of students' race, institutional characteristics, and whether the interactions are interracial or across multiple forms of difference. Implications for institutional practice and future research are discussed.

## Overall Racial Acceptance

(Simmons, 2010) wrote about a study that examines the relationship between college students' perceptions of their campus' multicultural climate and their acceptance of racial/ethnic diversity. I found this important in relation to my own research because the study used was based off survey data, which is how I plan to receive my data. Also, I want to learn how students feel about racial diversity in general at WVSU. The study was based on acculturation principles and survey data from 434 college students of diverse racial/ethnic heritage.

The results showed that valuing positive interactions with members of ethnocultural groups other than one's own is a positive mediator, and strength of ethnocultural identity is a negative mediator of the relationship between student perceptions of multicultural campus programming and personal acceptance of diverse racial/ethnic groups (p. 3). Each mediator independently contributed to the prediction of acceptance. Follow-up analyses, separately by ethnic group, showed that perceptions of campus programming predicted acceptance of diversity for the White subsample, but not for the Latino subsample. The two acculturation related constructs were important for both groups, with the model accounting for 28% and 24% of their respective variances in acceptance of diversity (p. 5).

## Overall Benefits of Diversity on the Campus

As a Communications student, I find researching blogs to be a very resourceful technique for obtaining information in a more condensed yet efficient manner. This blog gave eight helpful benefits about diversity on college campuses. (Hyman, 2009), tells how for some students, college is first time they have had the opportunity to have real interaction with people from diverse groups. Many times people are unknowingly segregated from other groups in schools,

churches and their neighborhoods. Diversity expands worldliness. Diversity also enhances social development. Interacting with people from a variety of groups widens students' social circle by expanding the pool of people with whom they can associate and develop relationships.

Diversity prepares students for future career success. Successful performance in today's diverse workforce requires sensitivity to human differences and the ability to relate to people from different cultural backgrounds. America's workforce is more diverse than at any time in the nation's history, and the percentage of America's working-age population comprised of members of minority groups is expected to increase from 34 percent to 55 percent by 2050 (Hyman, 2009). It prepares students for work in a global society. All professions require employees to associate with employers, coworkers, customers and clients from diverse backgrounds—worldwide.

By experiencing diversity in college, students are laying the foundation to be comfortable working and interacting with a variety of individuals of all nationalities. Interactions with people who are different increase students' knowledge base. Research shows that humans learn more from people who are different from people who are similar. Diversity promotes creative thinking, expands the capacity for viewing issues or problems from multiple perspectives, angles and vantage points and allows students to expand their views and consider multiple options when making decisions and weighing issues of morality and ethics. It enhances self-awareness. Learning from people whose backgrounds and experiences are different sharpens students' self-knowledge and insight. Lastly, diversity enriches the multiple perspectives developed by a liberal arts education. Students are able to obtain a more panoramic perspective of the world around them and a more complete view of their place in it.

## Underrepresented Races

In a case study published in a student journal by (Karkouti, 2015), the racial conflict that occurred at the University of Michigan (UMI) earlier last year when Black students expressed their frustrations with the underrepresentation, racial discrimination and disparaging remarks against African Americans on campus is discussed. This is valuable to my research because I want to discover if there are any underrepresented races or subgroups on State's campus. Student affairs is the service most relevant to the issue, and is a service I will be evaluating in my own research, so I found the references to be extremely relevant and helpful. The article primarily focuses on multicultural student services and explores how the student affairs division addresses the issues of discrimination and underrepresentation of racial and ethnic minorities in order to enhance campus racial climate and promote equal representation of socially oppressed groups. Finally, two multicultural proposals that can be used to enhance student affairs practitioners' multicultural skills and guide them in transforming their educational institutions are presented.

## Religious Diversity

The final journal article I researched by (Mayhew, 2014) discusses the perceptions of campus climate among students of diverse religions and worldviews. In my survey I will be including a section on religion, and I felt it was important to compare a different study on religion on campuses to gain a deeper understanding of the subject. Results from this study suggest that climate perceptions and experiences were more negative among worldview majority students (e.g., Protestants, Catholics) than among worldview minority students (e.g., Muslims, Jews) and nonreligious students. This study examined self-identified worldview and its influence on campus religious and spiritual climate perceptions and experiences and offers insight into a

series of theoretical tenets often used to examine college and its influence on students. The results from this study suggest the need to reexamine prevailing notions of context and its relationship to student identification patterns when addressing questions related to student religiosity, spirituality and worldview. Although students in the religious majority may enjoy the privileges associated with growing up in a country where the prevailing narrative normalizes the Christian experience, these students perceive and experience the campus climate as more negative than students from other faith traditions and nonreligious students. Examining the layers of this developmental location is an important first step toward understanding the exchange occurring between students and their worldview climates.

The knowledge gained in this literature review has helped me to gain a better understanding of the subject matter of diversity and its effect on students and a campus as a whole. The issues in diversity need to be understood in order for school officials to address them and make corrections. The wellbeing of students is one of the primary focuses of colleges and universities, and allowing these students to express themselves and display their diverse individuality and unique characteristics in an unbiased, comfortable environment is crucial to their growth and development. Despite the steps that have been taken over time to increase acceptance of diverse individuals, it is clear that there are still prevalent issues on campuses, such as racism, sexism, ageism, homophobia, etc. By having a greater understanding of the issues at hand and conducting my own research, I hope to gain a better insight of the issues in diversity that the students at WVSU see and experience in order to help students feel comfortable and properly represented on campus.

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## METHODOLOGY

I chose to use quantitative and qualitative methods for my research so that I could have a deeper understanding of how the students feel about diversity. I chose to use a questionnaire, interviews and content analysis as my tools. The subjects involved in my research were all WVSU students of various ages, sexes, sexualities, religions, race/ethnicities and economic statuses. I wanted all students to have a chance to answer the questionnaire because it would further enhance the message of diversity in my study. As for the interviewees, I selected five students whom I know personally that are affiliated with diversity in one way or another. I kept the names of the students anonymous in order to protect their identity.

In the questionnaire that I distributed, students were asked demographic information in the first section and how they felt about diversity in the second section. I chose to use the demographic section first so that I could understand the backgrounds of the students who were answering the surveys, and because people like to answer questions about themselves. I thought that if they could answer about themselves first, they would be more likely to continue and answer about their feelings on diversity. Some examples of questions I asked were, “Have you ever felt discriminated against on this campus?” and “Do you feel you have a sense of belonging on campus?” I wanted to know how people truly felt about their campus experience in relation to diversity, and how they felt about diversity as a whole. A total of 50 people filled out the questionnaire via Facebook and paper.

For the interviews, I chose a student from each college, four total, and asked them questions about their personal experiences with diversity and if they thought their college promoted diversity compared to the campus as a whole. I wanted to see if there was a lack of diversity and if it went deeper than just how people treat one another in the union or during

social events. Some examples of questions I asked are, “Would you consider your college to have an evenly distributed amount of diversity?” and “What is your definition of diversity? How do you encourage people to honor the uniqueness of each individual? How do you challenge stereotypes and promote sensitivity and inclusion?” Each student had a different view on diversity, and I found that to also be very important in my research and the interviewing process because the more insight I have to the issues, the more I can generalize students’ attitudes toward diversity.

I chose Facebook as my main medium for distributing the questionnaires and conducting the interviews because most people that attend State use Facebook, and it’s easier to reach people on there. I was able to post the link to my questionnaire on several WVSU pages, such as Cultural Activities, LGBTQ and International Student Services. The interviewees also liked the idea of responding through Facebook private messaging because it gave them time to ponder the questions and answer them in as many words as they would like, as well as the fact that it gave them the option to answer at their convenience. That way people that I am not even friends with on Facebook had access to fill out the questionnaire. My secondary method for distributing surveys was handing them out to students in my classes. I chose this method because it allowed students to answer the questions quickly and return the questions to me promptly. A total of 50 people completed the questionnaire.

Lastly, the content analysis consisted of analyzing the demographics of the WVSU student body, catalogue and groups on campus. By finding out how many students there were of each race, sex, religion, etc., I was able to determine have concrete statistics of the overall diversity on campus. The catalogue allowed me to see a list of every class offered at State, that way I could see how many classes promote diversity, and which areas are lacking. By analyzing

the groups on campus, I was able to see which diverse groups are being represented and which ones are not. Analyzing the content helped build the foundation for the questionnaires and the interviews by laying out the cold, hard facts about diversity.

## ANALYSIS

After interviewing a student from each college, I found that the students are very concerned about diversity on campus. I tried to interview a mix of students, some being Black, White, Hispanic and gay. This way I would have an even broader perspective on how diversity is affecting these people. The student from the college of arts and humanities made this comment,

"Diversity makes people see themselves in other people in some way or another, even if there are some differences, and when people see the commonalities in others, the differences they have become a lot easier to understand and tolerable. I believe that Black students are represented of course. Walk around and look at campus's student body, walk into a class room, take a look at the faculty...It's all predominantly white and WE ARE AN HBCU. We are clearly struggling with diversity at WVSU and it's disheartening as a Black student. The struggle with diversity at our university makes me afraid that our history of this college will be forgotten."

This statement was very powerful in displaying how Black students feel about the state of diversity on campus. The student eluded that she was not the only Black student or WVSU student period that felt this way about the growing number of White students and faculty on campus.

A Black female student from the college of professional studies said, "Racial tensions in the criminal justice department are extremely high, and it's no exception for the criminal justice classrooms. There are heated, and sometimes uncomfortable, debates in some classes if the

professor is willing to go there. Some professors are timid. I believe that some of the criminal justice professors aren't very experienced in teaching about diversity. When it comes to diversity, there's not much of it in criminal justice but that may be because of the make-up of the student body. There's not one criminal justice faculty member that is not White. I definitely think about this fact when I think about all of the craziness that's going on in criminal justice system right now. I think there's an obvious correlation between the underrepresentation in the actual criminal justice field and the criminal justice classrooms," she said.

This statement showed that the attitude toward the lack of diversity in the college of professional studies, particularly the criminal justice division, is very negative.

The White female student from the college of business and social sciences said this about diversity, "I am certain that there are groups that are underrepresented but I do not feel that any group is mistreated. I believe that the sociology program in particular promotes diversity. Many of the courses require us to objectively study various people groups and recognize what makes them unique in their own respects. I cannot think of anything that could be done to improve diversity on campus."

This student's attitude was positive toward diversity in the college of business and social sciences, particularly the sociology division, and she believed the diversity on campus was fine.

The White, gay, male student from the college of mathematics and natural sciences said this, "I feel with the legalization of gay marriage, gay people have become more widely accepted around the country and on college campuses. This being said, I still feel like I am the 'odd man out' in my classes. Sure, people treat me with respect, but I'm still 'the gay kid in the class.' I long for

the day when gay students blend in evenly with straight students, and we can ditch the stereotype."

This student's attitude proved that while the campus is respectful of people who are gay, there is still a stigma on these people because they are different. The student eluded that people from his college were less accepting of his lifestyle than per se those in the college of arts and humanities.

Lastly, a Latino male in the psychology department said this about diversity: "I think that diversity on campus has become more prominent in the past year, and I feel that this has opened up incredible opportunities for both WVSU and International students alike."

This student had a very positive outlook toward diversity and international students and felt that WVSU is doing a good job in promoting diversity and opportunities for all students.

According to Student Affairs, the school's ethnicity statistics as of 2015 are as follows:

- Hispanic/Latino: .46%
- Black or African American: 9.56%
- White or Caucasian: 48.31%
- American Indian or Alaska Native: .49%
- Asian: .35%
- Native Hawaiian or other Pacific Islander: 0%
- Unknown: 40.3%

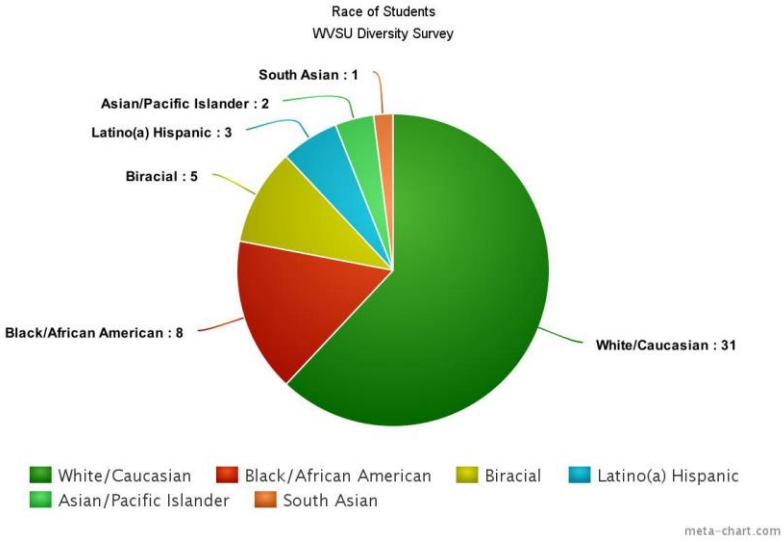
Only .53% of the student body is composed of international students.

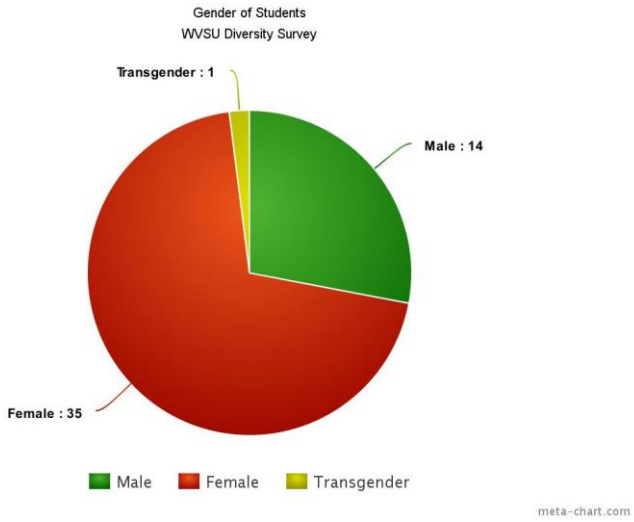
When analyzing groups and organizations on campus, there only three faith based organizations: Fellowship of Christian Athletes, Campus Awakening and Catholic Campus Ministries, all of which are Christian based organizations. Out of the Greek organizations, Alpha

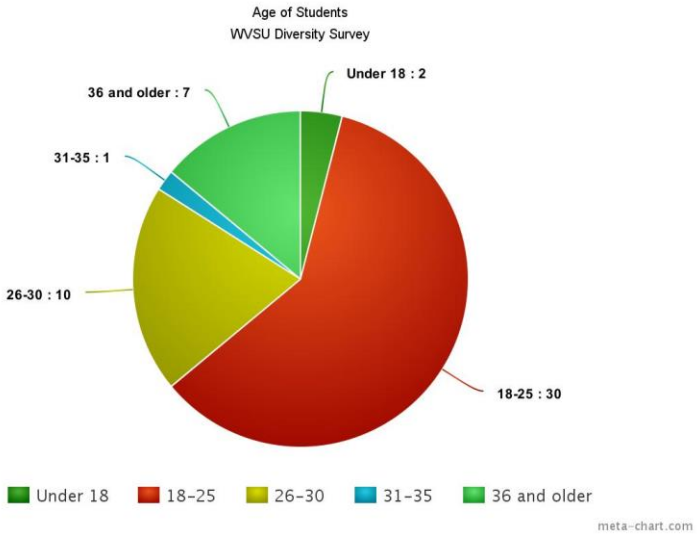
Phi Alpha is the only fraternity that promotes African-American heritage. Alpha Mu Gamma promotes studying foreign languages, literature and civilizations. Pinnacle is an organization for non-traditional students (25 years or over). Gay-Straight Alliance is a club designed to bridge the gap between LGBTQ students and straight students' cultures and serves as a safe place for LGBTQ students. The International Student Association is open to all students who are interested in international activities. Minorities in Agriculture and Natural Resources Association (MANRA) provides a framework for the academic, professional and social development of minority students within the fields of Agriculture and related areas. The National Association for the Advancement of Colored People (NAACP) strives to improve the political, educational, social, and economic status of minority groups; eliminate racial prejudice; and keep the public aware of the adverse effects of discrimination. Students Organized for Disability Awareness (SODA) helps promote disability awareness and the needs of students on campus who have disabilities. Women in Communications is the only organization, beyond a sorority, that is strictly for women.

