

DISSERTATION

GRANDMA, COULD THIS DISSERTATION BE MY INDIGENOUS TAYAL FACIAL
TATTOO? AN AUTOETHNOGRAPHY OF OVERCOMING THE FEAR OF STATISTICS
THROUGH THE DICHOTOMOUS USE OF P-VALUES

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ABSTRACT

GRANDMA, COULD THIS DISSERTATION BE MY INDIGENOUS TAYAL FACIAL TATTOO? AN AUTOETHNOGRAPHY OF OVERCOMING THE FEAR OF STATISTICS THROUGH THE DICHOTOMOUS USE OF P-VALUES

This dissertation's idea began with my class notes and questions in the statistics courses I attended in my doctoral program. These notes and questions originally were about the concepts of the bell shape, statistical distribution, and hypothesis testing. They then became my inquiries of p-values because what I learned in the courses about how the dominant use of p-values have generated inequities such as academic bias and misleading statistics education; they caught my attention as inequities were at the root of my learning growing up as a Taiwanese Indigenous student and woman.

I reference Indigenous critical theories' (ICT) concept of *challenging the mastery of knowledge via centering Indigenous intelligence in the knowledge* (Justice, 2016) as the primary epistemology to conduct this autoethnographic study. All in all, using autoethnography as the research method, I ask four research questions to explore my meaning-making of learning the dichotomous use of p-values:

1. How do I make meaning of the dichotomous use of p-values in the statistics courses I attended?

The exploration of this research question illustrates how and why I was drawn to the issue of p-values and what is the essential problem of using p-values dichotomously. Using p-values

dichotomously means using statistical significance to decide the effectiveness of a research treatment or intervention.

2. How do I make meaning of the dichotomous use of p-values in the literature of this study?

The analysis of this research question shows the broader contexts of the canonical teaching and use of p-values and that of inequities engendered by them. To answer this research question, I explored the history and philosophy of the connection between statistics and scientific research and inequities caused by using p-values dichotomously. These inequities explored and explained in this study are death, job loss, life threats, and academic bias.

3. How do research questions 1 and 2 help me address inequities discussed in this study as an Indigenous woman researcher?

The answer to this research question explains how the inequities generated from improper use of p-values. It also aligns with the inequities I have encountered as an Indigenous woman and graduate student in a country not of my birth.

4. How do research questions 1, 2, and 3 help me overcome my fear of statistics?

Pondering this question led me to complete this dissertation—*Grandma, Could This Dissertation Be My Indigenous Tayal Facial Tattoo? An Autoethnography of Overcoming the Fear of Statistics Through the Dichotomous Use of P-Values*.

This study not only critiques the dichotomous use of p-values but also explains the inequities generated from it by unraveling the social norm ingrained in the use of p-values. It also heals me from feeling unintelligent, timid, and small about statistics as, during the process of completing this dissertation, I have overcome the fear that accompanies emotional trauma associated with the numeric dimension of confirming realities.

ACKNOWLEDGMENTS

The process of this dissertation taught me a hard lesson about the power game in academia and how I could be free from it. The me who wanted to pursue a career in academia was not intact after this, but I survived. Those who understood, sympathized, empathized and those who did not understand or laughed at my anger, tears, hurt, vulnerability, feeling belittled, feeling untrusted, feeling disrespected, and feeling trampled on due to my position at the bottom of academia all fertilized my spirit as an Indigenous student and woman.

Matt, thank you for being my partner and my other half who always brings me back joy from out of my sorrow and anger toward power games and my own pride. Your relentless companionship for the last 15 years in my life, including my personal, academic, professional, emotional, mercurial, realistic, and unrealistic journey has given me the best friend, partner, colleague, and advisor whom I most trust, rely on, and share all with. Your final proofreading made this dissertation clearer. Your listening, comforting, and feeling angry, lost, and sorrowful in the writing process with me completed the whole soul of this dissertation. Your adoring this dissertation when I can no longer like it gives this dissertation a reason to exist.

Dad, thank you for teaching me how to persevere. You are one of the Indigenous peoples¹ in the colonial world who suffers discrimination and inequities the most. Yet, you have taught me how to laugh at power. Yes, the world is full of power games, but our souls stay intact.

¹According to Indigenous critical theories and my Indigenous ways of knowing that honor and practice collective community and wisdom, throughout this dissertation, I pluralize the word *people* making it *peoples* to counter the singular (individualist) meaning of “people.” This singular use of “people” has been standardized in English writing which tends to ignore multifaceted elements that exist in a cultural, ethnic, and/or racial categorization.

Albert and Yoyo, your listening and sharing in my exasperation throughout this process reminds me that I have the best siblings I could ever have. Your being proud of me in my graduate studies was the most profound encouragement when I felt that I could not go on in my Ph.D. program.

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DEDICATION

For Grandma and our Creator (Yavagansama), with love, as you had taught me:

Love is patient, love is kind. It does not envy, it does not boast, it is not proud. It does not dishonor others, it is not self-seeking, it is not easily angered, it keeps no record of wrongs. Love does not delight in evil but rejoices with the truth. It always protects, always trusts, always hopes, always perseveres. Love never fails. (1 Corinthians 13: 4-8)

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CHAPTER ONE: INTRODUCTION

Grandma used to tell me that we Tayal (the name of my Taiwanese Indigenous tribe) women are strong, and the proof was on our faces: traditional facial tattoos.

“How, Grandma?”

“Having a tattoo on our faces means that we are strong and smart enough to be good at sewing, planting, making all the decisions regarding household affairs and are ready to marry a man who can compete with us. We take care of everything in the house, and they go out and hunt.”

“But you don’t have a facial tattoo and neither do I, Grandma! Does this mean that we are not strong?”

Grandma crossed her fingers, bowed her head, and said:

“It’s okay, we don’t have to be strong; we have Yavagansama (the Creator).”

“I think you are strong, Grandma!”

“I know! I planted and nurtured all the land we had! Your Grandpa just went to Jinchating (Mandarin for a police station) to work and drink!”

“Did the Japanese not allow you all to have facial tattoos?”

“Yeah, but it’s okay. At least they were better than the Chinese government when they came to settle in 1949.”

Taiwanese Tayal Facial Tattoos: Strong and Smart

I often think about the idea that I don’t have a facial tattoo; therefore, I wonder if I can be considered a Taiwanese Indigenous woman like those strong women. I don’t sew and I don’t plant even though sometimes I make decisions regarding my household affairs. According to

Tayal traditions, I definitely don't think that I am qualified to marry even though I have been married for ten years.

I often imagine that I have a facial tattoo. I can try to get one, but can I bear the needle pounding ink into the pores of my face? I am not strong enough! I can go to a tattoo shop to get a tattoo on my face, but it would not be the same.

I don't have a Tayal's facial tattoo; in my Indigenous tribe, it means that I am not strong nor smart enough. Ah! That's why I am not good at math.

"It's okay you are not strong and smart! We have our Yavagansama (the Creator)." I recalled Grandma often comforted me this way.

"I know, Grandma! But I want to be smart!"

"Pray to Yavagansama!"

Grandma & One of My Indigenous Ways of Knowing

Grandma said that the strongest and smartest Tayal woman is one who learns the world (various kinds of knowledge) to share, love, be kind, be humble, and be flexible to appreciate each other's value and ability even though Chinese colonial peoples teach us to possess, be cold, be proud, and be strict to judge each other's achievements.

Grandma, I want to tell you: Things here often are cold, cruel, and strict to judge like when I was in Taiwan. I often still feel dumb here like in Taiwan growing up, especially when I am speaking another language and trying to pursue my dream. This world is also scary like when I used to learn statistics.

Grandma! I want to tell you: I am now older, and I am now more educated. In fact, I am now close to reaching a high degree in the U.S., a Ph.D. I have now been educated for 27 years in Taiwan and six years in the U.S. I am now writing a dissertation. It is a research study where I

am showing my story of learning as a Taiwanese woman. My story begins with wisdom and learning I gained from you.

The Biggest Contribution I Believe Is Overcoming My Fear of Statistics

I believe that the biggest possible contribution of this dissertation is that I have overcome my fear of statistics. It also means that I have studied statistics like studying the monster as I anatomized it. Grandma, I was dissected and torn apart in this process of facing the monster, much like how Chinese people used to tear you apart and said, “No offense, it’s just business.” If, like you, I can gracefully cross the rainbow bridge (a Taiwanese Tayal Indigenous saying, meaning “crossing over” or “passing away”) at the age of 96, it will be because I am your grandchild and I have your blood pulsing in my veins, helping to guide me. Grandma, I don’t expect that peoples will genuinely applaud me for my achievement in this world, but Grandma, I just want to survive, like you did when you were on our land.

The Indigenous Me, Autoethnography—Using Factions (Akintunde, 1999; Aragon, 2016) as the Essence of My Memories

I am a Taiwanese Indigenous, cis-gendered, dark-skinned, and married woman who recently gained my U.S. citizenship. For the first 27 years of my life, I was educated in Taiwan. Figuring out my gift for languages provided me with the ability to teach others how to speak American English. This led me on my journey to the United States. I also married my American husband and decided to pursue a Master’s degree in Ethnic Studies and now a Ph.D. in Education. You could say that I love to learn but only if I make the learning fit my needs. Unfortunately, most of my education has led me away from my own personal beliefs, visions, and Indigenous ways of knowing. Yet, even when the learning is difficult, I persist. There is something in me that loves to learn. But only when the learning makes sense to me according to my Indigenous

ways of knowing. In an effort to make sense of my own learning and how my Indigenous ways of knowing influence my examination and approach to knowledge-making, this study explores my experiences of learning quantitative research about p-values.

This study is approved by my university's Institutional Review Board (IRB). As you read my story, please note that I use dialogue and quotes, but in the spirit of autoethnography, I use *faction* (Akintunde, 1999; Aragon, 2016), both fiction (i.e., narratives not from direct quotes) and facts to provide my personal story. Such use of fiction is used to bring to life my individualized recollections as best as I remember them. The quotes are not precise but rather constructed to tell my story. Unlike a study utilizing direct quotes from interviews, my autoethnographic quotes are memories used to portray the essence of my lived accounts of conversations with peoples. These memories also include past personal research notes drafted during meetings and classes. As an English language learner, Taiwanese Indigenous immigrant woman, and graduate student in the U.S., my interpretation of the interactions with peoples in this study is stated through my lens.

The essence of this dissertation is my autoethnography of learning and unlearning p-values. My learning and unlearning in this study reveal where I unravel how math and statistics collide into my past, present, and future. Over the years, I have taken five statistical courses with Professor A², we have discussed how academic bias can be generated by how peoples learn and use p-values in quantitative research.

Before this dissertation, I was not fond of statistics; in fact, I feared it. I feared it because it tended to make me feel unintelligent, and this feeling of unintelligence often triggered my fear of navigating the world as an Indigenous student and woman.

² Professor A is a pseudonym for a professor who taught me quantitative research. I use this pseudonym in this study to make my autoethnography reader-friendly, and the professor signed IRB consent and agreed to be portrayed and depicted in my autoethnography with this pseudonym. There are no direct quotes from him in my study but rather reflections based on the use of my recollections, interpretations, and research notes.

Being a Taiwanese Indigenous student and woman, I often fear judgment, coldness, cruelty, pride, and possession in the world like how I fear how most Chinese peoples treat the Taiwanese Indigenous. All this constantly reminds me of how gigantic and powerful the world seems to be and how small and weak I feel in a system of education that does little to accept Indigenous peoples.³

Alongside the aforementioned fear when considering my dissertation topic, I felt the need to talk about the dichotomous use of p-values because there were inequities generated from p-values that I observed from my studies and courses in statistics, all of which were personal to me. As I reflected on how I learned the studies and courses in statistics about p-values, I could see clearly how inequities were at the root of my learning.

Inequity is “an instance of injustice or unfairness” (Merriam-Webster Dictionary, 2021). Grandma cared; Mom cared; Dad cared, so I care, too. Caring for fairness is in our blood. It is a living thing for me, my Yavagansama (the Creator), my families, and the world. Therefore, in this study, I first revealed the root causes of injustice in my experiences, which influenced my learning and provided background to my research purpose.

The Dichotomous Use of P-Values

What is the dichotomous use of p-values? It means that, in the process of evaluating statistical inference in quantitative research, some researchers use a predetermined number as a

³ Purposefully, throughout this dissertation, I use the word *Indigenous peoples* instead of “indigenous people” to counter the singular meaning of “people” and the non-capitalized term, “indigenous.” The singular use of “people” in Western “Standard English” simplifies and ignores the fact that multifaceted characteristics and diverse differences exist in a cultural, ethnic, and/or racial categorization such as the Asian American, African American, Middle Eastern American, Chinese people, Native people, etc. Indigenous critical theorists advocate for using *peoples* instead of “people” to notice, represent, and respect the diverse and disparate elements within a cultural, ethnic, and/or racial categorization (Allen, 2012; Moreton-Robinson, 2016). Also, I capitalize *Indigenous* in this study to honor my Indigenous roots as Indigenous critical theorists have promoted using the capitalized term, *Indigenous*, to resist society’s everlasting colonial control of *Indigenous peoples* by using a linguistic term, “the indigenous people” to devalue our indigeneity of the world (Allen, 2012; Moreton-Robinson, 2016).

threshold (e.g., 0.05 or 0.01) to decide the statistical inference of their research and make a binary scientific claim such as whether a research intervention works or not (Goodman, 2019); it means that if the number is smaller than 0.05 or 0.01, the research intervention or treatment is effective (i.e., the research has statistical significance or is statistically significant).