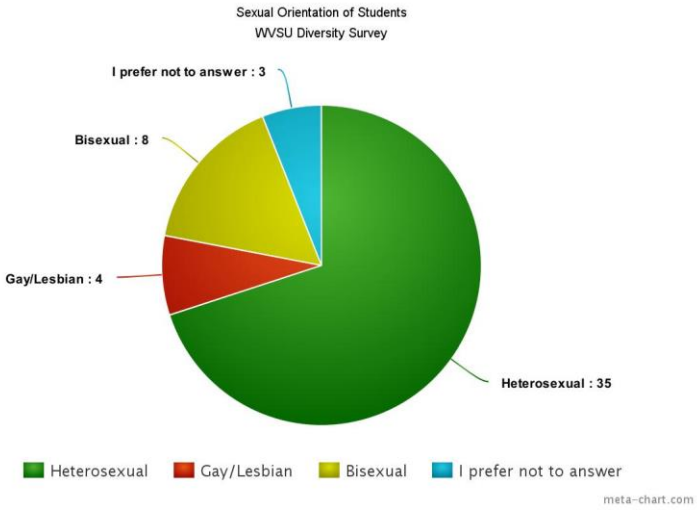
When looking through the course catalog, I noticed 53 courses offered that promoted diversity. 25 of them promoting Africans and African-American culture, 10 promoting women, and the others promoted world religions, history of diverse cultures, foreign language, theories of poverty and minorities in America. The majority of these classes were offered in the English, art and history departments. There were little to no courses offered on Asian culture or people with disabilities.

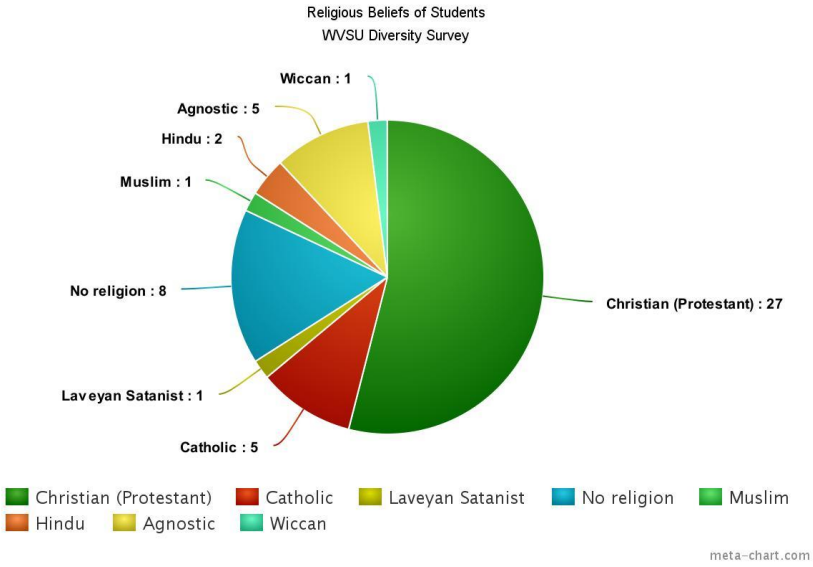
Here are the results from my survey:

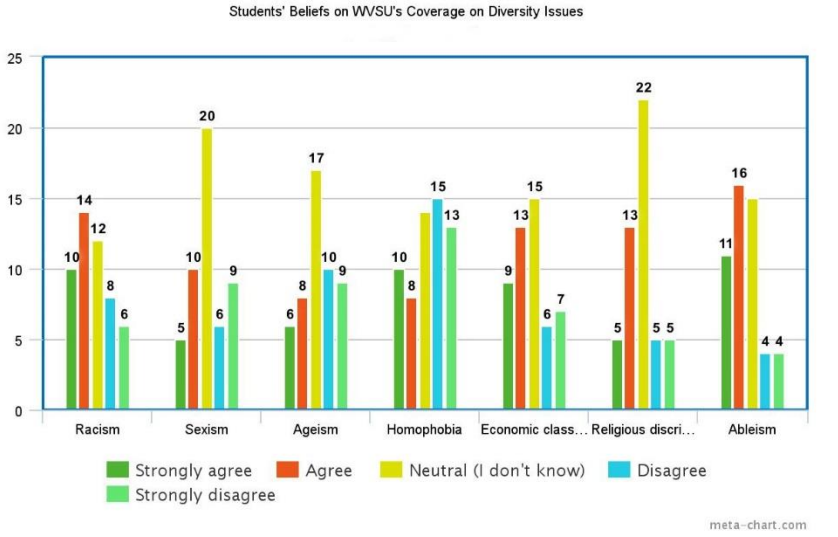


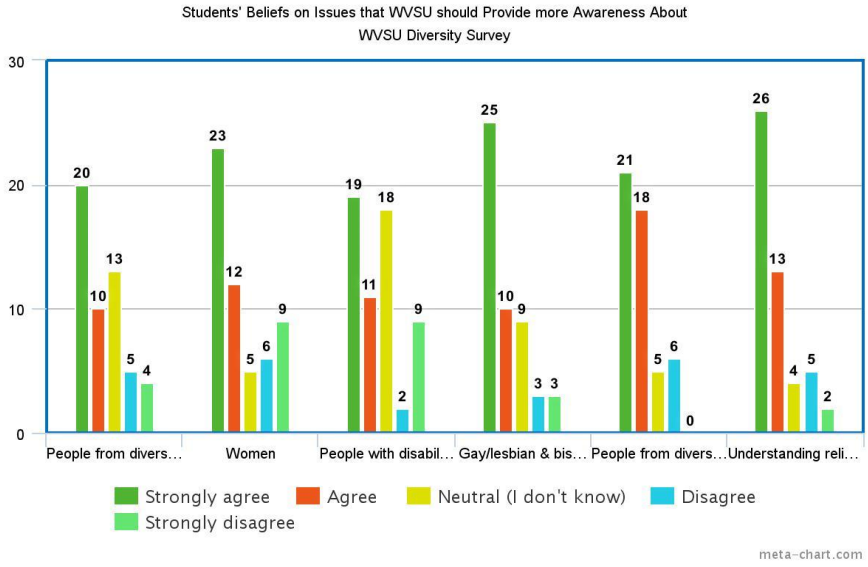



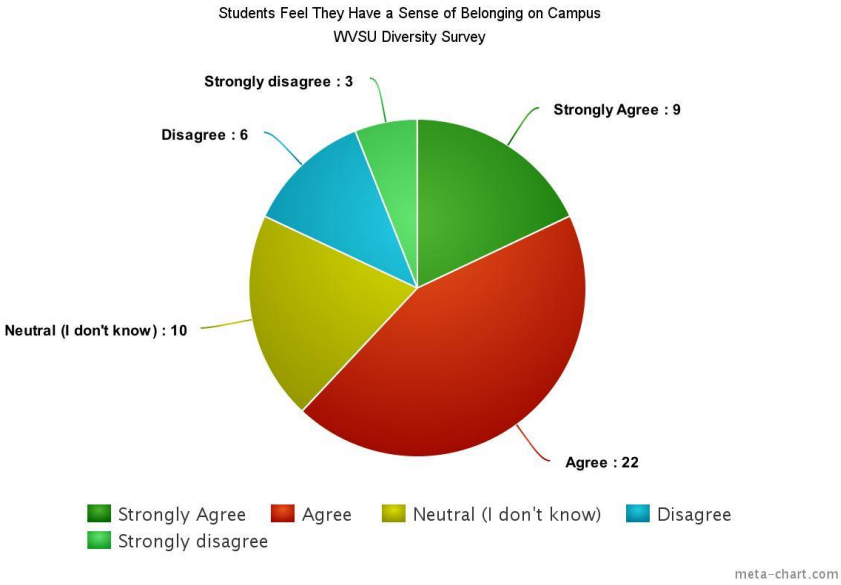

Age of Students
WVSU Diversity Survey
Under 18 : 2
36 and older : 7
31-35 : 1
26-30 : 10
18-25 : 30
Under 18
18-25
26-30
31-35
36 and older
meta-chart.com

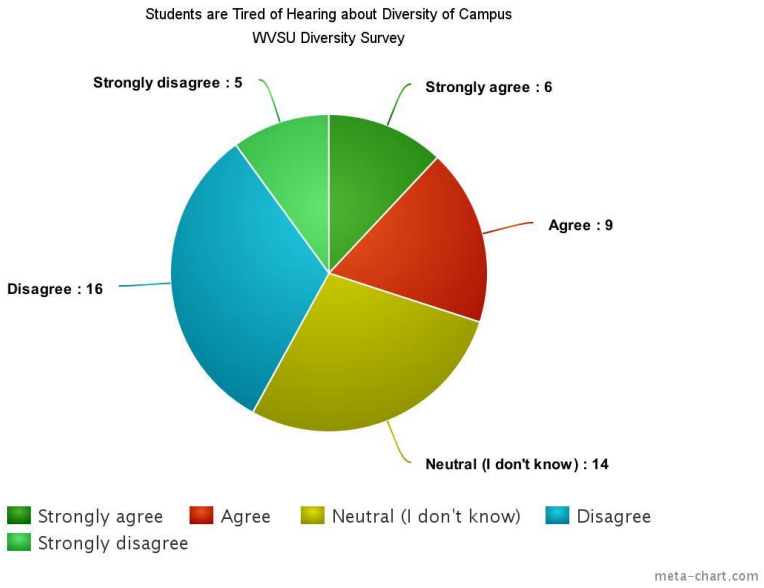

Sexual Orientation of Students
WVSU Diversity Survey
I prefer not to answer : 3
Bisexual : 8
Gay/Lesbian : 4
Heterosexual : 35
Heterosexual
Gay/Lesbian
Bisexual
I prefer not to answer
meta-chart.com

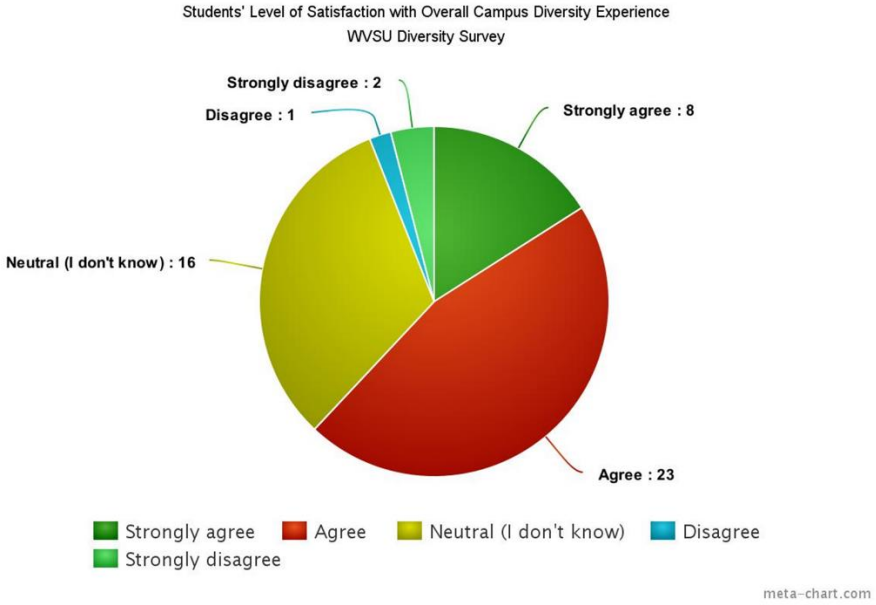

Religious Beliefs of Students
WVSU Diversity Survey
Wiccan : 1
Agnostic : 5
Hindu : 2
Muslim : 1
No religion : 8
Laveyan Satanist : 1
Catholic : 5
Christian (Protestant) : 27
Christian (Protestant)
Catholic
Laveyan Satanist
No religion
Muslim
Hindu
Agnostic
Wiccan
meta-chart.com


Students' Beliefs on WVSU's Coverage on Diversity Issues
25
20
15
10
5
0
Racism
Sexism
Ageism
Homophobia
Economic class...
Religious discri...
Ableism
Strongly agree
Agree
Neutral (I don't know)
Disagree
Strongly disagree
meta-chart.com


Students' Beliefs on Issues that WVSU should Provide more Awareness About WVSU Diversity Survey
30
20
10
0
20
10
13
5
4
23
12
5
6
9
19
11
18
2
9
25
10
9
3
3
21
18
5
6
0
26
13
4
5
2
People from divers...
Women
People with disabil...
Gay/lesbian & bis...
People from divers...
Understanding reli...
Strongly agree
Agree
Neutral (I don't know)
Disagree
Strongly disagree
meta-chart.com


Students Feel They Have a Sense of Belonging on Campus
WVSU Diversity Survey
Strongly disagree : 3
Strongly Agree : 9
Disagree : 6
Neutral (I don't know) : 10
Agree : 22
Strongly Agree
Agree
Neutral (I don't know)
Disagree
Strongly disagree
meta-chart.com




## DISCUSSION

After completing my research, I think that the student body seems overall pleased with the state of diversity on WVSU's campus, however, there are still areas that need improvement to ensure the highest quality of diversity for all students. According to the 2014 U.S. Census, 93.7 % of West Virginia's population is White, which makes sense that the majority of students

who attend WVSU are White. The majority of State's students are also commuters, which demographically makes sense that the people coming from the surrounding areas are White. This being said, State is an HBCU, and it is strange that there are not more Black students attending this school. The Black students that I spoke to clearly feel unrepresented and like a distinct minority on this campus. In contrast to the White commuter students, 6 out of the 8 Black students surveyed came from other states and live on campus. What I found interesting in terms of religions is that a student listed as a Laveyan Satanist. I did not know there was such a thing until I conducted this research. Another important finding is that out of 50 people surveyed, 18 were nontraditional students. As I have looked around State's campus, many of the people I see are middle aged, which is interesting to find on a college campus. I feel that there are not enough activities or services offered for nontraditional students considering the amount who are on campus.

While it is important for the school to appeal to the majority, they must also not forget to appeal to the minority students as well. Most of the students in the graduate program at WVSU are international students, and I feel that there need to be more opportunities for those students. The lack of organizations for people of various faiths and cultural backgrounds is not helpful to the status of diversity on campus.

To answer my research questions:

1. Overall, the students surveyed are happy with the diversity on campus. However, those interviewed see room for improvement.
2. The activities on campus appeal to the majority, but not the minority. There need to be more options in order to satisfy these students' needs.

My recommendations for future research are to survey more students in order to get an even more accurate reading of how they feel, particularly international students and students who are gay and/or have disabilities. I would also recommend interviewing more students to have greater in depth qualitative approach. I feel that speaking with various students from different backgrounds would help give a deeper understanding of how students who are diverse are treated on WVSU's campus.

**Aquatic Fungi**

**Tyler Kerr**

**Mentor: Tom Ford, Ph.D.**

## Literature Review

In the southern region of West Virginia and other neighboring Appalachian states the current generation is fighting a battle of polluted water systems due to years of unregulated mining and the urbanization of once unaffected areas. While current times have shown a significant trend in limiting the degradation of fresh water ecosystems, it is arguable that much damage has already been done. Coal mines, both in use and retired, have been shown to release significant amount of a variety of heavy metals into the surround ecosystems, usually via water flow. In conjunction, urbanized development tends to deposit significant amounts of metals into runoff water, only compounding the Mountain State's issues (Zhang & Han, 2011).

Pollution of fresh water ecosystems with heavy metals can and will have detrimental affects of a multitude of populations spanning both plant and animal life forms. Even though fresh water only makes up a minimal amount of earth total water supply, less than 1%, it is said to support around 100,000 species of described animals to date (Dudgeon et al., 2006). While the biodiversity of these ecosystems would be theoretically very stable, it has been in harms way since the industrial revolution and the population explosion we are experiencing. Aside from fresh water being a requirement for human life, it has been exploited for things such as transportation, industrial processes, agriculture, and specifically in West Virginia energy production via Coal mining. The result is that all these processes subsequently use fresh water to be the disposal outlet for any and all waste material, most of which is unnatural and toxic to the environment (Krish, 2015).

The effects of heavy metal contamination are known to significantly vary from ecosystem to ecosystem. While some plant flora are able to resist the effects of pollution, there a many species that are imperative to the ecosystem that readily uptake metals. In fact, some of the most effective pollution remediation techniques involve the introduction of certain plant species that uptake heavy metals at an astonishing rate, this will be covered more in depth later (Tangahu, 2011). Consequently several common heavy metals are known to be phytotoxic. Because the metals will block and disrupt the photosynthetic abilities, it has been shown to vastly limit flora growth in given regions (Clijsters & Assche, 1985). A disruption in the most basic level of the food chain can have detrimental, long-term effects on an ecosystem.