This binary scientific claim is decided by a p-value that is either smaller or bigger than a certain number (e.g., 0.05 or 0.01). The threshold of 0.05 or 0.01 was designated by a group of European scientists in the 19th century, and it has become the traditional threshold in science and social sciences for researchers to report if their research has statistical significance or not (Salsburg, 2001). In other words, if a research project's p-value is smaller than 0.05 or 0.01, the research has statistical significance; thus, the research is considered significant. If a research project's p-value is greater than 0.05 or 0.01, the research does not have statistical significance; therefore, the research is likely to be deemed insignificant. This binary way of deciding research's statistical significance or insignificance by only a p-value is the dichotomous use of p-values I critique in this study.

My Intention to Deconstruct the Dichotomous Use of P-Values

In 2019, I encountered a book *The Cult of Statistical Significance: How the Standard Error Costs Us Jobs, Justice, and Lives* by Stephen T. Ziliak (a professor of Economics) and Deirdre N. McCloskey (a professor of Economics, History, English, and Communication). They have fought to debunk scholars' claims of statistical significance. After reading this book, I sensed a need to talk about the dichotomous use of p-values. Ziliak and McCloskey (2011) critiqued statistical significance as scientifically false by saying:

Statistical significance is, we argue, a diversion from the proper objects of scientific study. Significance, reduced to its narrow statistical meaning only, has little to do with a defensible notion of scientific inference, error analysis, or rational decision making. (p. 2)

The problem we are pointing out here...is well known by sophisticated students of the matter and is extremely elementary—...by using Fisherian methods some of the putatively quantitative sciences have slipped into asking qualitatively *whether* there exists an effect [i.e., statistical significance] of Catholicism on national economic backwardness. (p. 4)

Here the co-authors were addressing that scientists should use their own expertise to decide the effectiveness of research intervention or treatment instead of using statistical significance as it is “the way” (almost the only way for modern quantitative researchers) to claim the effectiveness of the research intervention. Ziliak and McCloskey (2011) further argued that academics have promoted this fallacy by explaining:

How much energy did the crashing of the Indian subcontinent contribute to the raising of the Himalayas? How much did foreign trade contribute to the British industrial revolutions? How much genetic material is transmitted to the next generation? But medicine, economics, and some other sciences have stopped asking how much, especially in their academic...work. Or to be more exact, they believe they are interested in the quantitative questions of what this or that number really is in the world. But their way of deciding what that number really is—statistical significance or insignificance—and what difference it makes—doesn't give them the correct answer. (p. 7)

By writing “...some other sciences have stopped asking *how much*, especially in their academic...work” (Ziliak & McCloskey, 2011, p. 7), the co-authors above argued that only looking for p-values smaller than 0.05 or 0.01 to claim the research intervention's effectiveness has caused researchers to stop asking *how much* statistical inference examined by other statistical tools (besides p-values) could help them determine the effectiveness of the research interventions. Statistical tools like confidence intervals, effect sizes, or descriptive statistical data also could help researchers decide *how much* information based on their academic expertise to assess the effectiveness of their research interventions. In other words, as in the quote above, Ziliak and McCloskey (2011) argued that only looking for p-values smaller than 0.05 or 0.01 to claim the research intervention's effectiveness has led researchers to become too reliant on p-values' function in statistical inference to be aware of the issues of using them, thus, making the fallacy

worsen. This fallacy is using only statistical significance to claim the effectiveness of the research intervention. It is also called by this study *the dichotomous use of p-values*, which is planned to be relearned and deconstructed in this dissertation.

Motivation and Purpose

In 2008, in Taiwan, I was determined to be a bilingual language teacher who would travel the globe teaching languages, then one day I would become a linguist. I was younger and my future smelled like the combination of Starbucks and Hollywood movies—promising and global. No one warned me that being a linguist meant learning statistics. One morning, I finished my breakfast and took a 30-minute bus ride to my graduate department. The walk to my 10th-floor graduate department from the bus stop was usually muddy, humid, and full of pedestrians—a normality in Taipei’s streets. The sky kept drizzling. Finally, I got to the classroom without losing my vibrant mood due to the crowd (I used to suffer from fear of being in large crowds). I arrived 40 minutes early so that I could have some time to preview the textbook. I opened the textbook and saw some mathematical formulas describing the bell curve, z-scores, standard deviation, and so on. They literally “took my breath away.” I started feeling that I could not breathe well, and my head started pounding:

“You are doomed!”

“What are you getting yourself into?”

“This is a trap!”

“You are going to fail this class.”

I could not preview. I was trying to breathe. My whole head during the first class was all “math, math, math, math, math, math, and still math.” The professor was talking about math. The

only thing said by the professor that my mind was able to remember was, “Memorize these formulas, and next class we’ll have a quiz.”

Going Deeper Into My Fear of Statistics

“A math test! I thought this was a research method class!” I said to myself.

“I do not remember a lot of math formulas. Do I need to find a math tutor? But I don’t have time and money to do that. My time is occupied with my work and study.”

“Other Chinese students in class look so smart and confident in statistics. Darn it. Here it comes again. Something comes out from inside of me, and I know that later I will have to deal with this. Suppressing it only makes it worse and bigger.”

I remembered! I know what that thing is! I am still dealing with it now as an almost 40-year-old Indigenous woman. I am dealing with it better and able to recover more quickly than when I was in my 20s. The aforementioned thing that came out was a dark claw lurking under the quiet water of my consciousness. This dark claw still exists nowadays under my consciousness. I have never seen its face. I have never seen its body. I do not know if it is a monster, dragon, or bear—and not Yogi Bear. I cannot recognize what it is in full, but I know its claw.

I started recognizing its claw when I was really young—when I was about six years old. When it emerged, it dragged me under the quiet water of my consciousness, then my quiet consciousness became an emotional storm ferociously swirling and sucking all optimistic hope in me into its stomach and left only a vacuum releasing a vapor of loneliness, hopelessness, weakness, and timidity. The claw would keep dragging me down into its guts while my emotional storm continued whirling and telling me:

“Why are you here in this world?”

“You are disgusting.”

“Aren’t you worthy of anything?”

“You have nothing.”

“You don’t deserve anything good.”

“You will not have anything.”

“You are poor.”

“You are nothing.”

“I am going to devour you! You are just a piece of cake.”

When the storm came, I was scared and often shuddered at the repeated unpleasant surprises. I did not understand. I was afraid of telling anyone about this. If I told anyone, they would know that I was nothing and weak. Only my tears could fill this vacuum and bring back hope, joy, and strength. I still vividly remember while growing up that whenever this claw came out with the storm, later that night, after being put to bed, the vacuum and the fear would be too huge to bear; thus, great sorrow appeared. After the great sorrow, I started weeping inside my blanket. Mom and Dad could not know this because I wanted them to think that I was strong. Mom was such a strong woman growing up. She kept telling me that I should be as strong as her. Telling her about my fear (the claw) would make her laugh at me.

The claw has emerged beneath the surface of my consciousness for many years. It still lurks in my life. It took me longer and more energy to manage it when I was younger. Now, in my late 30s, it takes me a shorter time to gain hope and joy back, but I still fear it. I fear it as I fear the emotional storm that comes with the claw. Whenever the storm twirls, it roars with memories of anger and sadness toward many things unfair in my life such as the following:

I Was an Elementary Student Chatting With Dad at Dinner

“Ching, you have done a great job! You got the best GPA this semester among your Chinese peers. You are the only Indigenous student among them. Keep studying hard! We are Indigenous. We might not be smarter than the Chinese, but we can work harder to prove that we could be better than them,” said Dad.

I Was 11 Years Old

“Young girl! Are you ‘indigenous’?” An old guy asked me when I was at the intersection waiting for the traffic light after school going home one day.

“Yes! Why?” I responded to him.

“Okay! So how much do you charge for a night?” he asked.

“I don’t understand what you mean!” I walked away!

Mom, Cake Factory in Summer, Math, College Entrance Exam, and the High School Me

After I had just graduated from high school, one night in the Summer when I worked at a cake factory to earn my college tuition, my mom warned me,

“The College Entrance Exam is coming next month.”

“Yeah! I know! But I am so tired. Today I worked extra hours. Do you know that I worked from 8 AM to 9 PM? I am really tired now. Could we talk about this later?” I said grumpily.

“Your math is so bad, I am afraid your math points will drag your whole exam grade down so that you might not get into a good national university. A good national university’s tuition is cheaper! Everyone in our community knows that you always have good grades, so don’t let us down. Don’t make me ‘throw my face’ (a Chinese saying expressing for ‘lose face’).”

“I know! But I am tired! I don’t want to talk about this now.”

“You’d better get a good exam grade so you can go to a good national university; otherwise, you should just work in the factory for the rest of your life. I don’t have money to pay for your college. And you know we Indigenous peoples....” Mom kept shouting.

“I know! We Indigenous peoples do not have money to go to an expensive private school, and if I go to a reputable national university, I can prove that we Indigenous peoples could be as good as the Chinese. I know! You’ve said this eight thousand times!” I shouted back, then returned to my room and slammed the door.

“I know my math is bad! I know I am not smart! I know I should study harder! But I am really tired now! I am trying really hard! I know we are Indigenous! I know we don’t have a lot! I know we will never have a lot! I know we are poor! I know we get screwed by the Chinese! I know that the Chinese have everything! I know that the Chinese are the better ones! I know you are not happy with me! I know you think I am such a pain who never listens to you! I know you think I am ugly! I know you wish that I could look as pretty as Chinese girls so I could marry a doctor or a lawyer, not worrying about money again! I know you think I am too fat, and my skin is too dark! I know you wish your life would not be ruined by my birth! I know I make your life harder! I know you think that I am dumb! I know that you wish that my math could be better so I could get a scholarship to a better school, then you could ‘walk with the wind’ (a Chinese saying expressing ‘being proud of someone’)!” I shouted back to myself and Mom—quietly.

Fear of Math, Statistics, the Dark Claw, and My Emotional Storm

I fear the dark claw that accompanies my emotional storm. It makes me feel small and hopeless. And I am afraid of this feeling telling me that I am worthy of nothing and that my life

is not worth living. But I like my life, and I don't want to not live it. I fear the storm because it goes against my motivation and gratitude for life, and fighting it makes me restless. I am not afraid of fighting, but I am afraid of when my emotions push me into despair by yelling:

“Don't try anymore! You are nothing! The world is always going to be this unfair! No need to fight! Just let it be! Go with the flow! There is no hope to fight! You are always an 'indigenous' woman! No one will really listen to you, even your own tribe! They cannot even listen to themselves! We can try to prove that we are just as good as others, but the world is going to think forever that we are just the 'indigenous'! Don't try so hard! Let it be! Let your life rot, and you might find true freedom!”

My fear of statistics was derived from my fear of math as my fear of math revealed my hopelessness in the emotional storm mentioned above. If I were not fond of love, hope, and joy, I would not fear hopelessness. What statistics often reminded me of was not the fear itself; it was the memories twirling in the emotional storm alongside the dark claw that instigated my fear. This fear told me that I was so small, timid, weak, hopeless, and unintelligent. If the claw would have never come out again, I might not fear statistics, but I never knew when it would reemerge.

My Questions About Statistics

In the first year of my Ph.D. studies, I asked why the normal distribution is bell-shaped. In the second year of my Ph.D. studies, I asked why we have to use hypothesis testing in most quantitative research. In the third year, I wondered why the p-value for rejecting the null hypothesis is set at 0.05 in most research in social sciences. Early in the fourth year of my Ph.D., I realized that I had taken all the graduate statistics courses offered by our department, and I still had many questions and fear about statistics that still sometimes made me feel dumb and might summon *the dark claw* again.

In 2019, in Professor A's statistics courses, some questions were answered, but my primary focus shifted to questions about the p-value's 0.05 threshold. While learning that it was misused in research in science and the social sciences, I started having more tangential questions:

“Why did we always use p-values this way?”

“Why didn't my professors in my first graduate program tell me not to make this dichotomous decision?”

“Why did they make me feel that it was too intellectually challenged for me to understand statistics?”

“Why did they only teach me to just memorize math formulas for statistical problems?”

“Why did they tell me to not ask too many questions about foundational theories in statistics, saying that it was just wasting my time?”

“Why did my dear friends who were becoming experts in quantitative research tell me to be practical and stop asking why we had to make hypotheses (‘These are just the basics of quantitative research,’ they said)?”

“But I cannot do hypotheses if I cannot fathom why we need to,” I screamed to myself.

“Why does the confidence interval need to be checked with two tails?”

“Why tails? Why do we have to put our samples, usually behaviors of human beings, into tails? Statistically speaking, when our samples are in the zones of ‘tails’ on the graph of the bell-shaped distribution, it means that the behaviors of our samples are either, in particular, ‘bad’ or ‘good’ compared to the average zone (the 68.26% zone).”

“Could we just all be in the 68.26% zone? Being in the 68.26% zone addresses that our research samples, certain human behaviors, are within \pm one standard deviation (meaning

that our samples, certain human behaviors, are averagely fine). But could it be just no zone at all? Could human beings not be evaluated by the normal distribution?"

I talked to Professor A in 2019 again about my questions mentioned above, and he commented that I was, in essence, questioning the dichotomous use of p-values as I was struggling with the following concept: Why does a research treatment have to be considered effective only based on whether the p-value is below 0.05, which is related to a zone that is outside of the confidence interval of 95% of the population?

Purpose of the Study

The purpose of this study is twofold that I would like to share. First, I would like to share how my learning and exploring the dichotomous use of p-values help me overcome my fear of statistics. Second, I would like to share how my meaning-making of the dichotomous use of p-values shows inequities in society as these inequities not only impact other lives but also mine. How do these inequities impact my life as a graduate student in academia (e.g., statistics is science, statistical inference can find the truth, p-value smaller than 0.05 or 0.01 means research is significant, etc.)? Well! For the starter, inequities from the dichotomous use of p-values in the quantitative research world made me feel dumb. They made me feel that I was not good at math as a Taiwanese Indigenous student. They made me fear statistics because whenever I tried to figure out some mathematical formulas in a statistics textbook, my confidence sank and shouted:

“You are such a dummy in the world!” I said to myself.

Like my mom said whenever I could not solve a math problem:

“I know it’s hard for you! It’s not your fault. We Taiwanese Indigenous peoples are just not as smart as the Chinese peoples.”

“Are you saying that being smart means being good at math, Mom?” I murmured inside my head at the age of seven.

Epistemology: Indigenous Critical Theories (ICT)

I am Indigenous. In this study, I use Indigenous critical theories (ICT) because it influences my epistemology. The idea is *challenging the language of mastering (claiming) knowledge* (Justice, 2016). It offers me a framework as a Taiwanese Indigenous American to explore my learning the knowledge of p-values. This idea of ICT aligns with my Indigenous ways of knowing as a Taiwanese Indigenous woman drawing upon what my grandma said. She said that the strongest and smartest Tayal woman is one who learns the world (various kinds of knowledge) to share, love, be kind, and be flexible to appreciate one another’s value and ability instead of possessing things, being cold, being proud, and strictly judging each other’s achievements.

Discussing my learning of the dichotomous use of p-values by using the idea of *challenging the language of mastering (claiming) knowledge* (Justice, 2016), this study explores the norm of a research practice, the dichotomous use of p-values, whereby the Western science and academia predominantly values empirical research that can claim knowledge as its possession.

Scholars and theorists of ICT strive to challenge traditional Western thinking of mastering knowledge for owning or possessing it. They have made efforts to officialize their inquiry of problematizing mastering (claiming) knowledge in academia. Daniel Heath Justice (2016) wrote in “A Better World Becoming” by explaining this inquiry:

But in the academy I think we have elevated the concept of understanding without also insistently holding up humility as its counterpart. Many of us tell our students—and ourselves—that “mastery” (a problematic term) of a subject is the goal, but we forget or choose to ignore that the more familiar we become with any topic, the more mystery will

be revealed.... The language of mastery (and, too often, of understanding itself) is etymologically and ideologically language of domination; it is the language of knowledge as biddable possession, as subjugation, as exploitation. To base understanding on stripping bare the mysteries of human experience is to treat knowledge as something that one person or one culture takes from another. (Justice, 2016, pp. 22-23)

Justice's (2016) idea of challenging the mastery (claim) of knowledge is guided by many Indigenous peoples' ideas about *place*—centering ourselves in various ways of learning, like what Chadwick Allen's (a transnational Indigenous theorist) has caveated about global comparative frameworks' infringement upon Indigenous local place by making the Indigenous place marginal:

Many Indigenous intellectuals, inside and outside the dominant academy, are understandably wary of global comparative frameworks for Indigenous studies—literary, cultural, or otherwise—when there is so much work still to be done within specific, distinct traditions and communities.... The local, having finally won a place at the academic table, becomes engulfed (once again) in the name of the global. Perhaps more so than their non-Native colleagues, some Indigenous intellectuals wonder how a single scholar or even a small group of scholars can possibly know enough to bring together multiple Indigenous literatures emanating from multiple distinct cultures and histories on a truly equal basis. If together equal is the primary goal, they ask, what kind and what quality of scholarship can be produced? Whose interests can it serve? (Allen, 2012, p. xiii, as cited in Justice, 2016, p. 21)

While Allen (2012) said, “The local, having finally won a place at the academic table” (p. xiii), he also caveated that the studies of local academics were likely to be used in the name of the global. When Justice (2016) stated, “The language of mastery...is etymologically and ideologically language of domination; it is the language of knowledge as biddable possession, as subjugation, as exploitation” (p. 22), he reminded Indigenous scholars to be aware of the etymological and ideological domination that is expressed by the language in their academic works, and this might allow the Indigenous works to be colonized again.

I extend Allen's (2012) caveat and Justice's (2016) statement to argue that when local studies are expressed with global language, local elements tend to be jeopardized, indigeneity

then is still exploited by colonialism in the name of globalization. I further argue that Indigenous works are especially likely to become biddable, possessed, subjugated, and exploited through Western academic scrutiny. As Western academic scrutiny is essentially and naturally endowed upon the power of assessing (judging) knowledge production by extracting information from others, any Indigenous academic work that contains *opacity*⁴ (Linder & Stetson, 2009) and uncertainties could be crucified by Western academia. Therefore, I argue that we want the autonomy to remain our right to exist without constantly explaining to non-Indigenous peoples why we exist and why we perceive and approach things in ways that are different than the non-Indigenous. I also wish that we did not have to constantly reveal everything about the Indigenous thoughts just to prove to non-Indigenous academics how and why the ways we are different. If we Indigenous scholars capitulate to colonial ways and give up our rights of maintaining opacity in our academic works, on one hand, we could make our works better fit into Western ways of knowledge assessment; however, on the other hand, we then might need to bear the consequence of losing the essence of our Indigenous ways of knowing, learning, and doing things.

Allen (2012) and Justice (2016) were asking Indigenous scholars to locate ourselves at the center of the knowledge we learn and study by maintaining the essence of our Indigenous ways of knowing and not giving up our rights to opacity (at least to maintain our Indigenous human rights to not be dissected and anatomized in a 100% transparent way in Western academia). However, I share the pain of Allen (2012) and Justice (2016) as I have, most of the time, become entrenched in Western academia, and sometimes I compromise and give up my rights to express my Indigenous ways of knowing in doing and writing research. It is easy for me

⁴ Containing *opacity* (having a autonomy to not explaining everything to the non-indigenous) for Indigenous scholars means that we choose to not disclose all the aspects of our rituals, practices, and beliefs to the academic world just for the sake of non-Indigenous voyeurism (Linder & Stetson, 2009).

to compromise as often we graduate students are considered babies in academia. If we want to maintain our opacity, not because we cannot explain, but because we wish to hold onto something essential in us (e.g., our Indigenous ways of knowing), we are considered immature in doing “academic work.” Professors change our sentences because they might need to conform to Western academia as well, or they just think we are not scholarly enough (not to mention English is my second language, and I definitely will be scrutinized on another level—“Are you sure you are writing this right in English?” Professors ask). Graduate students are not grown enough to maintain opacity. I get it! Many professors have told me that as long as I get that Ph.D. title, peoples will start listening to me. “Maybe! But I am still an Indigenous woman, and English is not my first language! My academic works in Western academia will still be scrutinized by intersectional layers of Western academia’s objectivity based on colonial, White, heteropatriarchy standards that do not embrace Indigenous ways. Also, global and imperial endowment upon Standard English, as it is the only representation to communicate (as opposed to World Englishes⁵), would tend to overlook the academic articulation of researchers whose English is their foreign/second language simply because their English might not appear in the list of “Standardized-English” such as American English, British English, and Australian English (Lin, 2020; Schreier et al., 2020). Whatever it is, it still doesn’t sound right! I murmured these things, but the professors never know my thoughts. My point is not that I want to be considered a

⁵ The term World Englishes (or World English) refers to a concept that English is used variously throughout the world, and its varieties in grammars, sentence patterns, words, etc. contain as many linguistic and communicative values as the so-called Standard English that colonial ways of English education have taught the world. Theorists and advocates of World Englishes (WE) critique colonial ways of treating Standard English (SE) as the only “standard” (e.g., American or British English) when assessing English writing and communication in English standardized assessment and academic writing. WE theories do not emphasize the idea that whose English (different from American or British English) contains “accents” like SE theories do. WE theories consider various Englishes have their own authenticity to claim their linguistic rights without being considered “subsets” and “different accents” of English, including Banglish English, Caribbean English, Chicano English, Chinese English, Hinglish, Nigerian English, Scottish English, Taglish, Taiwanese English, and Zimbabwean English, etc. (Schreier et al., 2020).

big shot or even heard by all in academia, but I do want to highlight how inhumane and colonial it could be when Western academia operates. I am just showing the propensity of colonial academia's ironic disinterest in open thoughts, original ideas, and flexible administrations from peoples outside of the status quo. Thus, when assessing someone's achievement, the system of higher education wants to certainly tell us that it is about being objective and "No offense, it's just business!" But it obviously ignores that it is often subjective with human preferences, politics, and selfishness.

Here is an example of the evolvment of the irony of the education paradox. Ronald Fisher, one of the important White European mathematicians who influenced statistics to revolutionize science in doing research, never was clear about what p-values calculate (Salsburg, 2001), yet Western academia has deemed him too intelligent to be understood. Therefore, p-values are still predominantly used in science and the social sciences to decide the effectiveness of a research treatment or intervention (Fidler, 2005; Salsburg, 2001). Ronald Fisher is deemed scientific and intelligent so his long-lived opacity is academically great; whereas, an Indigenous scholar could be considered only anecdotal when they try to register opacity to respect their Indigenous knowledge (Linder & Stetson, 2009).

"Is it not a paradox?" I asked myself, rhetorically!

Therefore, Allen (2012) and Justice (2016) encouraged Indigenous scholars to place themselves at the center of the knowledge we learn to endow honor, respect, and credence upon our Indigenous works because colonial academia will not do this for us. For Justice (2016), asking Indigenous scholars to ponder how to locate our *places* when researching our methods, questions, cultures, histories is to encourage Indigenous scholars to use our indigeneity to counter Western academia's imperialism and colonialism that possesses the knowledge of the

world. Such Western imperialism comes from stealing and pillaging our Indigenous lands, breaking our treaties, disrespecting and killing our peoples and destroying our ways of living, thinking, and being. Yet, we survive and we must thrive via our Indigenous ways.

Also, Justice (2016) asserted that Indigenous scholars must challenge the mastery (possession) of the knowledge that colonial academia considers the best way to acquire knowledge. Similarly, when my grandma talked about Chinese colonial possession of our land in Taiwan and the education of the Republic of China, she addressed that they brainwashed the Taiwanese to believe that Chinese culturalism (Chinese ways of doing things) is “the” knowledge”, “the civilization”, and “the glory” that should replace Taiwanese Indigenous peoples’ “barbaric cultures”, “practices,” and “anecdotes.”

With Justice’s (2016) idea of *challenging the mastery (claim) of knowledge* and my Indigenous ways of knowing mentioned above, I explored my own reflexivity of learning the dichotomous use of p-values in this study. Therefore, my meaning-making of the inequities generated from the dichotomous use of p-values not only reveals the possessive traits of how dominant society uses p-values but also illustrates how I overcome my fear of statistics as I place myself at the center of my learning of the p-values. By overcoming my fear of statistics (more precisely, overcoming my fear of the dark claw lurking beneath the surface of my consciousness), during the process of this dissertation, I have learned to assert myself amid others’ contributions, especially the contributions of my Indigenous peoples. This assertion is a new way of overcoming my fear of the dark claw that accompanies each emotional storm. It used to be my shuddering tears that washed away the fear. Now, this assertion empowers me to believe that I might be as intelligent as the Chinese or that there need not be a comparison because this kind of comparison is colonial—a *master’s tool* (Lorde, 1984) that dismantles the house.

Research Questions

My story, my truth, and my heart in learning through this autoethnography helped me know how I could overcome my fear of learning statistics by placing myself at the center. I asked four research questions to find my meaning-making of inequities generated from the dichotomous use of p-values. The four research questions focused on my experience in learning the history of statistics, statistical inference, p-values in the literature, and the statistics courses I attended from 2018 to 2021.

1. How do I make meaning of the dichotomous use of p-values in the statistics courses I attended?
2. How do I make meaning of the dichotomous use of p-values in the literature of this study?
3. How do research questions 1 and 2 help me address inequities discussed in this study as an Indigenous woman researcher?
4. How do research questions 1, 2, and 3 help me overcome my fear of statistics?