In conjunction with plant degradation due to metal additives, the macro invertebrate and fish population of polluted waters are also being affect. While these organisms do not directly uptake heavy metals, they are being effected through the chain of energy (Dallinger et al., 1987). As plants provide the majority of energy for an ecosystem, if plant population numbers decline so must all other higher trophic organisms due to the lack of energy in the environment. Aside from this, the plants that are viable resources from animal organisms, if they are infected with pollutants the higher biota will be taking them in with their food. Within this system bio magnification has been observed meaning that the higher you go in the trophic system the more concentrated the pollutants will be. This means that the highest predators in the food chain will deal with the highest level of metal toxicity. One of the biggest dangers this presents to the fish population is that metals in water are known to readily bind to the gill filaments (Playle et al., 1993). This can drastically limit the amount of oxygen made available to the fish, which can be lethal in many low oxygen water systems.

With the extreme amounts of pollution and ever rising popularity of preserving natural ecosystems, the amount of research and development of remediation methods has also increased

significantly. When it comes to removal of heavy metals from fresh water ecosystem, the techniques can be broken down into two basic categories: ex situ and in situ. The former of these techniques always involves the removal of sediment from the waterway to be treated at designated water treatment facilities. While this technique is very effective at ridding the environment of pollutants, it arguably harms the environment even more than before due to the immense ecosystem disruption and industrial invasion, no to mention this time and cost that must go into the project. The later of the two choices, in situ, involves treating the pollution in the water system with minimum disruption. Since there to dates is no efficient way to simply precipitate metals out of water out in a river, the popular and effective technique is add certain plant and fungal organisms to the environment that while counteract the pollutant symptoms. As fore mentioned, there are several plant species that will uptake heavy metals at an outstanding rate, and when paired with mycorrhizal fungi can preform even better. If these non-essential organisms are introduced to a pollute environment, they will in theory help divert some of the pollutants from the native flora, mitigating the overall effect on the environment (Khan et al., 2000).

**Materials and Methods**

There were four study sites that ran along Brush Creek, West Virginia from Brush Creek Falls to Princeton, West Virginia. The Brush Creek Falls and Pikeview sites were located in more rural areas surrounded by forest while the Firetower and Willowbrook sites were located in very close proximity to the town of Princeton. The collection data was in mid-November, optimal timing for fungal spore production. For the fungal spore testing, 200-ml of water was collected and filtered through 6-µm filtration paper. Two filter paper punches from each location were then stained using lactophenol cotton blue and glycerol. The spores where then counted using 10 fields of view for comparison.

**Results**

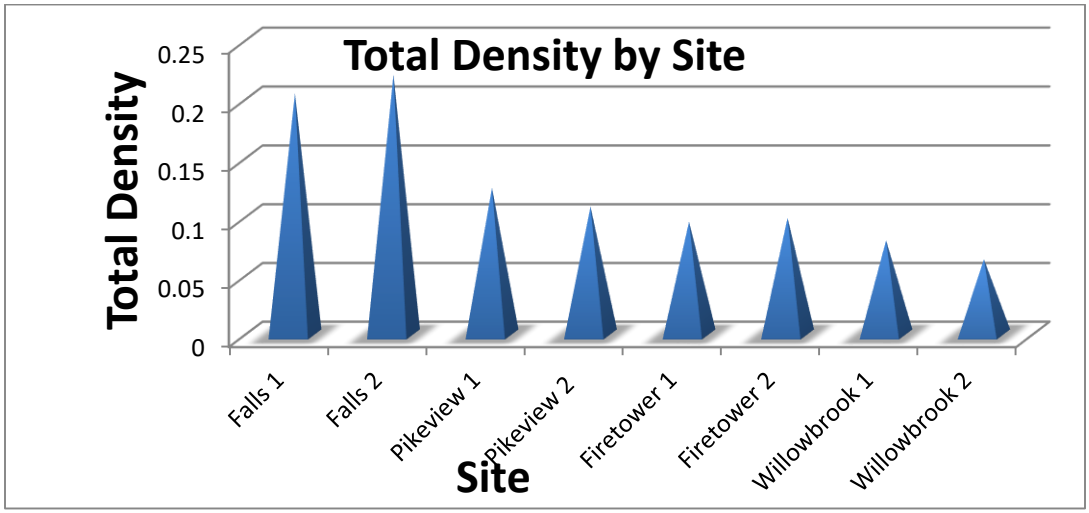
The data analysis was done comparing both the Shannon-Weaver index and the species density across all four testing sites. The Shannon comparison showed differences in species abundance across the sights as seen in Table 1.

Table 1. Shannon Weaver Score comparison across all testing sites.

| Site | Shannon Score |
|---|---|
| Falls 1 | -0.62615425 |
| Falls 2 | -0.622968984 |
| Pikeview 1 | -0.589212085 |
| Pikeview 2 | -0.558072608 |
| Firetower 1 | -0.658481645 |
| Firetower 2 | -0.528595155 |
| Willowbrook 1 | -0.557301253 |
| Willowbrook 2 | -0.265294996 |

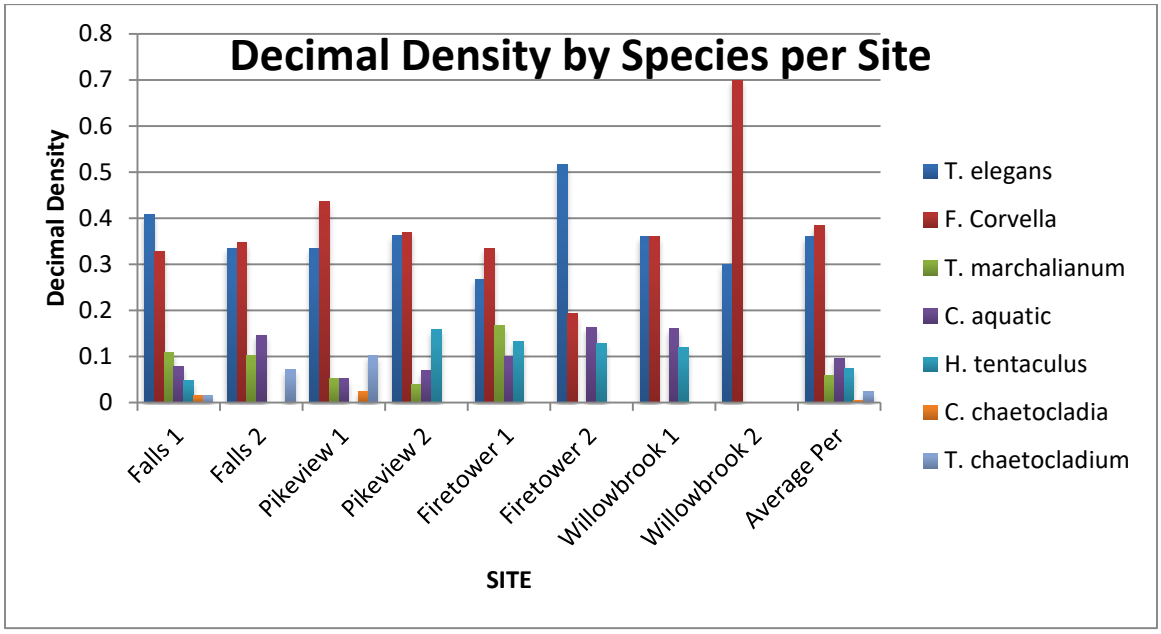
Total densities were also compared across all sights, as seen in Figure 1 to look for trends in abundance verses urbanization. A distinct trend was found.

Figure 1. Total organism densities compared by sight from least urbanized area to most.



An analysis of species density per sight was also done to, in conjunction with the Shannon Weaver, determine if there were any differences in the spread of species per sight.

Figure 2. Decimal densities of different species as found per site.




**Discussion**

Based on the Shannon Weaver index, there is certainly a trend downward in species variance as we moved closer into and through urbanized areas. With the highest Shannon scores at the first two sites, relatively unpopulated areas, we can infer that metal pollutants and other harmful materials have less affected these areas. The Firetower and Willowbrook sites seem to suffer from some significant pollution issues based on the above findings and previous knowledge of the area. Hopes were that an increase in species diversity would occur at the Willowbrook site, signaling some natural remediation occurring as the river left the city of Princeton, but this was not the case.

From all 8 samples taken across the 4 selection sites, there were a spores collected from a total of 7 fungal species as seen in Figure 3. These were all fungal species that are common to southern West

Virginia Rivers. Not all 7 species were found at each location with this only happening once at the Falls site. Based on findings, it would appear that *Tretrachaetum elegans* and *Flagella corvella* are the most common fungal types found in this ecosystem and are likely very resistant to pollutants. The species spread in Figure 3 goes hand in hand with my findings from the Shannon scores showing that the un-urbanized sites held a greater diversity of fungal spores indication less pollution.

All fungal spores collection was done at such a time that there should have been more then adequate numbers for each site for testing. Based on this knowledge, the significantly greater number species found at the first site compared to all other is another indication of the effects that populated areas are having on the latter sites.

To further support the findings that have come about from this testing, more data collection needs to be done and numerous other sites in the area to get a accurate grasp on specifically where the pollution becomes more significant and where it is finally remediated to normal. Also water testing would be a huge help to determine what pollutants are most abundant.

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# A DYNAMIC RESPONSE TO SHEAR HEATING:

*Overprinted pseudotachylyte from the Homestake shear zone, Colorado, USA*

A Final Report for the McNair Scholars Program, Concord University. (Mentor: J. L. Allen)

**M. Q. Merson** – *Environmental Geoscience Program, Concord University, Athens, WV*

**Abstract** – Pseudotachylyte adjacent to a ductile shear zone within the Homestake shear zone reveals an atypical fabric and internal mineral growth that differs greatly from pristine pseudotachylyte found at greater distances from the ductile shear zone. The fabric and mineral overprinting of the pseudotachylyte vein is interpreted to be a dynamic response to a thermal anomaly generated from the shear heating of a localized mylonite zone. A one-dimensional model of heat diffusion and viscosity change from shear heating within 0.7 km of the ductile shear zone reveals pseudotachylyte generated at a depth of 10 km may have experienced a ~100°C temperature increase and a decrease of viscosity by ~1 order of magnitude. Exposure to this thermal anomaly for an extended period of time would cause mineral overprinting of a pseudotachylyte matrix.

## 1. Introduction

Pseudotachylyte-bearing faults have been traced through the northern Sawatch Range of central Colorado and have been divided into three main segments – the Hornsilver-Holy Cross segment, the Savage segment, and the Homestake Creek segment (Allen and Shaw, 2013). These three segments together make up the larger Homestake shear zone. Each segment is comprised of pseudotachylyte-bearing steep faults that range from dextral oblique to strike-slip. In addition to pseudotachylyte bearing faults, zones of mylonite and ultramylonite are also present. Pseudotachylyte from the Homestake shear zone is typically pristine and has been previously described in great detail (Allen et al., 2002; Allen and Shaw, 2013). The main mylonite zone has been traced for at least 20 km (Allen and Shaw, 2013) with pseudotachylyte present within the mylonite and in adjacent localized regions. This study focuses on samples of pseudotachylyte that were collected within ~300m of the Homestake shear zone main mylonite zone (Hornsilver – Holy Cross segment). This pseudotachylyte was noted to be medium-to-coarse grained in hand-sample with stretched lithic clasts and transposed injection veins. In thin section, the matrix is completely overprinted with sub-millimeter recrystallized mica, quartz, and feldspar grains with no visible microcrysts. This study will (1) briefly describe the characteristics of the overprinted pseudotachylyte, (2) present a one-dimensional model for dynamic recrystallization as a result of shear heating, and (3) explore an interpretation suggesting the pseudotachylyte overprinting was a dynamic response to localized events.

## 2. Geologic Setting

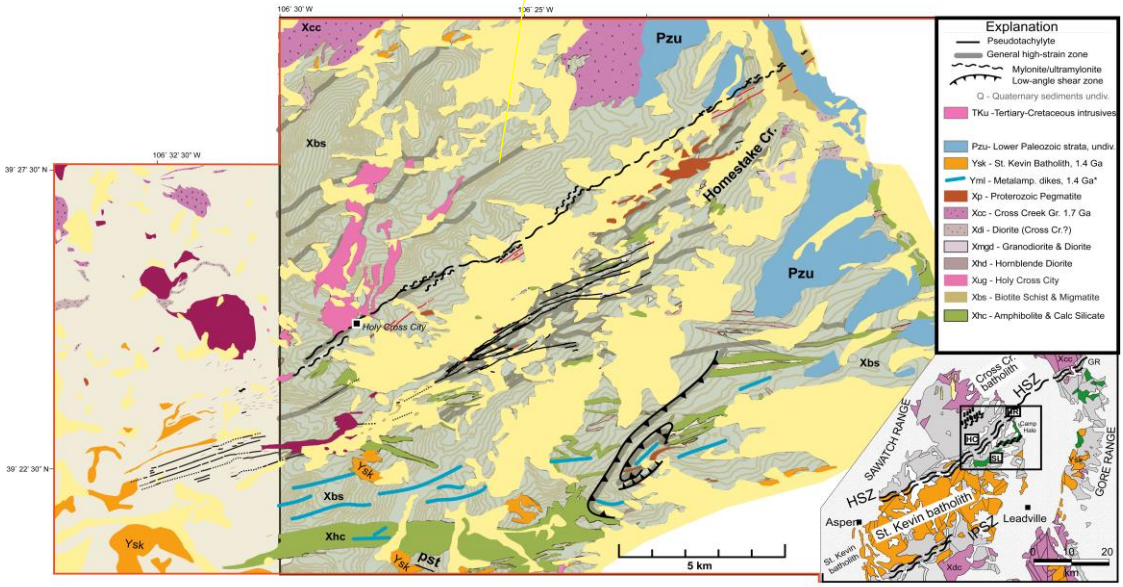
### *2.1. Reginal geology*

The Homestake shear zone is located within the northern Sawatch Range of Eagle County, Colorado (Figure 1). Tweto and Sims (1963) first mapped and described the geology of this region and its relation to the Colorado mineral belt - a composite of Laramide and Tertiary plutons and ore deposits that interacted with the early to middle Proterozoic intracontinental-tectonic structures (Shaw et al, 2002). The Homestake shear zone is a ~10km wide anastomosing network of tectonites that trend north-west parallel with the regional foliation. (Shaw et al, 2002). This shear zone contains evidence of both brittle and ductile deformation along with steep reverse faults and isoclinal folds. The best exposures of the shear zone are found among glacially polished outcrops along Homestake Creek south of Red Cliff and at the old mining spot at Holy Cross City (Shaw et al, 2002; Lee et al, 2012).

The Homestake shear zone displays a complex history of tectonic events that have been described by Shaw et al. (2001, 2002) and Allen and Shaw (2013) (Table 1). The main focus of this study is the description of pseudotachylyte that was generated during the D3 – D4 events and was later overprinted.

Figure 1. Location of the Homestake shear zone. Below: a generalized geologic map of Homestake shear zone showing distribution of mylonite-ultramylonite and pseudotachylyte bearing fault zones. Geologic map image courtesy of Allen and Shaw, 2013.


Hornsilver Campground



*2.2 Petrology of Homestake shear zone*

The predominant host rock of the Homestake shear zone is locally migmatic, fine-to-medium grained, semi-pelitic gneiss (Allen, 2005; Lee et al., 2012). Exposures of calc-silicate gneiss, biotite schist, mafic to ultra-mafic dikes, and aplitic dikes - all of which are locally cross-cut by granitic dikes – are dispersed throughout the shear zone (Lee et al., 2012). The Homestake shear zone contains localized regions of Mesoproterozoic mylonite, ultramylonite, and pseudotachylyte veins that cross cut the host-rock foliation. The most spectacular exposure of mylonite within the Homestake shear zone is visible in an outcrop directly above the Hornsilver Campground (Figure 1). This zone reveals

**Table 1. Summary of tectonic events, fabrics, and structures in the Homestake shear zone**

| **Event** | Age | Temperature | Structures | Foliation/ Lineation/ Kinematics |
|---|---|---|---|---|
| **Phanerozoic reactivation** | Early Paleozoic and Laramide | Low T | NE-striking brittle faults cutting basement and cover along NE and W flanks of Sawatch Range. | Variable dip slip to strike-slip kinematics on steep, basement rooted brittle faults concordant to preexisting Proterozoic foliation. |
| **D4** | ~1380 Ma? | Moderate- T (~300-400°C) | Subvertical ultramylonite in NE striking shear zones – coeval pseudotachylyte bearing fault zones. | Subvertical ultramylonite foliation and stretching lineation in shear zones. Ultramylonites dextral SE-side up; pseudotachylytes dextral strike slip and oblique slip on subvertical faults, and local top-to-SE on steep NW-dipping reverse faults. |
| **D3** | ~1420-1380 Ma | Moderate- T | Subvertical mylonite in NE-striking shear zones – up to >50-m-wide. | Subvertical mylonite foliation and stretching lineation in shear zones. Mylonites record dextral SE-side-down kinematics. |
| **D2** | ~1780-1620 Ma | High- T (>500°C) | Upright folds (NE-SW) | Anastomosing high-strain domains within the Homestake shear zone parallel to axial plane of $F_2$ folds, subvertical mineral lineation (sil, qtz, bio). |
| **D1** | >1710 Ma | High- T | Isoclinal recumbent fording | Low angle composite ($S_0$-$S_1$) foliation, axial planar to $F_1$ folds. |

From Allen and Shaw, 2013.

intense grain size reduction with strong, near-vertical planar foliation. The mylonite is light-brown to grey in color with stretched quartz ribbons. This $D_4$ mylonite zone is a total of ~30m thick that consists of a ~10m thick ultra-mylonite band nested within the mylonite (Shaw et al., 2002). The fabric of this mylonite displays SE-side-down dextral kinematics (Allen and Shaw, 2013). Pseudotachylyte veins have been discovered within and adjacent to this mylonite zone (Allen and Shaw, 2013), indicating coeval brittle and ductile deformation.