Chapter Summary

Grandma! Thank you for teaching me our Indigenous way of knowing: The strongest and smartest Tayal woman is one who learns the world (various kinds of knowledge) to share, love, be kind, be humble, and be flexible to appreciate each other's value and ability. My mom, dad, uncles, aunts often say that I am like you—always learning. Your colonial language is Japanese, and mine is Mandarin. I never learned Japanese when you were still here with us (as Dad, your dear son, hated Japanese), but you learned Mandarin to talk to me. I remember that I was the only person who you invited in the family to your college degree commencement. You were 90 years old, and I was 17 years old. I was so proud of you, and I could tell you were so proud of

yourself, as well. I now know why I was the only grandchild who you invited to the commencement. You wanted me to pursue higher education—higher and higher! Colonialism could give us the degrees we want to pursue, for the sake of learning or surviving, but it could not take away how we learn the world and how we resist all the greed and possession that takes over the world in the name of civilization. Grandma! This dissertation is about how I learned statistics, how I learned p-values, and how I countered the dominant narrative of doing quantitative research. I know you were not interested in statistics, but I know you would care about inequities if you were here with me. You sewed, planted, harvested, learned, and you survived. I am like you: I studied, I studied, studied, learned, and I survived. Grandma, I know I often am lost in this academic world and forget about the essence of learning like you. But, Grandma, could this dissertation be my Tayal facial tattoo?

CHAPTER TWO: LITERATURE REVIEW

I used autoethnography as the methodology, and I referenced Indigenous critical theories (ICT) as the epistemology because it aligned with my positionality of being an Indigenous woman researcher and graduate student. I wrote this literature review in a conversational and storytelling manner as this can accentuate this study's self-reflexivity (Adams et al., 2015). Also, I employed ICT's emphasis on storytelling and narratives when conveying my meaning-making and analysis of the literature discussed in the study.

Literature in Statistics and Recollections of Dialogues in Stories as Primary References

Before this autoethnography was designed as my dissertation study in 2021, I had been making notes about my learning of p-values in the graduate statistics courses I attended and audited in my doctoral program; therefore, many of my dialogues and stories in this study reference these notes. The conversations or stories in this literature about my stories are not direct quotes but facts of my recollections as best as I remember them.

How I made meaning of the dichotomous use of p-values was heavily grounded in the literature. Many scholars who challenged the dichotomous use of p-values focused on analyzing p-values' mathematical and statistical logistics (Gill, 1999; Sawyer & Peter, 1983; Wasserstein & Lazar, 2016); whereas, I used my conversations with the literature to share a sociological side of the dichotomous use of p-values (Goodman, 2019).

In 2018, I learned the dichotomous use of p-values (using statistical significance) by studying the history of statistics because I wanted to know why using p-values was so important to science and the social sciences. Exploring this led me to understand the historical background of why the dichotomous use of p-values became so prevalent.

One afternoon in 2019, a professor in the Department of Statistics at my university came to Professor A's statistics class as a guest speaker to speak about the misuse of p-values. He mentioned that the Department of Statistics was hosting a book club and we were welcome to join. The book he mentioned was *The Lady Tasting Tea: How Statistics Revolutionized Science in the Twentieth Century* by David Salsburg (2001). This study club was not, specifically, for discussing p-values; the guest professor just happened to mention it. I could not join the study group due to a schedule conflict. But the book's name was intriguing to me. I bought it and read it because I wanted to know how and why p-values were invented and used in science and the social sciences. The book was written by an accomplished statistician in Pharmaceutical Science, David Salsburg (2001). He illustrated the history of how statistics took on an imperative role to revolutionize scientific experiments. He described the process of how scientific experiments were conducted from ways of using idiosyncratic observation to ways of employing abstract mathematical measurements developed from mathematicians and statisticians such as Karl Pearson, Ronald Fisher, Jerzy Neyman, and William Sealy Gosset in Europe.

A Brief History of the Use of P-Values

Before the 19th century, doing science was like doing observation with a philosophical belief that “there was a small number of mathematical formulas...that could be used to describe reality and to predict future events” (Salsburg, 2001, Location No. 115). Around that time, most scientists believed that the discrepancies between the observed scientific experiments and the predicted were errors because if everything was determined, then these errors might eventually diminish if more precise measurements were used; however, “...by the end of the nineteenth century, the errors had mounted instead of diminishing. As measurements became more and more precise, more and more errors cropped up” (Salsburg, 2001, Location No. 133).

I was surprised to learn that, before the 19th century, science and statistics were not sharing the same philosophy when doing research. During that period, scientists conducted experiments by observation to discover the truth; whereas, statistics were created by mathematicians who critiqued scientists' ways of doing experiments as too anecdotal (Salsburg, 2001).

See! I knew it! Statistics are about math.

After all, I grew up in a place where teachers told us that science could be the ultimate way of finding truth and that statistics and mathematics were the scientific tools that could help us find the truth. In other words, we were taught that anything considered or called scientific was “the best” way and “the best” knowledge; therefore, mastering the tools of sciences (i.e., mathematics and statistics) was paramount to being smart. Well, I used to think that I was not smart because I was not good at mathematics and statistics. One might say that they do not disagree, thinking that I am just being entirely honest. One might think that I am good at math and statistics; I just insisted on truly understanding the processes involved. Still, these comments could not make me feel I was intelligent in math and statistics.

At first, it was difficult for me to keep reading this book because I hated reading anything related to math, and Salsburg (2001) kept talking about how great those mathematicians were when they laid the foundation of statistics via mathematical theories.

“Math, math, and math again! Seriously, I can't seem to escape it,” I murmured in my mind.

Before the 19th century, analyzing statistical distribution (the foundation of understanding p-values) was not considered a scientific problem, nor did the use of mathematical probability become a theoretical formula for scientific research's measurements of a statistical distribution

(Salsburg, 2001). However, according to Salsburg (2001), Ronald Aylmer Fisher, a mathematician who graduated from Cambridge, built the foundation of the statistical revolution that transformed how all fields of science designed experiments in the first half of the twentieth century (at that time, scientists started using statistical tools to design and assess scientific experiments instead of only using observations as they had previously done). Ronald Fisher also invented mathematical formulas for calculating p-values. Ronald Fisher's book, *The Design of Experiments* (Fisher, 1966), revolutionized all fields of science by transforming how scientists conduct research (from doing idiosyncratic observation to primarily using statistical methods to collect and analyze the data). Salsburg (2001) explained this transformation:

Long before Fisher came on the scene, scientific experiments had been performed for hundreds of years. In the later part of the sixteenth century, the English physician William Harvey experimented with animals, blocking the circulation of blood as it flowed from the heart to the lungs, back to the heart, out to the body, and back to the heart again.... Until Fisher, experiments were idiosyncratic to each scientist. (Location No. 228)

As a consummate mathematician, Ronald Fisher's analyzing various kinds of data on the fertility index, rainfall, and crop yield led him to conclude that "...the scientist needs to start with a mathematical model of the outcome of the potential experiment" (Salsburg, 2001, Location No. 267). Fisher later discovered the analysis of variance, which became the basic theoretical framework, for randomized experiments⁶ in science (Salsburg, 2001). However, Fisher did not establish all this out of nowhere. Most of his mathematical and statistical theories were based on Karl Pearson's achievement of the Pearsonian revolution—"...the idea that the 'things' of science are not the observables but the mathematical distribution functions that describe the

⁶ Gliner et al. (2017) defined *randomized experiments* via the term *randomized experimental designs*: "Remember that...in randomized designs the *participants* are randomly assigned to the experimental and control groups. Random assignment of participants to groups should eliminate bias on *all* characteristics *before* the independent variable is introduced (pp. 79-80).

probabilities associated with observations” (Salsburg, 2001, Location No. 500). Salsburg (2001) attributed Pearson’s contribution between science and statistics to the following event:

“Pearson’s ideas about distribution functions and parameters came to dominate twentieth-century science and stand triumphant on the threshold of the twenty-first century” (Salsburg, 2001, Location No. 509). However, Salsburg (2001) later claimed that Fisher’s invention of p-values, based on Pearson’s contribution to the concept of distribution functions and parameters, became the most influential mathematical tool to evaluate most research and experiments’ statistical inference in modern statistics, science, and the social sciences.

Statistics Is Not Only About Objectivity as Science Claims but Also Subjectivity

Returning to Fisher’s achievement, his influential book *Statistical Methods for Research Workers* (Fisher, 1925, 1928, 1954) played a vital role in influencing scientists to employ statistical analysis widely as described by Salsburg (2001):

The text, *Statistical Methods for Research Workers* was like no other mathematics book that had appeared before it. Usually, a book of mathematics has theorems, and develops abstract ideas and generalizes them, relating them to other abstract ideas. If there are applications in such books, they occur only after the mathematics have been fully described and proven. . . . *Statistical Methods for Research Workers* begins with a discussion of how to create a graph from numbers and how to interpret that graph. The first example, occurring on the third page, displays the weight of a baby each week for the first thirteen weeks of life. That baby was Fisher’s firstborn, his son George. The succeeding chapters describe how to analyze data, giving formulas, showing examples, interpreting the results of those examples, and moving on to other formulas. None of the formulas is derived mathematically. (Location No. 706)

Even though many mathematicians considered this book lacking theoretical mathematics, it was “...rapidly taken up by the scientific community” (Salsburg, 2001, Location No. 706). Afterward, a Swedish mathematician and statistician, specializing in mathematical statistics, Harald Cramér,

published the book *Mathematical Methods of Statistics*⁷ (Cramér, 1999) to offer theoretical proofs that Fisher (1925, 1928, 1954) did not explain regarding p-values' formulas.

Reading this, I thought that even though areas like science and statistics could be considered objective, their history shows them to be quite subjective. For instance, no matter how objective Fisher's great work could be considered as a canonical contribution to building the foundation of statistics in history, his work still needed to be interpreted and published by another mathematician to be accessible to most scientists wherein subjectivity might be involved in the process.

Thinking about this, I wondered what our scientific research's statistical methods would have become today if Harald Cramér had not helped to interpret and develop Fisher's work for general science readers. Could we be able to *not* use the statistical significance now?

"Even so, you still need to deal with math, Hsiao-Ching," I said to myself.

"Damn it!"

Salsburg (2001) also believed that Fisher's achievement mentioned above could be attributed to his dedication as a geneticist and his participation in the eugenics movement at the time. Whereas another prominent figure in the history of the statistical revolution, Karl Pearson, did not let his political stance (influenced by the theory of Karl Marx) have much effect on his mathematical contributions. Fisher allowed his political stance (eugenics theories) to drive him to studiously analyze, develop, and revise mathematical formulas for statistical analyses (Salsburg, 2001).

He joined the eugenics movement and, in 1917, published an editorial in the *Eugenics Review*, calling for a concerted national policy "to increase the birth-rate in the

⁷ Harald Cramér (1999) expounded mathematical methods of modern statistics in this book. This book explains the development of statistical inference, including Ronald Fisher's intervention of p-values. It also explains how probabilists transformed the classical calculus of probability into a mathematical theory.

professional classes and among highly skilled artisans” and to discourage birth among the lower classes. . . . Fisher’s politics contrasted with the political views of Karl Pearson, who flirted with socialism and Marxism, whose sympathies lay with the downtrodden, and who loved to challenge the entrenched “better” classes. Whereas Pearson’s political views had little obvious effect on his scientific work, Fisher’s concern over eugenics led him to put a great deal of effort into the mathematics of genetics. (Salsburg, 2001, Location No. 678)

How can we be sure that statistics and science are all about objectivity? The story above clarifies that research is completed by human beings who bring their socio-political views and epistemological subjectivity into their work. Fisher not only let his political and personal support for the eugenics movement of the time to influence his development of mathematical theories, but he also utilized his own child in his research, an overtly biased and subjective choice for a participant. Still, his brilliant yet misguided efforts revolutionized science—forming the foundation of statistics.

Statistics’ Subjective Contribution and Racist Eugenics

Learning Fisher’s contribution to fields of mathematics, science, and statistics, I thought about how research stems from the sanctioned racist eugenics movement, yet Fisher is hailed as the father of revolutionary mathematical research. As racism evolved, educators and researchers continue to be impacted by this history of racism, and understood as epistemological racism (Scheurich & Young, 1997, p. 12).

In 1997, Scheurich and Young stated:

One of the worst racisms, though, for any generation or group is the one that we do not see, that is invisible to our lens—the one we participate in without consciously knowing or intending it. Are we not seeing the biases of our time just like those a hundred years ago did not see the biases of their time? Will those who look back at us in time wonder why we resisted seeing our racism? (p. 12)

Furthermore, Fisher’s intelligence in mathematics (math again!) and contribution to statistical inference did let the field of statistics revolutionize the field of science—making

quantitative measurement the gold standard of validating scientific research. This let me understand a little bit of why using statistical inference, especially using p-values, coming from Fisher's theories of statistical inference, could become canonical teaching in science and statistics.

Statistics Is About Math for Me

Canonical teachers in science and statistics have educated researchers that Fisher's mathematic formulas could validate the science of the measurement (Goodman, 2019; Salsburg, 2001). While this teaching has been popularly received and believed, it is a fallacy to believe that a p-value smaller than a certain number could predict the effectiveness of a research intervention (Fidler, 2005; Goodman, 2019; Salsburg, 2001; Ziliak & McCloskey, 2011).

"I knew it! It's math again! I am telling you, Hsiao-Ching. You cannot escape it," I said to myself.

"No wonder I feel dumb all the time," I replied.

"The world tends to tell us that math could solve issues in science, and science is the smarter way of living and understanding (at least in the colonial places I live in)."

"I told you, Hsiao-Ching Lin, being smart is being good at math," I concluded.

After reading the aforementioned history about statistics, I sensed how inequities might be generated from the dichotomous use of p-values due to two principles that science would like us to emphasize: certainty and objectivity. Goodman (2019), a prominent statistician and scientist, believed that *different disciplines have different jurisdictions* and that *the use of p-values is a social phenomenon* (Goodman, 2019). Despite such assertions from a respected scientist like Goodman (2019), the field of science still predominantly uses statistical inference as if it is an objective truth. They still tell the world that statistical significance can provide

quantitative and scientific results (i.e., certain truth) and scientific suggestions (i.e., objective suggestions). Some disciplines might not be so absolute about the objectivity involved in statistical significance, but some disciplines might be. Goodman (2019) showed that the way researchers use statistical significance depends on different disciplines' jurisdictions such as different ontologies, epistemologies, paradigms, axiologies, methodologies, practicality, etc.

Misunderstandings of the Nature of P-Values and Inequities Generated From Them

Most scientists do not understand what a p-value really calculates. They do not decipher that it can only calculate the *assumed* statistical range of the research population parameter (Thompson, 1996). Ziliak and McCloskey (2011) explained that scientists' not understanding what p-values calculate started with their ignorance of the nature of p-values.

The Nature of P-Values and How They Are Misunderstood

Many statisticians (e.g., Fidler, 2005; Fisher, 1966; Wasserstein et al., 2019; Ziliak & McCloskey, 2011) have warned that *the nature of p-values* is a range of probability (0 to 1.0) that can *only assume* whether or not the research sample is derived from a population targeted in a research project (Thompson, 1996). Ziliak and McCloskey (2011) considered this nature of p-values more of a descriptive sample parameter than a numerical prediction. Also, "...no p-value can reveal the plausibility, presence, truth, or importance of an association or effect" (Wasserstein et al., 2019, p. 2). However, in canonical statistics education, a p-value is often taught to be a probability (i.e., a certain number) to predict if the null hypothesis is true (Agresti & Finlay, 2009). If the null hypothesis is true (for most researchers trained in statistics), it means that the research intervention is not effective. This canonical definition about p-values with the conception of the null hypothesis in most statistics education, if not further clarified, is one factor contributing to why researchers are misled to consider that a certain p-value number could

predict whether a research intervention works or not (Fidler, 2005; Goodman, 2019; Thompson, 1996).

Even though most scientists do not know what p-values calculate, they still use them as a social norm (e.g., having statistical significance means having significant research), and they tend to ignore that a p-value only displays a descriptive range of a sample parameter (Ziliak & McCloskey, 2011). Accordingly, when they use p-values while not knowing that p-values are more of qualitative descriptions than quantitative measurements, they are using a subjective method to decide an objective solution (e.g., if the research intervention/treatment works or not); thus, it could be unfair and unjust, inequities then come from this conflict (Ziliak & McCloskey, 2011). This conflict then has been promoted to claim that the research is significant due to its efficacy in establishing objectivity and certainty (e.g., giving an absolute quantitative number to decide a research intervention's effectiveness via a p-value's number).

It Is Not Equitable to Use P-Values and Teach Statistics as They Are Only Objective Numbers Derived via Abstract Concepts

After learning the history of p-values and how statistics education misguides researchers' use of p-values, I argue that the statistics that revolutionized science can be subjective, too. This subjectivity is apparent in how Fisher's contribution to the theories of statistical significance was influenced by subjective factors such as his personal political stance, academic dissemination of his theories, and the need for another mathematician to interpret Fisher's to-that-point unproven yet long-accepted mathematical theories. Therefore, the dichotomous use of p-values appears to be an inequitable thing to do because it is unfair to justify why a p-value's subjectivity could claim scientific research's objectivity.

This inequity is personal to me because the teaching in science and statistics predominantly used to teach me in an absolute way about math and statistics, and this caused me to feel self-conscious about math and statistics because I had trouble putting myself into the objectivity. For instance, I was having difficulties understanding why statistical distribution is crucial to the math formulas of p-values because I do not know where I put myself in the statistical distribution.

Further, I argue that using p-values and teaching statistics, as they are only objective numbers (through tremendously abstract concepts), is a form of research and epistemological oppression that has generated inequities for students like me. I do not fit the mold of fixed thinking generated by math, science, and statistics. This mold containing objective principles of thinking math, science, and statistics through extremely abstract concepts was too far-fetched for me. When I really learn knowledge, including understanding it and knowing how to apply it to my daily life, I learn it through hands-on activities and places that I can imagine myself in. For example, when I learned English in college, I imagined myself speaking English in Chicago, and English grammar, words, and sentence patterns were concrete enough for me to work on. Whereas, when learning math, science, and statistics in graduate school, I could not understand them concretely because math formulas in textbooks were too abstract. I did not know how to place myself in a statistical distribution graph, and the concept of the null hypothesis and alternative hypothesis in science education never taught me how to locate myself in them.

As I mentioned above, I tended to have a hard time understanding various aspects of math, science, and statistics. In other words, when I asserted my Indigenous ways of thinking (locating myself in the learned knowledge) that contradicted the objective and abstract nature of math, science, and statistics, my non-compliant ways of thinking were subjugated, minimized,

and condemned; thus, learning how to use statistics such as p-values tended to make me feel self-conscious and unintelligent.

The Use of P-Values May Cause Inequities and Research/Epistemological Oppression

I argue that the epistemology of emphasizing certainty and objectivity could generate inequities. One of the examples of these inequities is shown in my story mentioned above about how I felt self-conscious and unintelligent due to the math and statistics education I received growing up because I was taught that math's and statistics' assessments could objectively disclose the truth and solve problems. Therefore, I often thought that if my math and statistics were not good because I had hard times putting myself in the objectivity of math and statistics, then I could not be certain of truth and solving problems; thus, I felt more unintelligent and self-conscious of math and statistics compared to others who had been trained better at math/statistics (e.g., my Chinese peers growing up).

The dominant way of using p-values dichotomously generates research and epistemological oppression, thus causing inequities to society such as academic bias such as biased academic publications and statistics education. In other words, claiming if research's p-values are statistically significant or not could impact statistics' and science's epistemological dominance of only reporting statistical significance to decide the effectiveness of a research intervention or treatment; therefore, researchers tend to believe that p-values could bring forth certainty and objectivity to solving problems. This epistemology affects most researchers to primarily use statistical significance to decide whether their research intervention works or not (Gelman, 2016; Wasserstein & Lazar, 2016; Wasserstein et al., 2019). This culture tends to be built upon the norm of craving for a definite validation in research through a binary statistical inference and the fear to question the problem of statistical significance (Gelman, 2016;

Wasserstein & Lazar, 2016; Wasserstein et al., 2019). Also, this culture is disseminated by researchers' education or institutions wherein scholars continue teaching researchers to claim statistical significance. Eventually, many academic publishing institutions endow publication credits to researchers who show "statistical significance" (Fidler, 2005; Gelman, 2016; Goodman, 2019; McLean & Ernest, 1998; Sawyer & Peter, 1983; Wasserstein & Lazar, 2016; Wasserstein et al., 2019), thus creating an idol regarding statistical inference in research, like what Ziliack and McCloskey (2011) said:

In statistical fields such as economics, psychology, sociology, and medicine the idol is the test of significance. The alternative, Gossetian way is a uniformly more powerful test, but it has been largely ignored. Unlike the Fisherian idol, Gosset's approach is a rational guide for decision making and easy to understand. But it has been resisted now for eighty years. (p. xvi)

I am not here to say whose approach is better. I am just making the case that if there are many other ways to evaluate a statistical inference in research, why do most researchers ignore other ways? Ziliak and McCloskey (2011) believed that it might be primarily due to the academic norm in science and the social sciences wherein dominant scientists' canonical teaching tends to emphasize Fisher's p-values when evaluating statistical inference, e.g., insisting on using a p-value number to decide a research intervention's statistical significance and using it to claim the truth and objectivity of a research's intervention. I agree with Ziliak and McCloskey (2011) that this phenomenon is an academic bias that unfortunately has become an academic norm in the world.

Placing Myself Among the Inequities Generated From the Dichotomous Use of P-Values

After studying the history of the p-values, I wanted to know how the epistemology and paradigm of embracing certainty and objectivity have *concretely* produced the inequities in society because I wanted to *place* (Justice, 2016) myself among these inequities, so I could know

why learning the dichotomous use of p-values could be more than just statistics and mathematics. In other words, knowing the concrete cases of the inequities generated from the dichotomous use of p-values might help me reconceptualize my fear of statistics.

How I made meaning of the inequities in this literature review showed where I situated myself in the literature via my paradigm. Situating myself in the critical constructivist paradigm (G. L. Anderson & Barrera, 1995)⁸ when learning and using p-values, I tended to seek social and cultural phenomena for my meaning-making in this study. In other words, this situation was affected by the constructivist paradigm and critical paradigm where I sought interactive and subjectivist elements (Guba, 1990).

Compared to most researchers in statistics and science who are influenced by the positivist or postpositivist paradigms where science is to "...expose and articulate immutable natural laws" (Guba, 1990, p. 77), the critical constructivist paradigm helps this study produce idiosyncratic and participative knowledge that is usually expressed "in the form of pattern theories, or webs of mutual and plausible influence expressed as working hypotheses, or temporary time- and place-bound knowledge" (Guba, 1990, p. 77). Therefore, the critical constructivist paradigm influences how this study's webs of mutual and time-bound knowledge (Guba, 1990; Denzin et al., 2008; Denzin & Lincoln, 2018) interpret my learning of the dichotomous use of p-values.

Starting with learning the history of p-values as this study's webs of mutual and *time-bound knowledge* (Guba, 1990), this autoethnography ends with an interpretation of how the

⁸ G. L. Anderson and Barrera (1995) in "Critical Constructivist Research and Special Education: Expanding Our Lens on Social Reality and Exceptionality" defined *critical constructivist paradigm*: "...the assumptions of a phenomenological, constructivist perspective wherein the meaning of social reality is perceived as created over time within a context of social interaction" (p. 143): conflict, subjective, consensus, and objective. Critical paradigm locates between conflict and subjective and "...uses qualitative methodologies and shares with subjectivist epistemologies a view of society as socially constructed rather than objectively defined" (p. 144).

norm/culture of preferring objectivity and certainty could produce inequities—*place-bound knowledge* (Guba, 1990, p. 77) such as practices of statistical significance creating places where peoples are treated unfairly.

Overall, I used my training in the critical constructivist paradigm (embracing subjectivity) to make meaning of my learning of the dichotomous use of p-values (learning the history of p-values). This process guided me to explore something more than just learning science, math, and statistics.

The epistemology and paradigm of predicting future events through scientific research prefer to offer certainty and objectivity that can create inequities. These inequities are supported by a *science secret* (Thompson, 1996) whereby a group of scientists, in a European scientific conference a few hundred years ago, arbitrarily designated (using a group consent with no theoretical and scientific experimental frameworks to support the designation) a p-value threshold (e.g., 0.05 or 0.01) as a quantitative number to decide whether their research intervention works or not (Salsburg, 2001). Afterward, many European scientists unanimously validated this threshold as the way to report research's statistical significance in the world of science. This arbitrary designation of p-values has promoted researchers to unapologetically trust the scientific nature of statistical significance (Salsburg, 2001). This designation has generated the kind of inequity (Ziliak & McCloskey, 2011) that used to make me feel there was only one way to learn statistics well; it means that being good at math and statistics is the way to learn statistics; in other words, for me, being good at math and statistics is being smart.

Another Form of Research and Epistemological Oppression From P-Values: Either I Die or Others Die

In 2019, one time in class, Professor A talked about the book *The Cult of Statistical Significance: How the Standard Error Costs Us Jobs, Justice, and Lives* (Ziliak & McCloskey, 2011). He mentioned it when explaining the more extreme problems derived from researchers' use of statistical significance in science and the social sciences. This guided me to study the inequitable cases by using statistical significance because inequities are personal to me—I abhor them.

“See! I remember when I read this!” I was thinking and talking to myself.

“Did I tell you that using p-values dichotomously could be a social phenomenon, Hsiao-Ching?”

“Um.... It's Goodman (2019) who told you.”