*2.3 Pseudotachylyte Description*

Pseudotachylyte-bearing faults within the Homestake shear zone have been mapped and described by Allen (2005, 2013) and Shaw (2002) (Figure 1), and since 1999, these fault systems have been a major part of study in Concord University's geology field camp. For this study, field samples of pseudotachylyte were collected from an outcrop ~300 meters south-west of the Hornsilver Ridge mylonite zone. This outcrop was part of a steep-limbed antiformal fold of migmatic-biotite gneiss cross-cut by an aplitic intrusion (Figure 2A). The northern limb of the fold hosted protomylonite and ptygmatic folds of the aplite and leucosomes, and the southern limb hosted migmatic-biotite gneiss. Pseudotachylyte veins were located on both northern and southern limbs of the fold (Figures 2B-D). Foliation measurements of the limbs of the fold average 290/75NE on the northern limb and

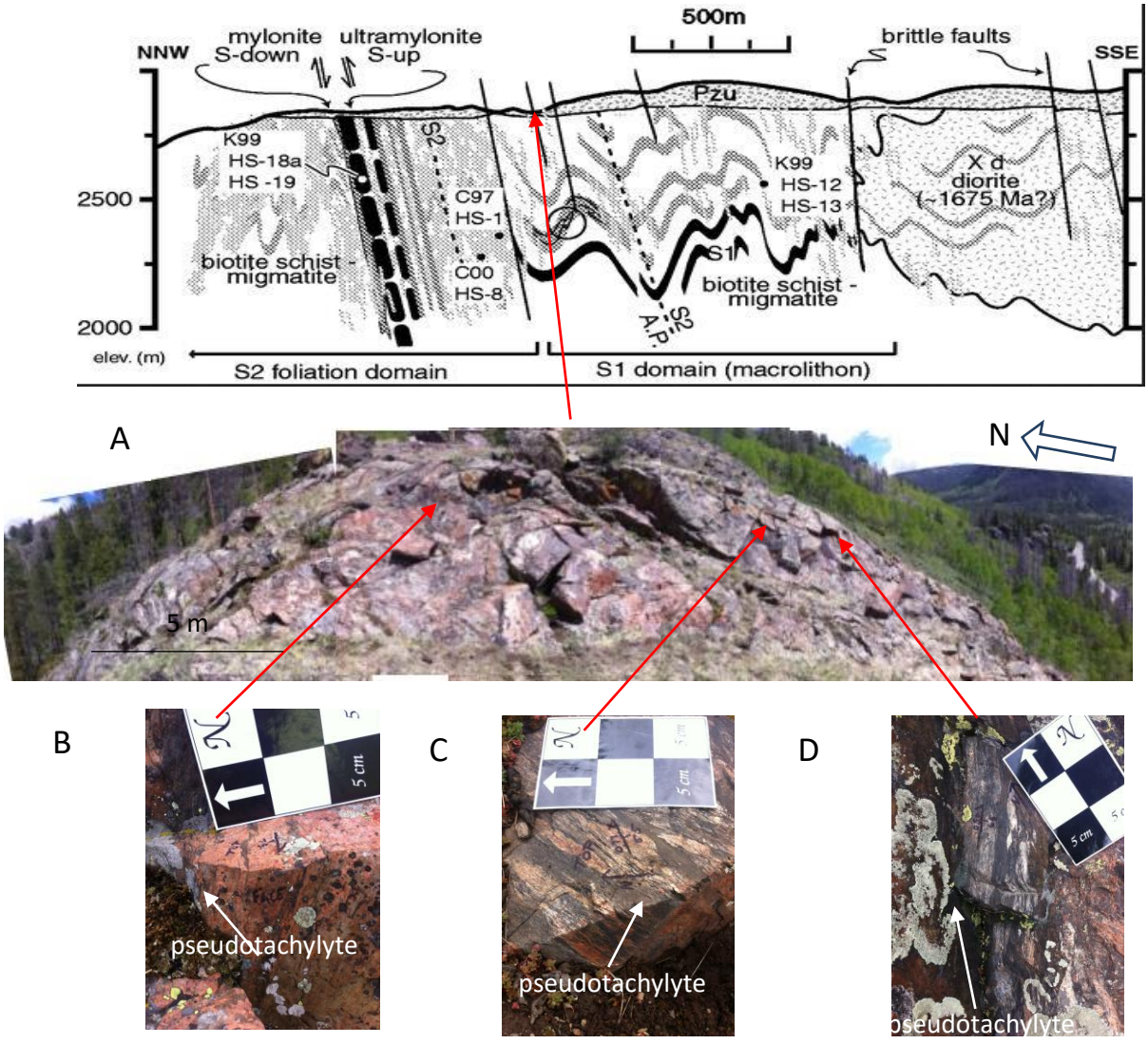
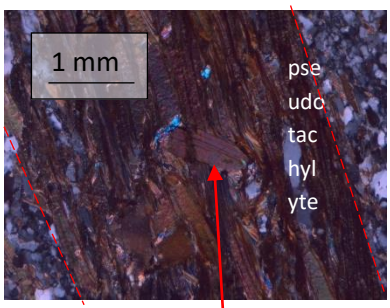



**Figure 2.** A) Antiformal fold ~300 m south-west from mylonite zone. Arrow points to approximate location within local cross-section. (Cross-section from Shaw et al., 2002). B – D) In-situ pseudotachylyte veins. Pseudotachylyte is slightly mylonitized with transposed injection veins.

*2.4 Thin Section Description*

The in-situ recrystallized quartz and feldspars. The geometry of the overprinted veins are consistent with other pristine pseudotachylyte veins found within the Homestake shear zone, but the matrix composition is much different. The most abundant mineral within the overprinted pseudotachylyte is biotite (Figure 3A) with recrystallized quartz and feldspar grains as the remaining

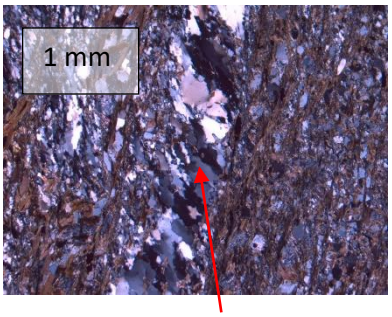



A Kinked biotite

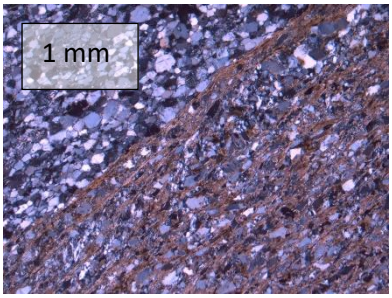
**Figure 3**.

A). Biotite is the most abundant mineral composing the overprinted pseudotachylyte. Biotite has strong preferred orientation.

B). Relict quartz lithic clast that is now reveals regime II recrystallization.



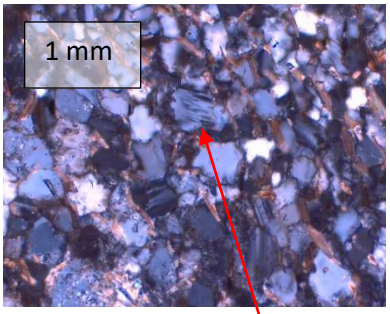

B Recrystallized relict clast




C

C). Overprinted pseudotachylyte boundary is sharp. The host rock is predominately recrystallized quartz and feldspars.

D). Recrystallized feldspars show flame lamellae, indication of low-medium grade deformation conditions (Passchier and Trouw, 2005).




D Flame lamellae

majority. The biotite reveals a strong, crystal-preferred orientation which could possibly be used as a shear sense indication. Muscovite also reveals a preferred orientation parallel to the biotite grains, while certain mica grains are kinked or folded. The dynamically recrystallized quartz grains of both the host rock and relict porphyroclasts within the matrix reveal regime two deformation textures (Hirth and Tullis, 1992) including subgrain rotation, sweeping undulose extinction, and core-and-mantle structures (Figures 3B and 3C). Some relict quartz grains are stretched into ribbons and truncated by the overprinted pseudotachylyte. Recrystallized feldspars reveal bulging recrystallization and certain grains include flame lamellae (Figure 3D). These deformation textures are indication of low-to-medium grade conditions (400-500°C) (Passchier and Trouw, 2005). pseudotachylyte veins collected from the outcrop south-west of Hornsilver Ridge are interpreted to be slightly mylonitized with stretched clasts and rotated injection veins (Figures 2B-D). In thin section, these samples are completely overprinted with grains of mica and

**3. Shear Heating**

Few mylonitic and metamorphosed pseudotachylytes have been analyzed and described from other shear zones (Passchier, 1982; Moecher and Steltenpohl, 2009; Kirkpatrick and Rowe, 2013). Veins of overprinted pseudotachylytes are currently unusual and may be consistently unnoticed or un-recognized in field observations. The metamorphism of pre-existing pseudotachylyte veins within the Homestake shear zone is interpreted to be a static overprint driven by dynamic processes within

an evolving shear zone. There are various geologic process that could possibly influence the temperature, pressure, stress, strain, and viscosity states within a shear zone. In absence of evidence for being a well-known metamorphic event at c.a. 1380 Ma, this study will evaluate the hypothesis of shear heating that drove the coeval metamorphism of newly formed pseudotachylytes.

Shear heating is the generation of heat from the mechanical work brought on by tectonic processes (Scholz, 1980) and influences both frictional and viscous properties (Rolandone and Jaupart, 2002). An active shear zone could increase the temperature of the local country rock enough for metamorphic reactions to occur. These reactions could take place centimeters away from the shear zone or up to many kilometers away. Shear heating in a thrust fault system is evidenced by an inverted metamorphic gradient within the footwall, and shear heating within a strike-slip shear zone is evidenced by a decreasing metamorphic gradient normal to the center of the shear zone structure (Scholz, 1980). If the applied stress on the shear zone is considered to be constant, then thermal runaway may take place (Fleitout and Froidevaux, 1980). Once a shear zone nucleates, the temperature within it will increase and the viscosity of the material will decrease (Fleitout and Froidevaux, 1980; Thatcher and England, 1998). The maximum temperature at the center of the shear zone will remain constant while the generated heat will be conducted into the surrounding country rock (Thatcher and England, 1998).

*3.1. One-Dimensional Model*

There has been much work done in order to model and theorize the effects that shear heating has on the local regions around a shear zone (Fleitout and Froidevaux, 1980; Scholz, 1980; Thatcher and England, 1998; Rolandone and Jaupart, 2002; Platt, 2015). For this study, the changes in viscosity and temperature near the Homestake shear zone mylonite were calculated using a simple one-dimensional model using formulas derived by Thatcher and England (1998).

The Homestake shear zone mylonite and ultramylonite formed under moderate temperatures conditions of ~300-400° C [573-673K] (Table 1) (Allen and Shaw, 2013). Temperature will decay from the center of the shear zone over a distance of:

$$\delta_T \sim 2\sqrt{Kt}$$

where $\delta_T$ is the thermal anomaly thickness, K is the thermal diffusivity of the material, and t is elapsed time since slip began (Thatcher and England, 1998, equation 2). Two calculations were made for an elapsed time of one-million years and 0.1 million years. Each calculation used a K value of 1.4E-12 $km^2s^{-1}$. These calculations reveals that over period of one-million years, the thermal anomaly will have a total thickness of 13.2 km, while over a period of 0.1 million years, the thermal anomaly will have a total thickness of 4.2 km.

*3.1.1 Host-Rock Temperature Change*

The temperature change in relation to the axis of the shear zone is dependent upon the inferred depth of the shear zone. Assuming a standard thermal gradient of 25°C $km^{-1}$, the $T_0$ (initial temperature) of the rock will be the following: 125° C [398 K] at 5 km, 250° C [523 K] at 10 km, 300° C [573 K] at 12 km, 325° C [598 K] at 13 km, and 375° C [648 K] at 15km. The slope of the thermal anomaly is defined by:

$$(T_{MAX} - T_0)/ \delta_T$$

where $T_{MAX}$ is the maximum temperature reached within the center of the shear zone (Thatcher and England, 1998). For this study, a $T_{MAX}$ of 400°C [673 K] was used.

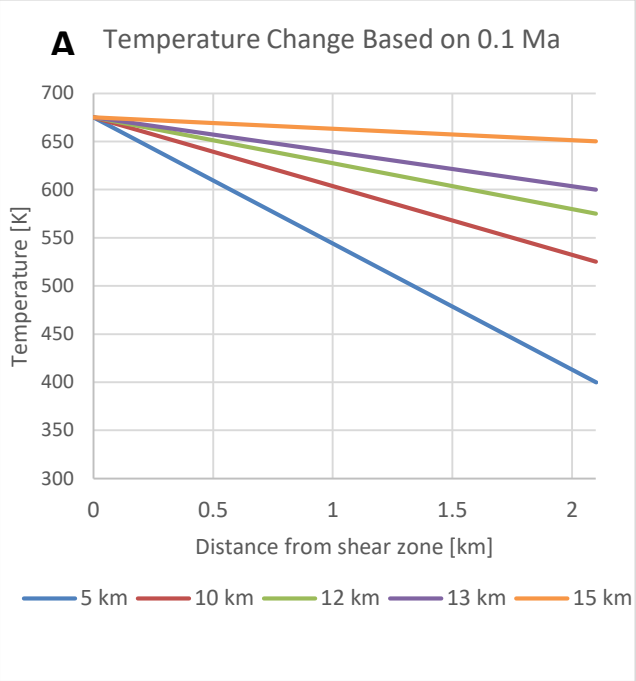
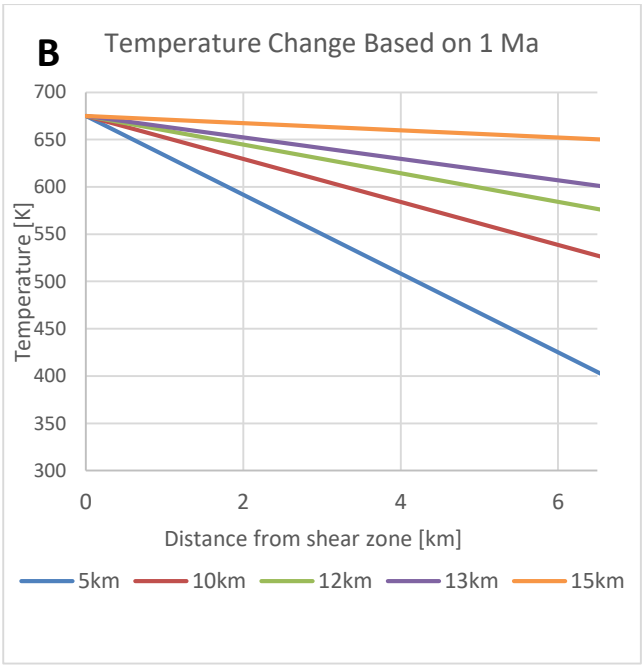



**Figure 4.** A) The change in host rock temperature at a distance from the center of a shear zone that was active for 0.1 million years. The various slopes indicate various depths of possible shear zone nucleation. B) The change in host rock temperature at a distance from the center of a shear zone that was active for 1 million years.




Figures 4A and B show the calculated temperature change of the country rock to the south-west of the shear zone axis. Figure 4A shows the temperature change if the mylonite zone was active for 0.1 Ma, while Figure 4B shows the temperature change in the mylonite zone was active for 1 Ma. The thickness of the generated thermal anomaly is greatly affected by the elapsed time it is active. Outside of the thermal anomaly boundary, the country rock temperature is equivalent to the temperature typical to the thermal gradient at that specific depth. As the distance from the shear zone decreases the temperature of the country rock increases accordingly.

*3.1.2 Host-Rock Viscosity Change*

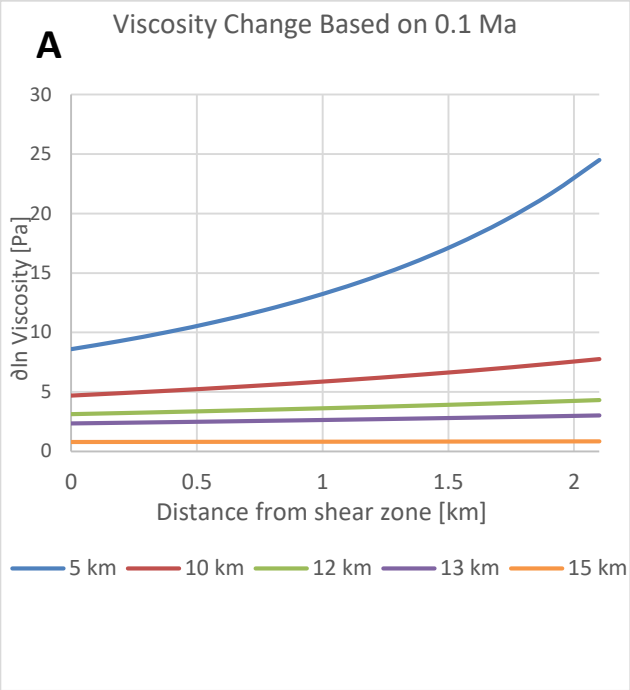
The change in viscosity of the rock is proportional to the change in temperature (Thatcher and England, 1998). This viscosity ($\eta$) change is calculated by:

$$\partial \ln \eta / \partial x \approx (Q/RT^2)( T_{MAX} - T_0/ \delta_T)$$

where Q is the activation energy for dislocation creep (2.49E5 J $m^{-1}$), R is the gas constant (8.314 J $K^{-1}$ $mol^{-1}$), and T is a temperature (K) between $T_{MAX}$ and $T_0$

(Thatcher and England, 1998 [equation B6]).

Figures 5A and B show that as distance to the south-west is increased from the shear zone axis, the country-rock viscosity increases. Figure 5A is the viscosity change of the country-rock based on a shear zone active for 0.1Ma, while Figure 5B shows viscosity change for a shear zone active for 1 Ma.




Note that the change in country-rock temperature and viscosity is greatest with a shallow-depth shear zone and the magnitude of change decreases as shear zone depth increases. For a 0.1 Ma active shear zone, a depth of 5 km will result in a temperature change of 130.9° C $km^{-1}$ and a ln viscosity change of 7.57 Pa $km^{-1}$, while a depth of 15 km will result in a temperature change of 11.9° C $km^{-1}$ and a ln viscosity change of 0.061 Pa $km^{-1}$. For a 1 Ma active shear zone, a depth of 5 km will result in a temperature change of 41.7° C $km^{-1}$ and a ln viscosity change of 5.06 Pa $km^{-1}$, while a depth of 15 km will result in a temperature change of 3.8° C $km^{-1}$ and a ln viscosity change of 0.019 Pa $km^{-1}$.

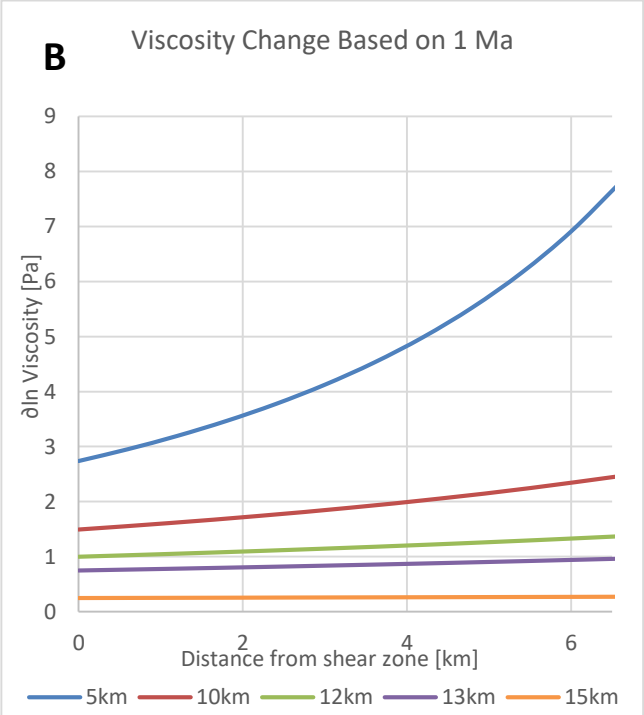



**Figure 5.** A) The change in host rock viscosity at a distance from the center of a shear zone that was active for 0.1 million years. The various slopes indicate various depths of possible shear zone nucleation. B) The change in host rock viscosity at a distance from the center of a shear zone that was active for 1 million years.

**4. Discussion**

When the described parameters are used in relation to the Homestake shear zone mylonite, regions normal to the ductile shear zone axis experienced an increase in host rock temperature and a decrease in host rock viscosity. The quantity of these changes are dependent upon the amount of time the shear zone was active and at what depth the shear zone nucleated. For this discussion, a shear zone with a nucleation depth of 10 km and an active time of 0.1 Ma will be considered. A shear zone with these specifications will generate a thermal anomaly with a total thickness of 4.2 km. The country rock within ~0.7 km of the shear zone would have experienced a 100° C

temperature increase. This increase in temperature with no increase in pressure would have been enough to cause an overprinting of generated pseudotachylyte. The pseudotachylyte proximal to the mylonite shear zone is interpreted to have been generated coeval with the ductile deformation (Allen and Shaw, 2013). The pseudotachylyte of this study was collected from an area ~300m from the main mylonite zone, well within the predicted shear heating thermal anomaly. In order to continually balance the heat generated by the dissipation, the shear heating thermal anomaly would remain constant for the duration of active deformation. This increased temperature of the host rock for an extended duration would allow for various sub-millimeter minerals to nucleate and grow within the pseudotachylyte matrix rather than the typical microlites as seen in pseudotachylyte observed at greater distances from the mylonite zone (Allen et al., 2002). The mineral compositions found within the pseudotachylyte are consistent with the original melt composition, which is identical to that of its host. The preferred orientation of the visible micas could be used as a strain indicator. The strain on the pseudotachylyte occurred as a result of decreased viscosity closer to the ductile shear zone. The coeval generation of pseudotachylyte and mylonite would allow for the generated pseudotachylyte to contain all the typical characteristics of pristine pseudotachylyte (injection veins, survivor clasts of wall rock, sharp boundaries), yet have an over-printed fabric due to the influence of the thermal anomaly. This could explain why the pseudotachylyte appears typical on the macroscopic scale, while the matrix is completely different than that of pristine pseudotachylyte. The shear heating anomaly would also have had a dramatic effect on generated pseudotachylyte closer to the shear zone, possibly erasing them entirely from the rock record. However, some pseudotachylyte have been observed directly within the Homestake shear zone mylonite (Allen et al., 2002), indicating that the brittle deformation event was the final deformation event before the system was entirely exhumed.

**5. Conclusion**

The Homestake shear zone is a complex system of intracontinental tectonic processes. The thermal anomaly generated from the ductile shear zone greatly influenced the surrounding country rock as well the pseudotachylyte within it. Calculations indicate that a ductile shear zone active for 0.1 million years would have generated a thermal anomaly with a total thickness of 4.2 km. If this shear zone nucleated at 10 km and had a maximum temperature of 400° C at its center, the temperature of the host rock normal to the shear zone would experience a temperature increase of over 100° C within 0.7 km of the shear zone axis. The same calculations indicate a shear zone active for 1 million years would have generated a thermal anomaly with a total thickness of 13.2 km. If this shear zone nucleated at 10 km and had a maximum temperature of 400° C at its center, the temperature of the host rock normal to the shear zone would experience a temperature increase of 100°C within 2.2 km of the shear zone axis. Pseudotachylyte generated within the mylonite zone was either completely erased or was generated during the last deformation event. Pseudotachylyte generated at a certain distance from the shear zone was generated with typical characteristics, though the interaction with the thermal anomaly would have allowed for larger mineral grains to nucleate and grow within the matrix while preserving the pseudotachylyte geometry.

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# Exploring Students' Perspectives on Advising and Registration

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Exploring Students' Perspectives on Advising and Registration

Late registration negatively affects students nationwide, both their likelihood of succeeding in a course as well as their tendency to face attrition can be influenced. At WVSU 1,262 students did not return for the 2013 school year. Several things correlate with late registration, some examples include advising techniques, the characteristics of the students' personality as well as the students' obligation outside of school. This paper investigates the various methods to improve registration trends and what causes students to register late is also investigated.

## Literature Review

Late registration is something that occurs at every institution and has negative impacts on the students' success and achievement. A study conducted at Stephen F. Austin State University in Texas by Ford et al. (2008) attempted to determine if students who register earlier for classes had a better outcome in the course than those who registered later. Student registration date and time was recorded for five undergraduate psychology classes from the beginning of pre-registration through the last day to add a course. They discovered a correlation between later registration and lower grades in the course, as well as lower GPA for the semester and lower overall GPA when compared to students who registered during pre-registration (Ford et al.,2008). Weiss (1999) agreed by adding that late registered students are more likely to fail or withdraw compared to students who registered on time. In addition, Safer (2009) found in his study of 7,200 students from California State University that the effects of late registration are more noticeable in males, upper classmen, and students who were in large lecture sections. Weiss (1999) suggested colleges no longer allow late registration, based on multiple studies that have shown that once late registration is eliminated student performance and retention greatly improved.

Many studies have shown that the connection between late registration and poor grades has more than one causal factor. Ford et al. (2008) further explained this relationship; they found that if one registered late they were less likely have their choice of classes. The authors (Ford et al., 2008) pointed out that many classes may already be filled; leaving the late registered students with restricted scheduling options of classes and instructors. These classes are likely not the students first choice. It has been found that if students do not view their instructor or their teaching method as interesting they are less likely to attend class and as a result get lower grades (Ford et al., 2008). This may explain the correlation between registration and course outcome.

In addition to lack of class choice, personality types may account for the relationship between time of registration and grades. Ford et al. (2008) attributed the phenomenon of late registration and lower grades to the relationship between the personality trait of conscientiousness and academic achievement and also the relationship between procrastination and academic achievement. They suggested that personality factors and behavioral indicators, like classroom attendance, are more predictive of academic success than achievement tests like the ACT or GRE (Ford et al., 2008). It has also been suggested that certain personality types predicts the likelihood a student will seek support from an advisor.

**Advising**

One of the key factors of early registration is advising. Many studies have shown that a relationship between faculty and students played a substantial role in the students' success (Ford et al., 2008; O'Keeffe, 2013). O'Keeffe (2013) suggested that for the quieter and more restrained students, developing a personal relationship with the school may be more difficult than for non-reticent students. Advisors interviewed in the study conducted by Weiss (1999)

reported that late registered students were also less confident in their academic abilities. Since the advising process can serve as a major form of interaction with faculty members, students who do not take advantage of this time miss an opportunity to create a bond with faculty outside of the classroom (Ford et al., 2008). O'Keeffe (2013) shared that the most important factor in advising is to help the students feel that they are cared for, this is especially true for at-risk students.

Creating personal contact with faculty can affect students' commitment to attaining a degree as well as their academic perseverance (Ford et al., 2008). O'Keeffe (2013) agreed by adding that students who participate in out-of-class communication displayed better academic and cognitive development than those students who did not. Ford et al. (2008) urged that to prevent the effects of late registration faculty must stress the academic importance of pre-registration during advising as well as freshman orientation.

**Characteristics of Late Registrants**

Much of the research on late registration centers on the characteristics of the students (O'Keeffe, 2013; Safer, 2009; Weiss, 1999). Safer (2009) reported that late registrants tend to be upper class men, nontraditional students that were enrolled part time. Furthermore, Weiss (1999) found that many times these students are employed full-time (Weiss, 1999). In addition, O'Keeffe (2013) found that part time students and those who held paying jobs were less likely to view themselves as students and therefore became less committed to university life and study (O'Keeffe, 2013).

These shared characteristics are often found in small state colleges. Weiss (1999) found that open-access colleges admit larger portions of high-risk students such as part-time and nontraditional students than institutions that are more selective. Being of this type, late registered students are more vulnerable to attrition (Weiss 1999). O'Keeffe (2013) pointed

out that a feeling of belonging is crucial to student retention and certain types of students are more vulnerable to attrition, including students who are ethnic minorities, students of low socioeconomic status, and probationary students (O'Keeffe, 2013).

**Characteristics of WVSU students**

West Virginia State University (WVSU) has a student population in which many of the characteristics of late registrants can be seen. In the fall semester of 2013, there were 2,677 students enrolled at WVSU. At WVSU 1,882 students were full time and 787 were part time. There was 1,469 female students and 1,208 male students enrolled. Of the total number of students enrolled in under graduate programs 300 students were of minority groups (American Indian, Asian, Black, and Hispanic) and 875 students identified as other. The average age of freshman students was 22.3, the average age of sophomores was 25, average age of juniors was 26.6 and the average age of seniors was 29.6 (WVSU Factbook, 2014). WVSU's student body has a substantial amount of nontraditional students.

**Registration efforts: What other colleges do?**

Many universities reward academically superior (e.g., honors) students by permitting them early access to registration. Those charged with promoting retention might contemplate offering early registration opportunities to students at the opposite end of the GPA distribution. At Texas A & M students who work on or off campus a minimum of 12 hours a week between 8 a.m. and 5 p.m. were eligible to preregister before the general student population Weiss (1999) discovered that retention and performance of students improves when late registration is not permitted. Freeman (2008) shared that during orientation at University of Wisconsin-Oshkosh an advising syllabus is given to first-year and transfer students to show what is expected to be accomplished through advising. The UW-Oshkosh constantly received bad reviews about their advising programs and decided to make a change

by hiring a director of advising (Freeman, 2008). UW-Oshkosh also utilized resources like the National Academic Advising Association which promotes that successful development of advising techniques through annual workshops and advising related research (Freeman, 2008). O'Keeffe (2013) argued that appropriating the counselor/adviser to student ratio can make a big difference in student retention as well as attract prospective students (O'Keeffe, 2013). Hofstra University's site offered step-by-step directions on how to register as well as common questions asked about the registering process and as well how to solve common problems. In an attempt to stop late registration at Indiana University Bloomington students are charged a fee for registering during the late registration window. While no efforts are universal, many programs are having success with focusing on advising as the catalyst for early registration.

**Registration efforts: What does West Virginia State University do?**

At West Virginia State University (WVSU) in order to ensure that students register early or on time Academic Affairs sends ongoing emails to students regarding registration and send out text messages to those who are falling in to the late registration window. WVSU also does house calls, "Spring Check Up" for residential students including calls from the Student Success Center. In addition, advising periods have been extended to give students an opportunity to meet with their advisor. There is also a "Spring in to Fall" event on campus for students to become aware of their advisor's name and location as well as email address and phone number. Deans and advisors also reach out to students who have not registered toward the end of the semester to encourage students to do so before the semester's end. WVSU also offers priority registering times to honors students, student-athletes and seniors (WVSU Factbook, 2014). Many efforts are being made to ensure timely registration however WVSU needs to recognize the uniqueness of its student body and tailor a process that will yield success in early registration trends as well as retention rates for the university.

## Conclusion

Many factors play a role in the students' time of registration which affects their overall academic outcomes. It is important to understand what encourages students to register on time in order to inspire other to do so. Also advisors and other individuals who play a major role in the students' academic lives should be consulted more regularly to further investigate the impact personality has on student success.

# Methodology

This section will explain the methodology of the study. The purpose of this study was to discover new options for advising and registration at West Virginia State University to decrease the number of students who register late. Research questions, design, variables and sample will be explained in the following sections.

## Research Questions

In order to ensure that students take advantage of registering early an evaluation of the advising practices at West Virginia State University (WVSU) was necessary. This section presents three research questions that were designed to determine what contributes to students late advising as well as what measures can be taken to encourage early advising. The research questions are as follows:

Q1. What are demographics of WVSU students who seek advising early, on-time, or late?

Q2. Why are students at WVSU late in seeking advising?

Q3. What can be done to encourage early advising at WVSU?

## Research Design

The study consisted of a correlational research design to reveal the connections between multiple variables. This research followed a descriptive design to outline what type of students register late and will offer explanations. All research questions will be answered using a cross-sectional survey technique using closed and open ended questions (Brians et al., 2011).