Ronald Fisher, the creator of p-values, could not explicitly explain what p-values really measured via his inscrutable mathematical formulas to any scientists but himself almost 100 years ago (Salsburg, 2001); therefore, I, of course, do not intend to convince peoples not to use p-values dichotomously (using the statistical significance) by illustrating the exact mathematical formulas and statistical concepts. This also does not align with the purpose of this study. However, Ziliak and McCloskey (2011) would encourage me to not even try to explain p-values' mathematical formulas, not because I am just a graduate student in education, who is not an expert in statistics nor science. It was because even though I was studying a prominent figure in statistical science, it could still be in vain to try due to the sociological pressure that I might encounter. This sociological pressure has influenced most researchers to assent to the ritual of

using statistical significance. Ziliak and McCloskey (2011) depicted this sociological pressure clearly:

The sociological pressure to assent to the ritual is great. In 2002 we gave together a talk at the Georgia Institute of Technology, where Ziliak was teaching, on the significant mistake in economics. Three researchers from the nearby Centers for Disease Control (CDC) attended. They agreed with us about “the cult of p,” as they put it. But they feared that their mere presence at a lecture against Fisher’s “significance” would put their jobs at risk and made us promise not to reveal their names. (pp. 9-10)

“Did you see that story, Hsiao-Ching? These three researchers! They started to understand the issue of dichotomous use of p-values, but they did not want to let peoples know that they knew the issue because they did not want to lose their jobs,” I shouted, after reading the story above.

“So? None of my business. We humans always have something to be afraid of. Big deal!” I answered myself.

“But I am angry at this kind of thing. I hate to see when peoples need to give in to power, just like Mom and Dad gave in to many landlords of our rented houses or even to the belief that if I can’t do math, I am stupid or it’s because I am Indigenous. Or how I gave in to my previous boss for a lower-than-average salary because of my Taiwanese Indigenous status in Taiwan. We gave in too much, including our pride, just to survive. Too many stories around me growing up about giving in to power make me too sad and too angry.”

“So what! It’s not like we could do anything about it.”

“At least I can talk about it. It is inequitable.”

“Hahaha! You want equity in the world! Good luck! The world is not fair! I thought you had learned this since you were in Mom’s womb.”

“I know! But I am still angry. At least there might be something I could do.”

“Don’t waste your time and energy.”

“I am still going to be angry! At least try to talk about it.”

“You know what? What’s ironic is that the three researchers probably did not know what Fisher’s idea of ‘significance’ really meant,” I quipped.

“Did I tell you that Fisher even reprimanded contemporary scientists for using the language of ‘significance’? He told them that the concept that guided them to use statistical significance was different than his concept of using statistical significance (Salsburg, 2001). After all, he was the inventor of p-values. But I wish that he could have made this caveat clear to everyone.”

“However, it was a shame that Fisher did not have the patience to explain his mathematical formulas to other scientists.”

I see the ignorance that might appear in research in the story above. The three researchers in the story explain how researchers may choose to still use statistical significance even though they know that it may jeopardize peoples’ jobs and lives (Ziliak and McCloskey, 2011). On the other hand, if these three researchers choose to publicly debunk the dominant use of p-values, they might lose their jobs.

“So, it might boil down to whether we are willing to lose our jobs or even cause other peoples to lose their jobs,” I replied to myself.

“This all sounds familiar to me! The monsters of inequities like to play the game of either I die or others die,” I concluded.

Chapter Summary

In this literature review, my narrative of the studies relevant to p-values shows that scholars’ and researchers’ learning and using p-values dichotomously are affected by the

disciplinary cultures where society believes that p-values can predict the effectiveness of the research intervention/treatment. Also, the institutional norms of disseminating p-values in textbooks and journal articles manifest the volume of “being statistical significance,” e.g., research being significant, scholars’ publications being considered significant, or other significance-related requirements. This way of finding the truth of a research intervention’s effectiveness, depicted in this chapter, is not kind—instead, it is selfish, according to my Indigenous ways of knowing (learning knowledge to love, share, be kind, and benefit each other). Also, this way of claiming knowledge exemplifies colonial entitlement of knowledge; it is selfish and self-promotion instead of unselfish and community-promoting, according to Indigenous critical theories.

A colonial world teaches researchers to strive for the mastery of knowledge so they can survive in the systematic/colonial competition or own the knowledge merely for the sake of self-achievement. With this mindset of considering one’s self-achievement crucial than communities’ wellbeing, researchers are limited to be wary of questioning the dichotomous use of p-values. Therefore, using p-values dichotomously generates not only research and epistemological oppression but also inequities in the world, in the name of the certainty and objectivity of science. However, if one argues, “There is nothing wrong in wanting to survive by protecting ourselves and seeking self-promotion because we are human, and this is our instinct.” I would not argue with this philosophy or morality (one might choose to use this term). What I will share is I believe there is something more than surviving by being selfish when it comes to being a human; at least, my Indigenous ways of knowing have taught me that community’s wellbeing should be crucial than personal survival since I was young in so many moments when I want to just think for myself.

CHAPTER THREE: METHODOLOGY

Using autoethnography as a methodology is more difficult for me than using a quantitative research method because English is my second language; it means that writing an autoethnography requires more personal, cultural, and contextual words in the U.S. that I did not naturally acquire while growing up. Using autoethnography as the methodology is more difficult for me than using a quantitative research method because by using a quantitative research method, I could hide myself in the language of “objective empiricism.” If I used a quantitative research method, I could provide a literature review without talking about my subjectivity; I could discuss research methods and analyses without revealing my critiques; I could display research results even if I did not believe they offered the full context; and my personal thoughts would not have to be scrutinized. However, in this study,⁹ I cannot do any of the aforementioned; therefore, using autoethnography is, for me, more genuine and rigorous than using quantitative research for this dissertation.

Even though I used to not like math and statistics, it does not mean that I do not enjoy quantitative research. In my experience, I actually do better in quantitative research because when I use a quantitative research method, writing the research process is less challenging because I am good at using “objective” language to report findings.

Why Do I Use Autoethnography as the Method?

Herrmann and Adams (2020) defined autoethnography in the following way:

⁹ This dissertation is an autoethnography that is approved by the Institutional Research Board at Colorado State University.

“Autoethnography” is comprised of three interrelated components: “auto,” “ethno,” and “graphy.”^[10] Thus, autoethnographic projects use selfhood, subjectivity, and personal experience (“auto”) to describe, interpret and represent (“graphy”) beliefs, practices, and identities of a group or culture (“ethno”). . . . However, the use of personal experience does not automatically make a manuscript autoethnographic; personal experience must be used intentionally to illuminate and interrogate cultural beliefs, practices, and identities (“ethno”). At its core, autoethnography assumes that personal experience is infused with social norms and expectations, and autoethnographers engage in rigorous self-reflection. . . . (p. 2)

Parameters of Autoethnography

At autoethnography’s core of illuminating and interrogating cultural beliefs, social norms, and identity practices (Hermann & Adams, 2020), I employed autoethnography as the methodology to illuminate and interrogate the social norm of the dichotomous use of p-values such as using statistical significance to decide the effectiveness of a study’s treatment or intervention. I needed to use autoethnography in this dissertation because this study’s purpose is to convey the meaning-making of my learning of statistical significance. Also, since I needed to display how I recognized that I had overcome my fear of statistics due to this learning process, I chose autoethnography as I centered my narrative upon interrogating the social norm of the dichotomous use of p-values.

Personal narratives in autoethnography often offer great credence for guiding some research to its conclusion as an autoethnographer owns their perspectives that are not diluted from others’ interpretations, as Lapadat (2017) said:

As the researcher and participant are one and the same person, the collection and interpretation of personal data allows the participant to speak in his or her own voice. The researcher is not appropriating the participant’s voice or misinterpreting the participant’s experience, because the researcher is the participant, the source of the data. Accordingly, it can be argued that the autoethnographer owns this inscription of the story, the perspective, and the voice, rather than having them filtered through another’s perspectives, agendas, interactions, and interpretations. (p. 593)

¹⁰ Hermann and Adams (2020) referenced Ellis et al.’s (2011) “Autoethnography: An Overview” to conclude this definition.

Limitations of Autoethnography

Personal narratives in an autoethnography may contain limitations such as "...a risk of leaning toward self-indulgence, superficiality, and sensationalism; and restriction of scope..." (Lapadat, 2017, p. 593). However, I argue that because this autoethnography also utilizes an epistemology of Indigenous critical theories and the critical constructivist paradigm that encourage researchers to use storytelling and narratives to unravel the complexity of their research, my positionality as a Taiwanese Indigenous woman researcher, American immigrant, and graduate student in the U.S. does reveal various contexts regarding learning p-values. Therefore, this autoethnography's self-indulgence, superficiality, and the restriction of scope (Lapadat, 2017) are minimized because the literature in this study offers the following ways to curb these possible negative outcomes:

- Social norm (i.e., using statistical significance as a golden rule) is displayed.
- Deeper educational implications (e.g. biased publications and statistics education) are expressed.
- Broader epistemological values (i.e., objectivity and subjectivity in Western academia and Indigenous ways of knowing) regarding p-values are interrogated.

Unapologetic Autoethnography

I am not defending why I use autoethnography in an apologetic manner. As Hermann and Adams (2020), the chief editors of the *Journal of Autoethnography* wrote: "...manuscripts should not apologize for autoethnography or discuss why autoethnography isn't a useful method or approach" (p. 3). My attitude toward using autoethnography is similar to Hermann and Adams' (2020) argument. They argued that when autoethnographers employ "...their fieldwork and experiences to create accessible, concrete, and sometimes evocative representations..." (p. 3)

into research, they embody *thick description* (Geertz, 2017). Geertz (2017) said that an ethnographer provides thick description via complex conceptual structures when observing and interviewing informants and rituals as “...doing ethnography is like trying to read (in the sense of ‘construct a reading of’) a manuscript—foreign, faded, full of ellipses, incoherencies...but written not in conventionalized graphs of sound but in transient examples of shaped behavior...” (p. 11).

Autoethnography could not only provide the thick description mentioned above but also offer the centralized first-person experience to “...deploy thick descriptions of culture to discern patterns, and reach out to audiences within and beyond academia for more broad-based participation and public dialogue” (Jones et al., 2016, p. 527). This is a significant reason why I trust using autoethnography to explore the meaning-making of the learned knowledge in this study.

Why Autoethnography Instead of a Narrative Analysis, Survey, Archival Research

There are multiple ways for a researcher to explore the meaning-making of any kind of knowledge that is learned such as narrative analyses of interviews, surveys, archival research, etc. However, when I examined the research questions in the study, I saw how autoethnography could assist me in exploring and illustrating my perspectives that other peoples might not be able to directly observe if I use a narrative analysis, survey, or archival research that mainly center others’ voices. In other words, I saw how autoethnography could help me center my positionality in this study when I reviewed my research questions:

1. How do I make meaning of the dichotomous use of p-values in the statistics courses I attended?
2. How do I make meaning of the dichotomous use of p-values in the literature of this study?

3. How do research questions 1 and 2 help me address inequities discussed in this study as an Indigenous woman researcher?
4. How do research questions 1, 2, and 3 help me overcome my fear of statistics?

Beyond the Self Through the Autoethnography

The autoethnography used in this study portrays an analysis beyond myself about learning p-values. An autoethnographic analysis essentially centers oneself in any study; however, it often illustrates different aspects from various sides and carries *arts of the contact zone*¹¹ (Pratt, 1991) where contexts of Indigenous voices and colonial forces are intertwined, as Pratt's (1991) quotes explained below:

Insofar as anything is known about him at all, Guaman Poma exemplified the sociocultural complexities produced by conquest and empire. He was an indigenous Andean who claimed noble Inca descent and who had adopted (at least in some sense) Christianity. He may have worked in the Spanish colonial administration as an interpreter, scribe, or assistant to a Spanish tax collector—as a mediator, in short. He says he learned to write from his half brother, a mestizo whose Spanish father had given him access to religious education. (p. 34)

Guaman Poma's letter to the king is written in two languages (Spanish and Quechua) and two parts. The first is important. The chronicle of course was the main writing apparatus through which the Spanish represented their American conquests to themselves.... (p. 34)

Autoethnography, transculturation, critique, collaboration, bilingualism, mediation, parody, denunciation, imaginary dialogue, vernacular expression—there are some of the literate arts of the contact zone. Miscomprehension, incomprehension, dead letters, unread masterpieces, absolute heterogeneity of meaning—these are some of the perils of writing in the contact zone. They all live among us today in the transnationalized metropolis of the United States and are becoming more widely visible, more pressing,

¹¹ Pratt (1991) introduced the concept of *arts of the contact zone* to explain how an Indigenous academic work could contain heterogeneous and various positions in the contact zone when conducting academic works (e.g., epistemologies of being Indigenous and colonized). Pratt (1991) believed that the concept of the contact zone is "...intended in part to contrast with ideas of community that underlie much of the thinking about language, communication, and culture that gets done in the academy" (p. 4). She contended:

Autoethnography, transculturation, critique, collaboration, bilingualism, mediation, parody, denunciation, imaginary dialogue, vernacular expression—these are some of the literate arts of the contact zone. Miscomprehension, incomprehension, dead letters, unread masterpieces, absolute heterogeneity of meaning...all live among us today in the transnationalized metropolis of the United States and are becoming more widely visible.... (p. 4)

and, like Guaman Poma's text, more decipherable to those who once would have ignored them in defense of a stable, centered sense of knowledge and reality. (p. 37)

Guaman Poma represents the Indigenous voice; whereas, the Spanish king embodies the colonial force that impacts the intelligent Indigenous official's life. Similarly, using autoethnography helps this dissertation move beyond my Indigenous self by also analyzing colonial power among the Western academics in the use of p-values.