## Variables

The previous section detailed the research questions; this section will define variables from the research questions. None of the variable used in the survey will be manipulated; therefore no variables will be dependent on one another. This study sought to identify correlates between demographics and advising patterns.

In this study demographics of students such as gender, age, classification, and major were investigated. Further variables include the time that the student was advised the previous semester either during early advising, regular registration, after open registration, after the semester's end, or at the beginning of current semester. In addition, if students were advised after open registration they were asked to explain by either choosing an option of writing their own response. The last variable captured had students rank options to increase earlier registration from 1 to 7, with 1 being most encouraging and 7 being least encouraging. The options include increased advising hours, nontraditional advising, registration events, academic incentives, financial incentives.

## Sample

The sample will exclude freshman students as well as general education courses based on the idea that there will be many freshman students enrolled those courses. The ideal

sample included 300 nonfreshman students with a 30% return rate. The survey was administered within the first week of the fall 2015 semester (August 17-21) to at least one professor from each of the 23 departments aiming for the larger class sections with the most students enrolled. The goal was a minimum of 15 students from each department.

## Results

### Demographics

Of the 217 people sampled 39% were male, 60% were female and 1% chose not to answer. The classifications of the 217 participants were also recorded. 14% classified as sophomores, 27% as juniors, 57% as seniors and 2% chose not to answer. Additionally, the participants were asked to specify their major. The results showed that of the 217 sampled roughly 17% majored in Criminal Justice, 16% majored in Education, 11% majored in biology, 10% majored in Social Work, 7% majored in Communication, and another 7% majored in Psychology. The remaining majors were dispersed evenly among the other 32% of participants.

### Registration

The survey prompted participants to disclose when they were advised the previous semester. 51% of participants were advised during early advising/pre-registration between March 9$^{th}$ and April 5$^{th}$. 21% received advising during registration between April 6$^{th}$ and April 20$^{th}$. Furthermore, 15% were advised after open registration, but before the end of the semester between April 20$^{th}$ and May 13$^{th}$. Another 9% were advised after the end of last semester, but before the beginning of this semester between May 15$^{th}$ and August 16$^{th}$. Another 2% were advised at the beginning of this semester, August 17$^{th}$ or later and the remaining 2% chose not to answer.

Of the 217 surveyed, 63 were advised after open registration and provided an explanation. 27% cited that they had too many other things to do. The two options that received the next highest response rate (6%) were that the student could not reach his/her advisor and that he/she did not think it was important. An additional 11% of respondents chose two explanations for registering after open registration. Of the 11%, 3% selected that they forgot and had too many other things to do. 2% reported that they forgot and do not know who their advisor is. Moreover, 2% cited that they could not get in touch with their advisor and could not meet during advisor's available hours. The last 2% that selected two explanations said that they could not in touch with their advisor and they were not sure they would be returning. Lastly, the two explanations offered by 2% of the sample were they were not sure they would be returning and offered a written response. A large portion of students (34%) chose to write in their own explanation which requires further qualitative analysis. The outstanding 27% was evenly distributed among the remaining explanations.

**Incentives for Future Registration**

The last item asked students to rank from 1-7 what would encourage them to be advised before the end of the semester; with one being most encouraging and 7 being least encouraging. Of the 139 participants who ranked alternate advisor 53% ranked it as least encouraging. The remainder of rankings was evenly distributed. Of the 172 students who ranked financial incentives like small percentage off of tuition or fees 61% ranked it as most encouraging. The remaining rankings decreased down to only 2% stating financial incentives were least encouraging. Of the 151 students who ranked academic incentives like bonus points or extra credit 39% ranked it as very encouraging. 85% of those sampled ranked academic incentives between 1 (most encouraging) and 4 (neutral). Of the 148 students who ranked registration events involving food, games, prizes, etc. that include advising and/or registration 25% ranked it as somewhat encouraging with 62% of the ranking evenly

distributed between 4 (neutral) and 7 (most encouraging). When asked to rank increased reminders through email, text messages, posters in visible areas around campus, etc. Of the 154 whom responded 56% of responses were evenly distributed between 4 (neutral), 5 (less encouraging) and 6 (even less encouraging). Of the 149 who ranked nontraditional advising through phone, email, or online chats the results were evenly distributed among 1-7. However, 36% of students ranked nontraditional advising as 4 (neutral) or 5 (less encouraging). Of the 152 students who ranked increased advising hours 20% ranked it as even less encouraging but only 5% ranked increased advising hours as the least encouraging. Moving on, 18% ranked it as the most encouraging. The remaining 57% responses were evenly distributed among 2 (very encouraging) through 5 (less encouraging).

| | N | 1-Most Encouraging | | 2 | | 3 | | 4-Neutral | | 5- | | 6 | | 7-Least Encouraging | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *f* | % | *f* | % | *f* | % | *f* | % | *f* | % | *f* | % | *f* | % |
| Increased Advising Hours | 152 | 28 | 18% | 17 | 11% | 16 | 11% | 23 | 15% | 30 | 20% | 31 | 20% | 7 | 5% |
| Nontraditional Advising Hours | 149 | 22 | 15% | 16 | 11% | 17 | 11% | 28 | 19% | 26 | 18% | 23 | 15% | 17 | 11% |
| Increased Reminders | 154 | 17 | 11% | 20 | 13% | 14 | 9% | 29 | 19% | 27 | 18% | 29 | 19% | 18 | 12% |
| Registration events | 148 | 10 | 6% | 10 | 7% | 37 | 25% | 21 | 14% | 26 | 18% | 26 | 18% | 17 | 12% |
| Academic Incentives | 151 | 22 | 15% | 59 | 39% | 28 | 19% | 20 | 13% | 10 | 7% | 9 | 6% | 3 | 2% |
| Financial Incentives | 172 | 104 | 61% | 27 | 16% | 17 | 10% | 6 | 4% | 8 | 5% | 6 | 3% | 4 | 2% |
| Alternate Advisor | 139 | 9 | 7% | 10 | 7% | 9 | 7% | 12 | 9% | 13 | 9% | 12 | 9% | 74 | 53% |

**Correlates**

Chi-Square was used to compare gender and registration time, the results were not significant (.475). A Spearman correlation was then used between ages and time of

registration the results yielded a significant figure of .325 and a coefficient of .067 which is a weak relationship. Correlates were not done with question 6 “if you were advised after open registration, please explain why” because the majority of students selected “other” which requires further qualitative analysis.

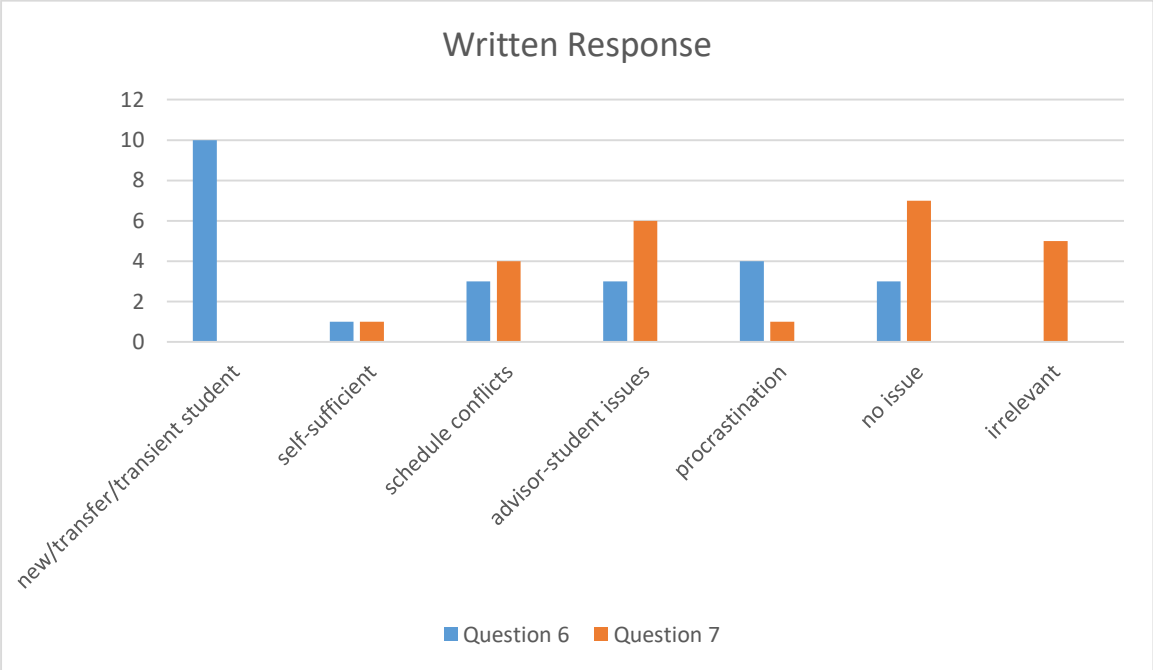
**Qualitative Analysis**

The data collected from surveys included written responses to question 6 “If you were advised after open registration, please explain why.” Also question 7 included the option for a written response “Which of the following would encourage you to register before the end of the semester?” The key terms issued to code student responses were the following: new/transfer/transient student, self-sufficient, schedule conflicts, advisor-student issue, procrastination, no issue, and irrelevant responses. Each term had to be defined. New/transfer/transient students is self-explanatory. Self-sufficient was defined as did not need or want assistance from advisors. Schedule conflicts were defined as having other commitments beyond the classroom which interfere with school obligations. Advisor-student issues were defined as having difficulty contacting advisor or not being satisfied with advising experiences. Procrastination was defined as putting off the task of advising or registering for classes. No issue was defined as being able to register on-time without difficulty. Irrelevant responses were defined as responses that did not pertain to the aforementioned question.

**Question 6.** In answering question 6 “If you were advised after open registration, please explain why.” twenty-four students included a written response. Of the 24 students, 10 were new/transfer/transient students. This type of response would indicate that WVSU is experiencing an influx of students transferring from other schools. This type of pattern insinuates that WVSU is becoming more attractive for college students. Additionally, four

students noted that procrastination lead them to be advised after open registration and three other students noted schedule conflicts. One student's response was categorized as being self-sufficient and the remaining three written responses revealed that those student reportedly had no issues with the advising process.

**Question 7.** On the last question of the survey students were asked to rank seven options in order of encouragement on question 7 "Which of the following would encourage you to register before the end of the semester?" Twenty-four students also provided a written response. Of the twenty-four written responses provided, seven students indicated no issues with encouragement to register on-time. An explanation to students indicating "no issue" would lead one to believe that students at WVSU properly prepare for registration without incentives. Furthermore, six students' responses were categorized as advisor-student issues. With that type of response one could assume that more needs to be done to build the relationship between students and advisors. Also five responses were classified as irrelevant. Four additional students indicated that they experienced schedule conflicts when registering for classes. The remaining two responses was labeled as procrastination and self-sufficient.



## Discussion and Conclusion

This research is important in understanding what may lead to certain registration patterns at WVSU. The results indicated that many students have issues with contacting and meeting with their advisors and the literature pointed out that having a good relationship between students and faculty plays a crucial role in student success (Ford et al., 2008; O'Keeffee, 2013). Furthermore, as the WVSU Factbook reported almost half of the previous year's registrants were part time students and many of the students at WVSU are identified as nontraditional students. According to Safer (2009) being a part time and nontraditional student is the perfect recipe to become a late registrant. Only 139 of the 217 participants properly responded to question 7 (incentives for registration). This likely occurred because question 7 was the lone item on the back of the survey sheet. Also many responses were invalid due to students responding with a check mark rather than a numerical value. To avoid this problem in the future I would suggest assigning each item a numerical value and providing students with a scale to rank items in order of encouragement. In regards to future research I would suggest using a larger sample and inquiring about student grade point average to investigate any correlations between GPA and time of registration.

Overall, time of registration is an important aspect of student success. In order to get students to take advantage of early registration it would be pertinent for WVSU to reevaluate their present advising procedures. With WVSU being a relatively small institution enrolling many nontraditional students it is important to recognize areas of necessary improvement to better the process of advising and registration for future students as well as faculty and staff.

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# Modifying Online Python Tutor for OpenDSA Pointer Exercises

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Abstract

When learning to program it is critical to receive feedback on your work. My project is concerned with providing visual feedback to students about the di cult topic of programming with pointers. OpenDSA is an online interactive textbook currently being used in introductory computer science courses at Virginia Tech. OpendDSA's programming exercises provide automated feedback to the student on whether the program is correct, but provide no visual feedback to a student about their own program. In order to fix this, Online Python Tutor (OPT), a framework for students to step through code execution, was incorporated into OpenDSA. Integrating OPT with OpenDSA required a few modifications to what parts of the program are displayed and how the data structures are laid out. With the assistance of OPT, students using OpenDSA will be able to view and step through the visualization of their submitted code.

## 1 Introduction

After Marc Brown wrote his dissertation about algorithm animations, many educators in computer science made contributions to the topic. He was not the first person to work in the field of algorithm animations but explored the effectiveness of the animations with student understanding [1]. It was not long until studies were conducted to learn how effective the algorithm visualizations were in teaching different concepts in computer science. It appeared that the passive experience of just viewing animations was not substantial enough to produce significant results. In 2002, studies were conducted to learn how effective algorithm visualizations were in teaching different concepts in computer science [7]. It appeared that the passive experience of just viewing animations was not substantial enough to produce significant results. This hypothesis was positively enforced after a metastudy was done by Hundhausen, Doublas, and Stasko that found 83% of their test group bene ted from completing activities along with watching visualizations. The action of simply viewing visualizations did not show signs of retention. The form of the visualizations and how they were presented to students played a major role in the success of students learning from them [7]. The visualizations that were displayed with color and appealing animations resulted in less effectiveness of retention of a concept. The studies showed that students interacting with algorithms (having the ability to manipulate the steps being displayed) had much better retention rates of the information. Thus, the motivation to create algorithm visualization and program visualization software emerged.

The next step in the process of developing computer science education software was to find a way to provide feedback to the student. A process of determining if the student could predict the next step in a visualization or complete an exercise based on the information presented to the student. The feedback needed to be displayed in a way that would allow them to better identify the source of the error, in the event the answer was wrong. Simply informing the user a given answer is right or wrong, does not present the student with sufficient feedback. The student is left with not knowing where the error lies. Another reason why delivering feedback is important is because the student could have correctly answered a question, but in a way that is inefficient. The system controlling the feedback would be able to analyze the students' answers and provide them with information about why the answer is right or wrong. This form of programmatic feedback could be done using automated

assessment. Automated assessment could relieve a professor of having to tediously grade hundreds of assignments and equip the student with instant results to their homework problems.

Based on the results from previous studies, having a system capable of producing program visual- ization(PV) and automated assessment(AA) could drastically change the level of difficulty for students in learning programming concepts. JHAVEPOP is one such system that contains PV and AA [3]. The exercises from JHAVEPOP deal with pointer manipulation and linked lists. JHAVEPOP was the inspiration for the modifications to OPT for OpenDSA pointer exercises.

# 2 Background

## 2.1 Program Visualization

Program visualization is the process of visualizing the execution of code, line by line. There are many program visualization software packages that have been developed over the course of the last thirteen years. In this manuscript, I only explain a few systems that this project utilizes. For more information on pro- gram visualization packages refer to "A Review of Generic Program Visualization Systems for Introductory Programming Education" [15].

### 2.1.1 JHAVE

Thomas L. Naps (2005) created a Java-Hosted Algorithm Visualization Environment, written as JHAVE [12]. It is not an AV system itself but rather a support environment for a variety of AV systems (called AV engines by JHAVE). The support environment allows for AV's to be “plugged in," then the environment gives controls to the visualizations. These include a standard set of VCR-like controls, pseudocode windows, input generators, stop-and-think questions, and meaningful content generation tools. JHAVE is indeed a nice tool to use, however, this system only satisfies two aspects of an online interactive textbook. Integrating the software into a textbook authoring environment would be optimal. This is not a program visualization software but has been utilized to create one.

### 2.1.2 JHAVEPOP

David Furcy implemented twenty linked list and pointer manipulation exercises into a system using the JHAVE platform. Since the JHAVE system supports a wide variety of algorithm visualization techniques, David Furcy translated code into the script based commands that the JHAVE library supports. JHAVEPOP visualizes the student's code and also contains automated assessment for the exercises [3].

### 2.1.3 Online Python Tutor (OPT)

Philip Guo did his dissertation at MIT on a program visualization software called Online Python Tutor [4]. He created it for Python 3.3 and 2.7 but there are now versions available for Java, JavaScript, Ruby, and TypeScript. It is fully equipped with text highlighting, execution arrows, VCR-like controls, breakpoints, and visually pleasing physical representations of memory. This is extremely flexible software that renders the visualizations of submitted code using HTML5, CSS, and JavaScript which allows you to start visualizing code without having to install any programs or updates. Students can go here and start visualizing their code in seconds. For this project, the Java version of OPT was used. David Pritchard created a Java package that allowed the visualization of Java code inside the OPT framework.

## 2.2 Automated Assessment

A system named AutoGrader which automatically assesses Java programming exercises was created at Miami University. This system can easily test built-in data structures and instructors have the ability to add structures not included in the standard libraries. AutoGrader is based on the concepts of JUnit. After an assignment is submitted, a report is created containing feedback about the code. Since AutoGrader does interface-based assessment, the report contains a series of tests for the functionality of each data structure. The feedback will distinguish which tests have passed and failed. In the event a test is failed, the user will receive a message containing the line of code where an error was first detected [5].

Researchers in Finland developed a system called Scheme-robo that assess exercises written in Scheme. Students have to email their code to Scheme-robo and the application responds in 10 minutes with a small report about the code submitted. This system mainly compares return values of submitted code with the correct return values supplied by the instructor in a configuration le. It supports keyword searches and program structure analysis. One unique feature that this automated assessment system contains is the ability to detect plagiarism [13].

ASSYST uses a graphical interface to grade assignments. The software was written to relieve tutors of laborious grading tasks. This package requires that the tutor provide information about each program being graded. ASSYST was created for introductory programming courses. It only supports the Ada programming language. When students submit their code to ASSYS it checks five components of their work: correctness, efficiency, style, complexity, and test data adequacy. The program supports program output analysis and static analysis [8].

In 2010, A program visualization tool with automated assessment was created by Juhn Helminen and Lauri Malmi known as Jype [6]. It is an interactive web-based learning tool. Jype was implemented in Java using the standard Swing GUI library and is platform-independent. It could be used as a Java web-start application or as a stand-alone application. It is meant to be used with a course management system. Jype is built on top of existing open source libraries Jython [2], Matrix, and jEdit. Also in 2010, an open source project that allows the assessment of simple JavaScript exercises emerged [9]. The application is easily embedded into any web-page. The instructor must supply the unit tests for each exercise. The downside to this project is that it is unsafe to save grades produced by the browser.

A system to check programming exercises for C programming was created in India in 2012. To verify correctness in assignments, the instructor must provide a verification program. This system uses a mathematical model where P is equal to the program, A is equal to some algorithm, and F is the function, since all functions have an inverse, they can write a verification program called the inverse of P which will have the reverse functioning of P. The verification program is compared to the student program to check if it is the reverse of itself.

FLOP was developed to try and minimize the amount of maintenance required in the use of automated assessment systems [11]. This system evaluates programs using black box testing much like AutoGrader. FLOP contains 130 built-in programming exercises and instructors can create problem sets from these with a few clicks. FLOP also provides the instructor with usage statistics of the problem sets. There is an option to view problem statistics or student statistics. Although you can specify collections of assignments in FLOP, there is no mention of how to create your own exercises within the system.

## 2.3 OpenDSA

A community based online interactive textbook project was launched in 2011 called OpenDSA [14]. This team had three implementation principles they established. One, the need for the traditional textbook style for displaying information was important. They recognized that some information was best presented by images and textual descriptions. The second principle was the need for visual representations of information. For some concepts, pictures and plain text is not enough to firmly digest the material. The third aspect is the hardest and most crucial component to any active-eBook, the need for interaction with the AV's. Unfortunately, it is the most time consuming and resource expending step for any online interactive textbook. For example, it took several student

years to produce the Virginia Tech Hashing Tutorial. The lessons in this tutorial are equal to the content that is taught in one week of class. Moreover, it took about two years to create one week of class in an active-eBook form. Putting this into even greater perspective, it could possibly take 28 years to develop an active-eBook for a 14 week-long semester college course. There is no evidence to support this claim, but hinging on the fact that it took two years to create one week's worth of material, leaves it open for stipulation. Looking at the extreme amounts of hypothetical time it could take to create these eBooks is likely a contributing factor as to why this group of researchers decided to make the active-eBook a community project.

The idea is much like an open source software development project. The need for many contributors in a project of this size is evident. With the need for much assistance in mind, they made arrangements for individuals interested in helping the cause by making a community forum which can be found at 2. The team makes use of a library they call JSAV, which stands for JavaScript AV, to create visualizations. Standards have been set for developing AV's and there is documentation to aid project contributors.

Karavirta and Shaffer introduced a new JavaScript framework for creating engaging algorithm visu- alizations with active learning features [10]. Since HTML5 has support for JavaScript and it is supported by all major browsers, Shaffer and Karavirta saw it very fitting to choose JavaScript for the AV library. HTML5 also runs on most tablets and mobile devices. JSAV represents the collective experience of three major AV development groups: the developers of TRAKLA2, Virginia Tech, and the JHAVE community. JSAV contains three main features: visual components, proficiency exercises, and flexible customization. The user interface of JSAV is all HTML with the functionality implemented in JavaScript. This system combines the best features of TRAKLA2 and JHAVE to create the ideal environment for incorporating automated assessment features and AV's into an online interactive textbook.

One of the most challenging parts to their work was building a community to commit to the project. However, there are over 1,000 contributors to the project today.

## 3 Purpose

To help ensure sufficient student progress and relieve professors from the task of intensively grading every programming exercise assigned in a classroom, researchers created automated assessment systems and program visualization tools. This project is intended to assist students in learning how to manipulate pointers by providing exercises equipped with instant feedback and visualizations of their answers. This will allow students to see the state of each pointer at any execution point in the program.

There are a few projects that have incorporated Online Python Tutor into their online computer science textbooks, but we took it a step further by allowing students to visualize code that they submit to each problem. Students will be able to interact with a physical representation for each line of code in a given answer. JHAVEPOP has this functionality, but it is not wrapped in a system capable of progress monitoring. JHAVEPOP is accessed via web-start application, whereas (after integration) the program visualizations on OpenDSA with the assistance of Online Python Tutor, will be displayed on the same page that the problem is presented.

## 4 Accomplishments

Three main tasks were achieved during this project:

1. Adjusted the Java version of Online Python Tutor to only visualize student code.

2. Modified the Online Python Tutor layout to closer resemble JSAV OpenDSA visualization format.

3. Implemented three JHAVEPOP style exercises on OpenDSA.

## 4.1 Adjusting the Java version of Online Python Tutor

The Java version of OPT was used for this project because the programming exercises on OpenDSA are for learning to program in Java. The Java version of OPT was created by David Pritchard. The adjustments for isolating student code deals only with the back-end. After code is received by OPT, it generates execution traces of the entire program in JSON format [4]. The execution traces are used to keep track of the current state of the program before each line is executed and to visualize them. As it is stated in Guo's work[4], each execution trace contains the following:

- The line number of the line that is about to execute.
- The instruction type (ordinary single step, exception, function call, or function return).
- A map of global variable names to their current values at this execution point.
- An ordered list of stack frames, where each frame contains a map of local variable names to current values.
- The current state of the heap
- The program's output up to this execution point.

In order to only visualize specific sections of code received by OPT, the unwanted execution traces must be removed. The back-end trace (the name given to the entire set of execution traces) is created, the execution traces meant for visualization can be filtered out by parsing the back-end trace. It is important to understand that the front-end uses this back-end trace to render the visualization onto the website. Before the trace is sent to the front-end to be rendered, filter out the traces that are not intended for display. To do this, I created an application called the jsonFilter to isolate student code. When a student enters their code in the exercise on OpenDSA, the user's code is wrapped into a JUnit test file, compiled, checked for errors, and then sent to the OPT back-end. The traceprinter package takes the Java code and produces the JSON object representing the entire program. If there are any compilation errors in the JUnit test file, it will not be sent to the traceprinter. The les that wrap the user's code must be prepped so that when the back-end trace is generated there are two flags to indicate when to start the trace filtering and when to end. Once the trace is sent to the jsonFilter, the startTraceNow() function and the endTraceNow() function are located and utilized. These are dummy functions used to signal the beginning and end of the filtering. Considering the code meant for visualization is sandwiched in between two les, it is rather intuitive to start filtering traces at the bottom of the first file and end it at the beginning of the second file. The remaining back-end

Figure 1: Example of execution trace

trace will only consist of the code from the exercise, along with the code entered by the student. After the back-end trace is filtered, it is saved it to a variable (in this example the filtered trace is saved in the variable name trace). The entire visualizer GUI is encapsulated in a JavaScript ExecutionVisualizer class. This class is contained in this JavaScript string in a format similar to this: *ExecutionVisualizer(parentNode, trace);* [4]. In order to visualize, the parentNode must be included inside the HTML file.

## 4.2 Modifying the OPT layout to closer resemble JSAV OpenDSA visualization format.

The display was modified to better resemble the JSAV format. For OpenDSA exercises, the original version of OPT shows a lot of unnecessary frames. These extra frames and long arrows could be distracting to the learner. Changing the layout allowed for a cleaner and more concise presentation of the information. Thus, the student will only see the objects being manipulated in the exercise itself.

The pytutor.js and pytutor.css are the two main les used to change the layout and display of the submitted code. These two les were slightly modified to produce the current display and layout for the OpenDSA pointer exercises. Class objects, lists, and trees are loaded to the screen using JavaScript and CSS. Pytutor.js reads in the execution traces and produces the visualizations. All of the code for adjusting the static analysis and display of the program are in pytutor.js and pytutor.css. Some progress was made but this step is far from complete. This is also mentioned in the future work section.

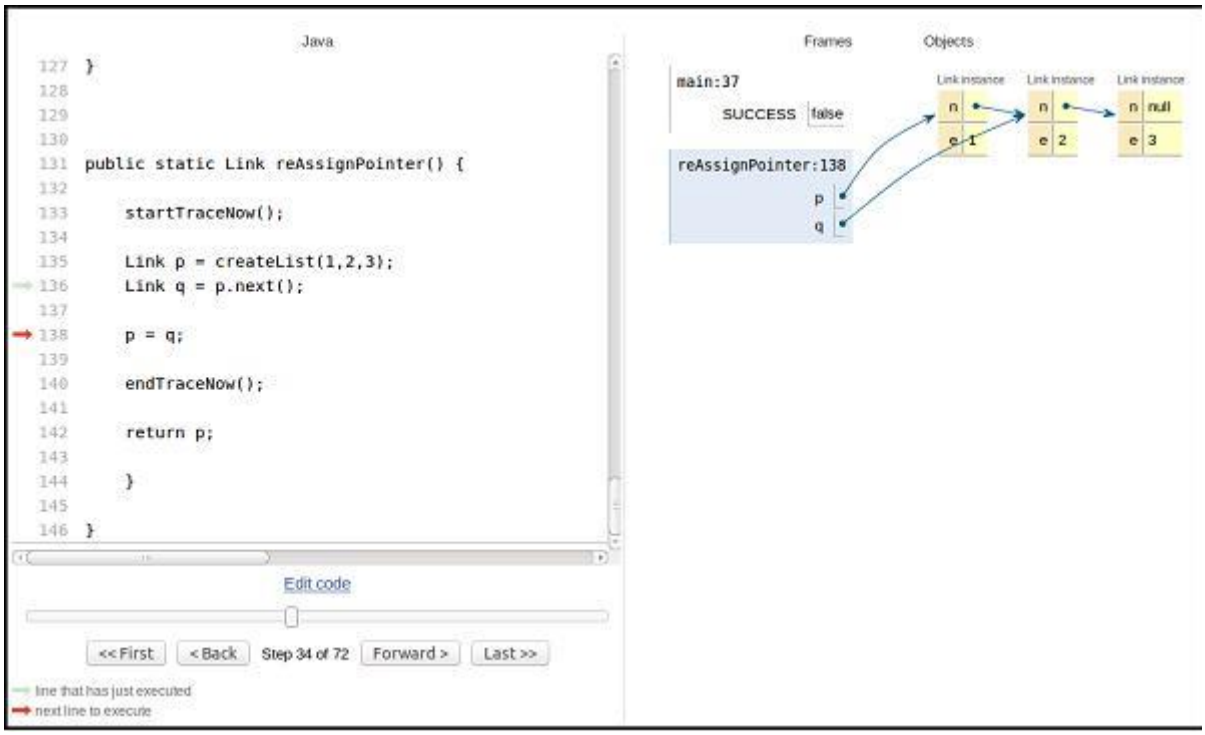

Figure 2: Layout of OPT before modifications.

## 4.3 Implementing three OpenDSA pointer exercises.

It was necessary to implement exercises on OpenDSA to understand how OPT was going to communicate with the OpenDSA framework. The exercises implemented were similar to the first three exercises found on JHavePOP[3]. It was mentioned in 4.1 that after code is submitted in the student interface on OpenDSA it is packaged into a JUnit test le. This le is then sent to OPT and the back-end trace is generated, filtered, and sent back to the front-end for visualization. The modified version of

OPT has yet to be integrated with OpenDSA. In figure 4 is an example of the program flow. At the time this project was being worked on, the communication between OpenDSA and OPT was done manually for testing purposes, but after integration it will be done programmatically.

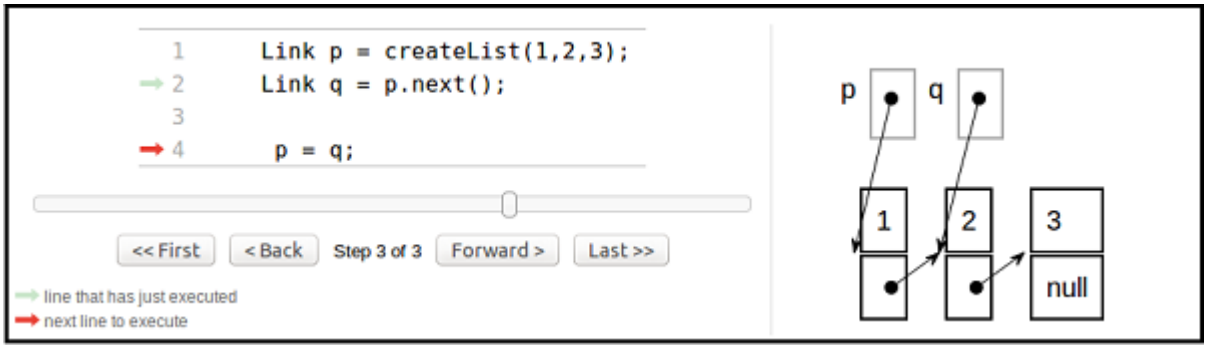

Figure 3: Layout of OPT after modifications.

## 5 Future Work

Here is a list of topics to increase the effectiveness of this project:

- Continue to modify the output of Online Python Tutor to look closer to the visualizations from JHAVE- POP.
- Implement each of the 20 exercises from JHAVEPOP on OpenDSA.
- Adjust the output to identify different data structures and render them according to type.

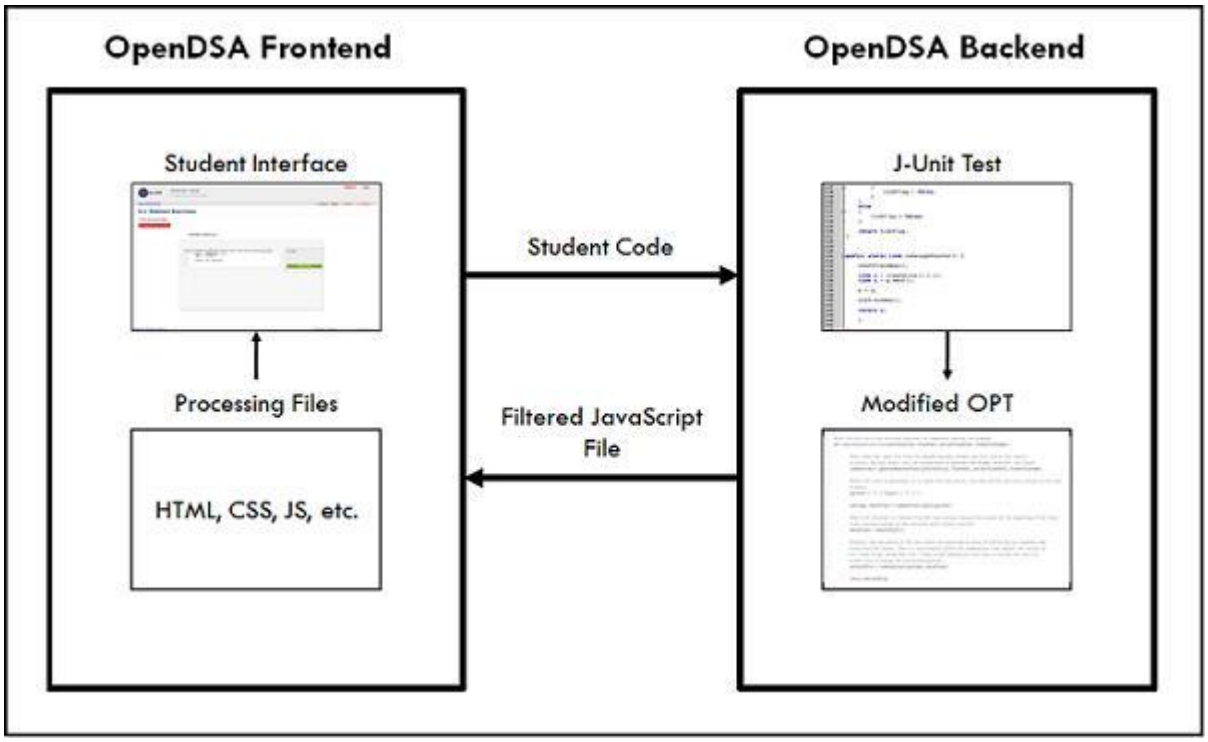

Figure 4: Program Flow.