Carolyn Ellis: Collaborative Witness in Human Relationships

Carolyn Ellis, an American communications scholar and ethnographer, argued that she did not have mentors in autoethnography but had colleagues and friends who were like-minded, who encouraged her autoethnographic works such as "Arthur Bochner, Norman Denzin, Laurel Richardson, Buddy Goodall, Mitch Alen, Ron Pelias,..." (Jones et al., 2016, p. 17). For her, writing autoethnographic works means that she continues to write stories that explore collaborative witnessing in relationships, experiences, and conversations—a calling and cornerstone of her research and life (Jones et al., 2016).

Stacy Holman Jones: A Relational Achievement Instead of Personal Narratives

Stacy Holman Jones, also an American communication scholar and autoethnographer, shared how she learned from and worked with Carolyn Ellis in writing autoethnography while studying performance and ethnography (Jones et al., 2016). When writing autoethnographies, she emphasized storytelling as a relational achievement instead of personal narratives in conducting research (Jones, et al., 2016). For her, she occasionally does autoethnography as a way to live and relate herself to the narrative of research; however, more often, she does autoethnography as a way to enter into research—a story that she lives in (Jones et al, 2016).

Tony Adams: Bringing Emotions Into Research

Tony Adams, chief co-editor of the *Journal of Autoethnography*, did not encounter autoethnography as personally as Carolyn Ellis and Stacy Holman Jones did. He mentioned that he did not choose autoethnography in his graduate work at first; in fact, he chose a traditional ethnographic method for his research dealing with environmental issues (Jones, et al., 2016). Recalling his decision of using a traditional ethnographic method, Tony Adams eventually decided that using a traditional ethnographic method to investigate “mediated representations of the environment found at The Florida Aquarium” (Jones, et al., 2016, p. 20) was not as satisfactory as using autoethnography:

...I initially steered clear of autoethnography as the primary research method for my dissertation; stubbornly, and ignorantly, I thought that the method would thwart the possibility of having an academic career. I worried about pleasing (imagined) traditional scholars at other schools instead of pleasing the professors with whom I worked and instead of doing the work that I felt mattered. (Jones, et al., 2016, p. 20)

Learning autoethnography from and with other prominent autoethnographers or ethnographers, including Carolyn Ellis, Stacy Holman Jones, Arthur Bochner, Robin Boylorn, and Andrew Herrmann helped Tony Adams bring emotions and experiences into his research process—a way of doing a living autoethnography (Jones, et al., 2016).

My Arts of Contact Zone and Counternarrative

Unlike Ellis, autoethnography is not a calling for my research and life, but, as a Taiwanese Indigenous immigrant woman in the U.S., I believe in the empowerment that storytelling through personal narrative can bring forth. Unlike Jones, I have not used autoethnography widely, but I am expanding my use of it in hopes to live in my research. I know I am living in my story; autoethnography is a way for me to express my experiences to broader contexts. Like Adams, I believe that using autoethnography in this study can help me infuse my

emotions and experiences regarding p-values into my research while also discussing larger contexts. These larger contexts could also be counternarratives; whereby, critical race methodologists use them to interrogate the center of power (Solorzano & Yosso, 2002). In this case, I interrogated the power of p-values via multiple contexts, including my own stories, history in the literature of statistics, my Indigenous ways of knowing, and Western scientific and academic culture. These larger contexts also contain counternarratives that are anti-monolingual and anti-monocultural from my *arts of the contact zone* (Pratt, 1991); my arts of the contact zone are my heterogeneous perspectives as a Taiwanese Indigenous immigrant woman in the U.S., researcher in Western academia, and graduate student in higher education in Taiwan and the U.S.

Therefore, what emotions and experiences did I bring to the issues of p-values through this autoethnography?

“Why not use interviews?” I asked myself one day when thinking about what method to use for this study.

“Of course, I could use interviews. It probably would be considered more valid or trustworthy in academia than using my own voice.”

“But could your interpretation of others’ interviews entirely represent your interviewees?”

“Could you answer your research questions only through others’ points of view?”

“Are you comfortable putting your name on the dissertation if the study is merely about interpreting others’ cultures and epistemologies?” I asked myself again.

“Okay, I’ll use autoethnography,” I answered to myself. Yet, I was fully aware that an autoethnographic study could not only contain first-person stories but must also include others’ narratives.

I believe that using autoethnography as the method in this study can help me explain the use of p-values with nuanced, complex, societal, and cultural experiences surrounding issues of learning and using statistical significance. Also, I argue that using autoethnography can assist me in describing the concept of p-values through my insider experience as they pertain to larger insights, knowledge, and cultures.

Using autoethnography drove this dissertation to illustrate how I made sense of the social norm of learning p-values. It helped me depict how I offered complex insider interpretation of learning p-values. It also assisted me in showing how the process of my learning p-values could be challenging and transformative for myself.

I hope that this autoethnography will provide a refreshing perspective to others trying to make sense of similar experiences like mine regarding the learning and use of p-value. And this refreshing perspective is my arts of contact zone (Pratt, 1991) and counternarrative (Solorzano & Yosso, 2002) about my learning of p-values.

Brief Introduction of Autoethnography

Ironically, there is no such thing called a purely objective research/study. There is only the difference between how much subjectivity is explicated in a study or how much subjectivity is hidden via how much objectivity the study is purported to have. When I was deciding if I should use autoethnography as the methodology of this dissertation, I sensed a need to offer a brief introduction of autoethnography to my readers as I assumed that this brief introduction of autoethnography might help peoples understand some historical and contextual information about autoethnography; therefore, they could better understand some broader perspectives outside of my autoethnographic positionality. In other words, this historical background of autoethnography helped me understand the cruciality of how my subjectivity in this study could

bring to the field of practicing statistical inference and the field of autoethnography. I hope that this can also help my readers to understand the importance of how this autoethnography's subjectivity can contribute to not only the field of using statistical inference but also the field of autoethnography.

Traditional ethnographic research in anthropology and the social sciences does not, in particular, challenge the limit of scientific knowledge—generalized knowledge is often used and contributes to the betterment of human life for scientific knowledge but is limited to describing micro-contextual elements of human lives (Jones et al., 2016). Autoethnography is built for social and political identities in research (Jones et al., 2016). It is also built to bind self and other together through various cultures (Chang, 2008). It is built to contrast research that merely promotes "...detached-outsider characteristic of colonial anthropologists..." (L. Anderson, 2006, p. 376).

It is claimed that autoethnography belongs to one branch of the Chicago School ethnographers (L. Anderson, 2006). Before 1979, autoethnographic works were categorized more as autobiographic works (L. Anderson, 2006); however, "... in 1979, cultural anthropologist David Hayano published an essay on autoethnography that clearly laid out a case for self-observation in ethnographic research" (L. Anderson, 2006, p. 376); thus, the term autoethnography started drawing more official attention. Later, two prominent schools of conducting autoethnographic studies have led autoethnographers in their respective understandings and goals for this methodology. *Evocative autoethnographers* focus on challenging the limits of scientific knowledge; detaching from colonial qualitative studies; examining the ethics and politics of research; infusing literary, aesthetic, emotional, and corporal knowledge; and interpreting social and cultural identities in research (Jones, et al., 2016).

Analytic autoethnographers might not emphasize personal emotions, experiences, and identities, but they believe that analytic autoethnography is more intimate than traditional ethnographic research (“realist ethnographic texts,” L. Anderson, 2006, p. 378).

Evocative autoethnographers and analytic autoethnographers have disagreed about the idea of how many personal experiences and emotions should be centered in autoethnographic research. Therefore, due to how the evocative and analytic autoethnographic schools believe about doing autoethnography, debates between these two schools will have continued since the 60s and 70s.—the debate about which one could be considered more autoethnographic in the field of ethnography,

Insider Knowledge and the Design of Study

Learning, observing, and conversing in the community of statistics courses and literature made me become an insider who could analyze the cultural phenomenon/experiences surrounding the learning and the use of p-values in the community—a complete member researcher (L. Anderson, 2006). Adams et al. (2015) identified the following features for designing autoethnographic projects:

- Foreground personal experience in research writing
- Illustrate sense-making processes
- Use and show reflexivity
- Illustrate insider knowledge of a cultural phenomenon/experiences
- Describe and critique cultural norms, experiences, and practices
- Seek responses from audience (p. 25)

Referencing the aforementioned features, I designed the following steps to complete this autoethnographic study:

1. Depict my reflexivity as an Indigenous woman researcher and graduate student
2. Expound my insider knowledge of the social norm of using p-values in Western academia

3. Show and critique broader academic and social norms in the practice of statistical inference (i.e., emphasizing objectivity, certainty, research significance, and misleading statistics education)
4. Seek responses from audience by dialoguing with myself throughout the study

Representation of the Study and Primary Audience Setting: Education

This autoethnography primarily represents educational settings where human practices can be examined, challenged, and used to guide social change (Reed-Danahay, 2009). Adams et al. (2015) identified four forms of representation for autoethnographers: *realism*, *impressionism*, *expressionism*, and *conceptualism*—borrowing concepts from artistic approaches, as conducting an autoethnography can be considered doing a kind of art (Leavy, 2019).

Realist autoethnographies use perspective—primarily the researcher’s perspective, but also the perspective of participants—to create a sense of verisimilitude, the feeling or illusion of reality.... Autoethnographers writing in the mode of impressionism are interested in creating an overall experience for readers, focusing as often on everyday subjects as on the epiphanies that shake, test, and change us.... In the visual arts, both realist and impressionist works might be seen as moving from an outside—a scene, an external physical world—to an inside—a sense of “reality” or an overall impression of an experience or context. By contrast, expressionist works move from the inside-out and focus on evoking moods and expressing emotions.... Conceptualism returns us to the “outside” world, questioning taken-for-granted assumptions about what art is, how it is created and valued, and what it might mean and for whom. Conceptualism also reimagines the role of the artist in culture. Rather than viewing artists as craftspersons who create material objects (e.g., paintings and sculptures) within a system of tangible and reliable value (as defined by critics, museums, and buyers), conceptualist artists are innovators who create new and often unexpected ideas, perspectives, and experiences. (Adams et al., 2015, pp. 85-88)

I used *conceptualism* (Adams et al., 2015) as explained in the aforementioned quote to reveal the dominant forms of using and learning p-values. Using conceptualism’s “...questioning taken-for-granted assumption...” (Adams et al., 2015, p. 88), I utilized the conversations in this study to question overlooked assumptions about what the statistical significance is, how it is created, and what it means to me.

Also, my stories in this study as a conceptualist autoethnography are the “...mechanism for conveying and critiquing cultural experiences, breaking silences, and reclaiming voices...” (p. 88)—in this case, the social norm of p-values, breaking silences of questioning the dominant use of p-values, and reclaiming voices of using p-values via a more truthful recognition as an Indigenous woman and graduate student in academia.

Moreover, my personal stories are the main source of my reflexivity in this autoethnography; wherein I examine my role, study purpose, and analysis as various forms of representation that also embody artistic elements such as inspirations from my heterogeneous cultures and identities in Taiwan and the U.S. All this expresses a spirit of *conceptualism* in doing autoethnography:

Conceptualist autoethnographies use first-, second-, and third-person narration and are highly reflexive. Conceptualist texts question the role and purpose of research and writing, the formality of research texts, the role of the author as artist, and the lessons that autoethnographies can offer writers and readers. In conceptualist texts, interpretation and analysis are the inspiration for story; showing and interpreting are tightly coupled. (Adams et al., 2015, p. 88)

Therefore, using conceptualism in writing autoethnography provides me a way to represent my research when discussing statistical concepts as one of “...conceptualist artists [who] are innovators who create new and often unexpected ideas, perspectives, and experiences” (Adams et al., 2015, p. 88). The new and unexpected perspective created by this autoethnography is the meaning-making of the dichotomous use of p-values through my conversations with myself and a professor, my descriptive accounts, my emotional investment, and my voice as an Indigenous woman and graduate student.

Ethics and Trustworthiness of This Autoethnography

Researcher vulnerability should be checked as “Autoethnographic work can affect the researcher in unforeseen ways” (Lapadat, 2017, p. 594). Writing and engaging in deep self-

reflexivity, especially regarding traumatic experiences, and being open to oneself and writing about it can elicit strong emotions (April, 2010; Ellis et al., 2011; Chang, 2008; Jones et al., 2016). This autoethnography conveys a traumatic experience about a system where my Indigenous ways of knowing are not valued, accepted, or respected. Also, the internalized oppression and ways my family bought into this, teaching me that I was not smart in math were traumatic. However, as I wrote this autoethnographic study, it provided healing and strength (Leavy, 2019) to me, thus helping me overcome my fear of statistics by sharing my vulnerability and allowing me to nurture my voice as it relates to my Indigenous nature of reality, values, and ways of knowing.