## 6 Conclusion

The goal of this project was to verify if it was feasible to isolate code visualized in OPT. It is possible to specify sections of code displayed in OPT by filtering the back-end trace. With the assistance of OPT, students will be able to visualize their code and receive automated feedback on OpenDSA pointer exercises (after the integration process is complete).

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# Relationship Between College Freshman Adjustment and Physical Activity

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Mentor: Dr. Jill Nolan

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## Abstract

Health behaviors of young adults can have a lasting impact on health later in life. Physical activity plays an important role in improving an individual's physical fitness and quality of life. Starting college is a significant adjustment that may lead to changes in health behaviors. College freshmen in a rural state (N=119) completed measures of physical activity, BMI, self-efficacy, social support, college adjustment, and health adjustment. A significant, positive correlation was found between health adjustment and physical activity, self-efficacy, social support, and overall college adjustment. Independent samples t-test found a significant difference in health adjustment scores between residents (M=3.1, SD=.67) and commuters (M=2.64, SD=.57); $t(115)= -3.94$, $p = .001$ with residents reporting greater health adjustment. In this sample, healthy college adjustment had a positive relationship with other health behaviors, including physical activity. Residents appeared to have greater health adjustment, suggesting that living on campus may facilitate healthier lifestyles.

# INTRODUCTION

## College Health

Health behaviors of young adults can have a lasting impact on health later in life. College is an exciting, stressful, and monumental time in young adults' life. Moving away from home brings about a sense of freedom and independence, and without parental supervision, students have the ability to make decisions on their own. College years are influential on shaping adult behaviors, particularly physical activity, diet, and other risk behaviors[1]. Such behaviors predispose individuals to future health problems. In theory, interventions during adolescence to early adulthood could potentially reduce the rate of weight gain and overall decreased physical health during this transition to adulthood.

## Obesity

Obesity is a condition associated with excess fat that often leads to a degeneration in cardiovascular health. A national epidemic of overweight and obesity is evident among all age groups, including children and adolescents[2]. According to the Behavioral Risk Factor Surveillance System, The greatest increases in overweight and obesity seem to occur in persons between the ages 18 and 29 years[1]. Sedentary lifestyles in combination with excess caloric intake are the general contributors to obesity[2]. Obesity in adolescence tends to carry over into adulthood. Socially, there is a stigma associated with college freshman in America referred to as the "freshman fifteen."[7] The idea being that as young adults go off to college they gain weight due to different changes in their lifestyles. For the most part, this holds true for the young adults that go away to college. While some are able to respond and combat weight gain with changes in their diet and exercise, not all young adults demonstrate this resiliency. Unfortunately, obesity is not easily reversible, therefor individuals entering adolescence with obesity can anticipate being obese throughout adulthood[2].

**Physical Activity**

Obesity trends in part are due to low levels of physical activity[5]. Physical activity is any body movement that works the muscles and requires more energy than resting[5]. Physical activity plays an important role in improving an individual's physical fitness and quality of life[4]. Being physically active is one of the best ways to maintain a healthy heart and lungs. Not only does regular physical activity help avoid excess weight gain and obesity, but evidence shows that regular physical activity also helps physiological and psychological health[3]. Given the many benefits, one would think that steady engagement in exercise would be normal. However, that is not the case. Epidemiological studies have shown the level of physical activity to decline from high school to college, and activity patterns in college populations are insufficient to improve health and fitness[3]. Such research also indicates that nearly half of all college students report a decrease in activity following graduation[3]. Inevitably, a decline in physiological, psychological, and overall physical health can result.

**Nutrition**

Nutrition, in addition to physical activity, also plays an important role in college weight gain and health. Inactivity and consumption of food energy that exceeds expenditure result in the storage of excess body fat, leading to obesity in adults and in children[6]. Thus, there is a significant relationship between nutrition and physical activity. The U.S. dietary guidelines defines a healthy diet as one that: 1) "Emphasizes fruits, vegetables, whole grains, and fat-free or lowfat milk and milk products;" 2) "Includes lean meats, poultry, fish, beans, eggs, and nuts;" and 3) "Is low in saturated fats, trans fats, cholesterol, salt (sodium), and added sugars" (United States Department of Agriculture [USDA], 2011). Defining a healthy diet is often challenging and abstract. When consumed in moderation, all foods can be part of a healthy diet, making it difficult, or virtually impossible, to specifically label foods as 'good' or 'bad.'[6] Eating habits are also a problem in the general population as well as among college

students. In general, cost and convenience are two factors that have a great impact on consumers' diet. In the college environment, particularly in dorms, food options consist of non-perishable items with little nutritional value. When paired with stress and lower levels of physical activity, heavy consumption of such foods lead to the infamous "freshman fifteen." Although most cafeterias and on-campus restaurants offer healthier options, unhealthy snacking and/or exceedingly large portions of healthy foods can still lead to an unhealthy diet.

**College Environment**

Physical activity, nutrition, and weight gain are all factors associated with the collegiate environment, but there are other factors and risk behaviors introduced during this time that also affect young adults. Such risk behaviors include drug use, alcohol consumption, and sexual health. Findings from the 1995 National College Health Risk Behavior Survey [NCHRBS] suggest that many college students engage in health risk behaviors including binge drinking, cigarette smoking, drug use, and unsafe sexual practices that increase their likelihood of serious health problems (Douglas et al., 1997). Such risk behaviors have consequences that can potentially affect their health. For example, unprotected sex can lead to sexually transmitted disease (STDs), sexually transmitted infections (STIs), and/or pregnancy. Similar things can be said about binge drinking, drug use, or cigarette smoking. All lead to a decreased sate of health, which can lead to other health complications.

**Social Factors**

Social factors as part of the college environment have an influence health behavior as well. College is a time of developing new habits. Incoming freshman may spend their first few weeks settling into a routine. This could include studying, working, exercising, and sleeping. The Theory of Planned Behavior is a specific social-cognitive model being examined in

college students relative to intervention effectiveness[8]. The Theory of Planned Behavior postulates that intention (to practice healthy behaviors in this case) is influenced by three conceptually independent theories: attitude toward the behavior, subjective norm, and perceived behavioral control[8]. In each of these theories, the perception of the individual is an important influence. Attitude refers to an individual's assessment of the outcomes of the given behavior, while subjective norm deals with others' attitudes toward the target behavior, along with their motivation to comply with those significant others[9]. Lastly, perceived behavioral control refers to the individual's discernment on how easy or difficult it is to carry out the behavior[9]. Peer groups, extracurricular activities, and residential status can influence all the above psychosocial factors to effect college health behaviors.

## METHOD

### Participants

The study sample consisted of college freshman in rural West Virginia. All participants had to be at least 18 years of age. The survey was sent out and administered via Qualtrics.

### Measures

***BMI.*** Student body mass index (BMI) was calculated based on self-reported height and weight data from the survey, using the formula:

BMI = ( weight in pounds / height in inches x height in inches ) x 703.

***Seven-Day Physical Activity Recall.*** The Seven-Day Physical Activity Recall (PAR) is a semi-structured interview that estimates an individual's time spent in physical activity, strength, and flexibility activities for the 7 days prior to the interview. The general format was integrated into the survey for individuals to indicate the time spent sleeping and doing physical activities for the past 7 days. The participant is to respond based upon the recall

process, day-by-day, to determine duration and intensity of the physical activities. Duration was measured in minutes. Physical activity was categorized into three different levels: Moderate, Hard, and Very Hard. Moderate physical activity is defined by the CDC as any physical activity that burns 3 to 5 calories per minute, such activities are typically in shorter time periods and include walking to class, work or the store[10]. Hard physical activity burns 6 to 7 calories per minute, and includes brisk walking and jogging[10]. Very hard physical activity burns more than 7 calories per minute, and includes running and sprinting[10]. Information from the PAR was assessed to calculate the total minutes of physical activity per week, and average hours of sleep per night.

***College Health Adjustment.*** An original questionnaire was developed to measure the changes in college freshman health behaviors since starting college. Questions were answered using Likert-type scale , in which questions could be answered with the following response options: Strongly Agree, Agree, Neither Disagree nor Agree, Disagree, or Strongly Disagree. The survey was scored with the Positive and Negative Affect Schedule (PANAS) method. In this 16-item survey, questions were asked involving perceived: stress, health, physical activity, eating habits, weight gain, ability to manage time, and utilization of campus exercise facilities. Negative health behavior questions were reverse scored, then all responses were averaged to create a range of good health adjustment (1) to poor health adjustment (5).

***Self Efficacy for Physical Activity.*** The Self Efficacy for Physical Activity assessed "barriers efficacy."[15] Individuals were asked questions about his or her confidence in overcoming barriers to changing their behaviors. The questionnaire consisted of 8 questions, and participants were asked whether he or she either disagreed, neither agreed nor disagreed, or agreed with the statements. Scores were averaged to obtain a cumulative self-efficacy score ranging from 1 to 3.

***Social Support for Exercise.*** Social Support was measured using an assessment developed by Sallis et al[10], in which the level of support individuals making health-behavior changes with exercising felt they were receiving from family and friends. Participants were asked to rate the degree of support they receive from friends and family on a scale from 1 (None) to 5 (Very Often.) These measures were used to develop a perceived social support regarding health-related behavior specific to exercise. Two measures were taken from this survey, one for friends and one for family. Scores were average and the total scores ranged from 1-5.

***College Adjustment Test.*** The College Adjustment Test (CAT) measures the consequences of the personality, stage, and inhibition-confrontation models for expediting the coping processes in relation to college adjustment in freshmen[13]. Measures for college adjustment were collected using a 19-item survey asking participants to rate to what degree they had experienced various thoughts and feelings about coming to college during the previous week on a scale from 1 (not at all) to 7 (a great deal.) Scales were combined to create a composite adjustment score ranging from 48 to 104.

## RESULTS

### Demographics

A total of 119 students were included in the analysis; 51(42.9%) commuters and 68(57.1%) residents. The majority were female 31(73.1%), leaving the remaining male sample to be 31(26.1%). The mean age was 19.39(SD=4.51). Of the 119 participants, 112(94.1%) were white, 5(4.2%) were black, and 2(1.7%) were of another race. Employment status of the sample was 9(7.6%) full-time employees, 47(39.5%) part-time employees, and 63(52.9%) unemployed.

| | Total<br>N (%) |
|---|---|
| N | 119 |
| Mean Age | 19.39(SD=4.51) |
| Gender | |
| Male | 31(26.1%) |
| Female | 87(73.1%) |
| Race | |
| White | 112(94.1%) |
| Black | 5(4.2%) |
| Other | 2(1.7%) |
| Residential Status | |
| Commuter | 51(42.9%) |
| Resident | 68(57.1%) |
| Employment | |
| Full-time | 9(7.6%) |
| Part-time | 47(39.5%) |
| Not Employed | 63(52.9%) |

**Bivariate Correlations**

Bivariate correlations showed a significant negative relationship between BMI and self-efficacy ($r = -.225$; $p \leq .05$). BMI and College Adjustment showed a significant negative relationship ($r= -.232$; $p \leq .05$). Bivariate correlations showed a significant positive relationship between Minutes Per week of PA and Health Adjustment ($r= .231$; $p \leq .05$); and Sleep and College Adjustment ($r= .245$; $p \leq .05$); Self-efficacy and Social Support (Family) ($r= .563$; $p \leq .01$); and self-efficacy and Social Support (Friends) ($r= .630$; $\leq .01$); and Self-

efficacy and Health

| Bivariate Correlations with Bonferroni Correction | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1. BMI | 1 | -.009 | -.167 | -.225* | -.108 | -.059 | -.232* | -.124 |
| 2. Minutes Per week of PA | | 1 | .-.005 | .123 | .089 | -.023 | -.006 | .231* |
| 3. Sleep | | | 1 | -.018 | -.045 | -.002 | .245* | .120 |
| 4.Self Efficacy | | | | 1 | **.563**** | **.630**** | .138 | **.566**** |
| 5. Social Support (Family) | | | | | 1 | **.709**** | .115 | **.450**** |
| 6. Social Support (Friends) | | | | | | 1 | .147 | **.521**** |
| 7. College Adjustment | | | | | | | 1 | **.333**** |
| 8. Health Adjustment | | | | | | | | 1 |
| *p ≤ .05<br>**p ≤ .00625 (Bonferroni Correction) | | | | | | | | |

**Independent Samples T-test**

Independent samples t-tests were used for mean comparison of health behaviors for residents and commuters. There was a significant difference in health adjustment scores between residents (M=3.1, SD=.67) and commuters (M=2.64, SD=.57); t(115)= -3.94, p = .001 with residents reporting greater health adjustment. There was also a significant difference in Social Support (Friends) between residents (M=2.7, SD=1.0) and commuters (M=2.0, SD=.82); t(110)= -3.65, p = .001 with residents reporting greater social support from friends. Lastly, there was a significant difference in Social Support (Family) between

residents (M=2.3, SD=1.0) and commuters (M=1.8, SD=.82); t(113)= -2.84, p= .005 with residents reporting greater social support from family members. There was no significant difference in College Adjustment, Self-efficacy, Total Minutes of Physical Activity, or Sleep Averaged per Night between residents and commuters.

## DISCUSSION

119 college freshman completed the survey. It was hypothesized that physical activity would influence college freshman adjustment and health adjustment. The bivariate correlation showed a significant positive correlation between minutes of physical activity and health adjustment. However, there was no significant correlation between minutes of physical activity and college adjustment. It seems appropriate that minutes of physical activity per week and healthy adjustment would show this significant positive relationship. The bivariate correlation also showed a significant positive relationship ship between Sleep and College Adjustment; Self-efficacy and Social Support (Family);

| | Health adjustment | College Adjustment | Social Support (Friends) | Social Support (Family) | Self-efficacy | Total Minutes Physical Activity | Sleep Avera per ni |
|---|---|---|---|---|---|---|---|
| Resident | 3.1(.67) | 72.5(15.5) | 2.7(1.0) | 2.3(1.0) | 2.4(.52) | 480.1(514) | 6.9(1 |
| Commuter | 2.64(.57) | 76.2(14.8) | 2.0(.93) | 1.8(.82) | 2.2(.57) | 337.2(509) | 6.6(1 |
| Score | t(115)= -3.94* | t(107)= 1.38 | t(110)= -3.65* | t(113)= -2.84* | t(115)= -1.73 | t(112)= -1.47 | t(116) 0.87 |
| *p ≤ .008 | | | | | | | |

and Self-efficacy and Social Support (Friends); and Self-efficacy and Health Adjustment; Social Support (Family) and Social Support (Friends); Social Support (Family) and Health Adjustment; and Social Support (Friends) and Health Adjustment; and College Adjustment and Health Adjustment. It was also hypothesized that commuters would have greater scores concerning health adjustment and college adjustment. The independent samples t-test showed a significant difference between Health Adjustment, Social Support (Friends), and Social Support (Family) between residents and commuters; with residents reporting greater scores. Given this information, the residential environment may support healthier lifestyle habits than those who commute. Differences in the social environments between a resident versus a commuter could be a primary factor for this. When comparing health adjustment, higher scores from residents could be due to the general residential breakdown of the college in this study; freshman commuters are all likely to be within a 45-minute radius according to the campus policy. In general, the rural region in the study has poor health statistics. However because residents did report higher scores, this supports campus policies for freshman to be required to live on-campus. Overall when considering college environment, health behaviors, and social factors, data showed that residents had better social support from both friends and family and overall better health adjustment. Limitations in the study include the convenience sample, and self-reported data. Moving forward with these findings, future research could be done in a more affluent area for comparison of socioeconomic background in relation to health behaviors.

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