Another ethical point that an autoethnographer should check is *emotional rigor and self-indulgence* (Lapadat, 2017, p. 595). It is addressed mainly by the group of analytic autoethnographers' critiquing autoethnographic studies that are considered too evocative. However, the group of evocative autoethnographers, including Carolyn Ellis, Tony E. Adams, Stacy Holman Jones, Robin M. Boylorn, and Mark Orbe, argued that emotional rigor and self-indulgence do not have to diminish the quality of autoethnography (Ellis et al., 2011); whereas, Lapadat (2017) addressed that self-indulgence should be decreased as much as possible to manifest an autoethnographer's analytic ability. However, similar to the positions of Carolyn Ellis, Tony E. Adams, Stacy Holman Jones, Robin M. Boylorn, and Mark Orbe (within the school of evocative autoethnographers), I argue that an autoethnographer's analytic ability does not have to relate to how much an autoethnographer prevails over their self-indulgence. Self-indulgence is not entirely negative for an autoethnography as some phenomena need more self-indulgence to unveil its personal-other-societal interwoven structures such as topics about bipolar, bulimia, depression, sexual harassment, etc. Without self-indulgence in describing the

aforementioned phenomena that require emotional, nuanced, reflexive, and dialogical elements between the self and others, autoethnographers might not be able to show the in-depth intricacy and complexity of their autoethnographies.

Therefore, I conducted this autoethnography via my emotions, narratives, epistemologies, paradigms, and researcher positionality regarding learning p-values and my careful studies of research methods over many years. This autoethnography focuses on my educational learning process regarding academic and social norms; therefore, it does not especially rely on self-indulgence experience to manifest the cultural or phenomenal issues that I would like to critique.

Limitations, Contributions, Member Checking, Thick Description of Using Autoethnography

Though this autoethnography may seem limited, as one may argue that this study contains the predominant narrative of the author, it does elicit complex perspectives through my meaning-making of the literature's narratives and my positionality. For instance, I am an insider within higher education but one who feels forever an outsider in higher education due to my Indigenous identity (anti-colonial academic thinking). My Indigenous ways of knowing and doing things might be too anecdotal for Western academia to "validate" my academic ability. Also, as a graduate student, I could be too immature to be seriously heard or considered a professional in Western academia. All this shows a positionality that establishes me as uniquely able to offer a perspective of an outlier and "n of 1"—meaning that my unique case illuminates how the claims of generalized truth will only take us to certain levels but do not apply to everyone.

I used member checking with my co-advisors as one of them was involved in the conversations in this study where the advisor's consent was provided. The greatest thick

description produced by this study is embodied in my reflexivity, critiques, and deconstruction of learning and using p-values. That is why this dissertation is defined as autoethnography.

Using autoethnography helped this study create a better understanding of learning p-values that occurred across cultures in Western academia and my Indigenous world in Taiwan and the U.S. I was able to be an artist while exploring my meaning-making of inequities generated from the dichotomous use of p-values via the following cross-cultural views and identities through the method of autoethnography:

1. My critical, Indigenous, and autoethnographic meaning in the poststructuralist discourse where my *arts of the contact zone* (i.e., heterogeneous identities and interpretations, Pratt, 1991) that clashed with each other
2. Indigenous right of *opacity* (i.e., embracing the uncertainties that my interwoven and conflicting identities created, Lindner & Stetson, 2009)
3. Epistemology in Indigenous critical theories (i.e., locating myself at the center of the knowledge)
4. The academic paradigm in Western academia (i.e., critical constructivist paradigm)

Overall, The method of autoethnography provided me a tool to convey how I learned the dichotomous use of p-values and how I overcame my fear of statistics in the learning process via a complex lens that does not simply represent traditional critiques of a statistical method such as mathematical and statistical logistics of p-values.

CHAPTER FOUR: FINDINGS & DISCUSSIONS

The *findings* of this chapter embed my autoethnographic stories and conversations in each section according to their corresponding topics and subtopics. The *discussions* mainly are exhibited via my analytical narrative and explain my interpretation of the *findings*; however, they are not limited to only analytical expression but are also displayed via my autoethnographic voice as this dissertation is an autoethnographic study.

Inequities Caught My Attention & Dissertation Direction Was Formed

Why did inequities catch my attention? Inequities are personal to me based on being born a Taiwanese Indigenous child into an inequitable society. Taiwanese Indigenous peoples have the lowest ethnic and social class status in Taiwan, a Chinese colonized country. Furthermore, I have experienced ethnic, racial, and gender discrimination as a Taiwanese Indigenous immigrant woman and graduate student in academia. The emotionality, harm, hurt, and feeling pushed out in both the U.S. and Taiwan have left deep scars in my soul. I am different. I do not fit in this Western mold. Such Western thinking renders me invisible and does not recognize me. As I reflect, my Indigenous roots are deeply wrapped in my heart, and my way of learning is awkward when it comes to the logical, math-ridden quantitative research. As an Indigenous woman and student in these two countries and two cultures, I witness the influence of Western research and epistemology academically. I am opening myself to realizing the inequities regarding quantitative p-values, which are hard to embrace in my natural Indigenous ontological values of reality. P-values govern the influence of the research world. I feel I must talk and discern my conscious and unconscious revelation of p-values. My deep fascination with how Western research operates formed this dissertation's direction.

Inequities caught my attention because, primarily, I believe that I am Indigenous in the world. My Indigenous ways of knowing that my grandma taught me conflict with the education infiltrated by Western epistemology (both in Taiwan and the U.S.) that I have received. I grew up learning and being taught by my teachers and families that I am not “science material” since I am Indigenous. Colonial society and my Indigenous families in Taiwan have infiltrated the following beliefs into the thoughts of Indigenous students like me—abilities in art, music, sports, and language are natural to us Indigenous, but science and math are not just the things for me and my Indigenous peoples.

“Mom made me think that being smart is being good at math,” I recalled aloud.

“Why does the world prefer to tell me that science and math are the better ways to discover the truth?” I asked rhetorically.

“Also, peoples often comment that Indigenous peoples are so inspirational, and Chinese peoples are so good at math and science,” wondered I.

“No wonder! I was believing the crap that Western epistemology has managed to tell the world: Only science and math could bring better and transparent truth, so being good at them could bring better certainties about the goodness of life and society (at least this is convincing enough to brainwash the world—who doesn’t want goodness of life? We are all humans who want good things). Therefore, peoples who are excellent in science and math deserve more credit and proprietary benefits; whereas, peoples who are not accomplished in math and science tend to be considered less intelligent and less deserving of most benefits,” I concluded.

“Maybe this is how colonialism was able to convince themselves and the world that it was God-ordained (not my Yavagansama, our Creator! For God’s sake!) to go to other

places, stick their condescending flags into the ground, imagine Native peoples' barbarian-ness, and tell the Natives that they made the Constitutions of the universe, A.K.A., we are more scientific and intelligent than you; therefore, we are more suited than you to have dominion over these places." Of course, colonialism gets more complicated than just being self-knightedly intelligent and lords of the lords.

All these mentioned above are inequities to me. They have been the main source of the teaching in science and statistics that predominantly have educated me in an absolute way about math and statistics, thus life and truth—embracing objectivity and certainty in the name of the happiness, freedom, development, wellness, and civilization of humanity. All this has caused research and epistemological oppression where peoples desire to believe that only objective measurements could bring concrete benefits to the happiness, freedom, development, wellness, and civilization of humanity, yet they ignore that often these objective measurements could only get humanity to a certain point and that they also have detrimental consequences.

Why did inequities generated from p-values catch my attention? Because I am Indigenous. If colonial conflicts and oppressions never happened in my life or if my grandma never taught me what it would be like to be a strong and smart Tayal, I might still believe that I am not as intelligent as I want to be. If this were the case, I wonder: Would I learn p-values in a different way that might not give birth to this dissertation?

Findings of Research Question 1: How Do I Make Meaning of P-Values in the Statistics Courses?

Goodman (2019) argued that the use of p-values is a social phenomenon. How I made meaning of the dichotomous use of p-values in the statistics courses I attended in my doctoral program revealed Goodman's concept that using p-values is a social norm. This concept conflicts

with Western ways of utilizing and teaching statistics, which purport to produce objective, measurable, and certain knowledge of skills; in other words, science is created to solve problems, and statistics are used to improve the measurements of scientific experiments objectively and mathematically (Salsburg, 2001; Kuhn, 2012). Therefore, how I made meaning of the statistics courses in my Ph.D. program boiled down to how I questioned the use of p-values, statistics, math and statistics education, and, finally, Western research and epistemological oppression.

Recalling what Goodman (2019) said about using p-values being a social phenomenon, I cannot stop questioning why so many researchers still believe that the p-values are about objectivity:

This brings us to the question of why eliminating P-value is so hard. The basic explanation is neither philosophical nor scientific, but sociologic; everyone uses them. It is the same reason we can use money. When everyone believes in something's value, we can use it for real things; money for food, and *P*-values for knowledge claims, publication, funding, and promotion.... The use of *P*-values is a social phenomenon upon which many social rewards and penalties rest. (Goodman, 2019, p. 27)

To explore using statistical significance, also called the dichotomous use of p-values in this study, and understand the connection between the social norm of p-values and its implications of objectivity and subjectivity, I started my meaning-making of the dichotomous use of p-values from my math classes growing up to disclose how my fear of statistics was derived from my anxiety of math. I then described the first statistics courses I had in Taiwan and the U.S. as a graduate student to interpret the relationship between my math classes and statistics courses (i.e., doing statistics is about doing math). Lastly, further illustrating the depth of my fear of statistics, I pinpointed how Western ways of teaching, learning, and using math, statistics, and p-values led society to embrace objectivity but ignore the subjectivity within them. All this was depicted in the statistics courses I attended during my doctoral program.

My Math Classes Growing Up

Growing up, my parents and teachers often told me:

“It was okay, you are too slow to do math well.”

“You are Indigenous! We Indigenous peoples are just not good at math as the Chinese peoples.”

“It’s okay! You are such a hard-working student. So what if your math is not good! At least you still can go to law school.”

Recalling a conversation with my mom when I was in seventh grade, I connected being smart to being good at math. She told me that at least I studied hard and got A’s in languages (English and Chinese) and Social Studies.

“Mom, I just don’t understand how the teacher teaches us to solve this problem and how it works for me? Look at this: $X^2 - 2X - 3 = 0$. She told us to memorize the strategy:

‘look at the front and the back and build up the middle, this strategy will guide you to $(X-3)(X+1) = 0$, and boom! You will get the answer.’ But I sat looking at her, puzzled and feeling: I just don’t see how this works for me.”

“Did you ask your teacher?”

“Yes, I told her that I could not see the ‘front’ and the ‘back’, and I definitely was not fast enough to build up the middle. I asked her whether there was another way to solve the problem in a way that I could understand.”

“What did she say?”

“She said that her strategy was the fastest way, and that I should try to learn it; otherwise, I would be too slow on the math test.”

‘Um..., yeah, you are too slow in thinking in math, as are most of us Indigenous. Keep learning, and hope you would get it,’ said Mom.

“But I am just not understanding why that is the only way, and I need to understand in my way and why I should use it,” I murmured in my mind without telling mom.

“Maybe I am just too dumb to figure that out fast enough.”

Being good at math when growing up in Taiwan was solving math problems in a test faster than the average students. I was not among the group that was above the average; in fact, I was below the average because I could not memorize formulas before I understood how the formulas worked. Usually, I did not get to understand them soon enough for math tests. It was like a cognitive clog in my brain: anything I did not understand or know how to apply to my own ways of knowing, I would forget. I often questioned:

“Why should we only memorize formulas to solve the math problems?”

“Can’t we solve math problems through our daily life experiences instead of math formulas?”

Growing up in my math classes, I questioned why each math test required us to solve almost 100 questions in 60 minutes. It created so much anxiety for me because I did not understand why math problems were created this way. These problems made it impossible to put myself in them. I often asked questions of math tests such as:

“Why did the teacher ask this question this way?”

“Why do teachers like to put rabbits and chickens in the same cage and ask us to count how many there were?”

“Why did we have to plant trees by the road and count how many gaps were between the trees?”

However, during a math test, time, like the colonial machines, did not stop for my questions that were deemed tangential. I was slow; I did not remember the formulas; and when I was “lucky” enough to remember the formulas, I could not justify them to solve the math problems, so I became extremely anxious and spent most of the time trying to calm myself down. I got bad scores, I lost my confidence in math, and I started feeling unintelligent.

On another day, a new math test was given. I asked too many questions during the test again, I was slow, then I became anxious. I tried to calm down for over 15 minutes, so I did not finish all the problems and received a bad score. This anxiety cycle on math tests occurred in most of my math tests throughout all my school years growing up in Taiwan.

Before attending graduate schools in the U.S., I did not know I was doing critical thinking when asking many of the questions mentioned above. My parents did not know I was desiring to learn in ways I could understand, and my teachers thought I just needed to practice, practice, practice. We concluded: I was not good at math because Taiwanese Indigenous peoples were not good at math—my parents and teachers told me that it might be genetic. However, I wished I could have known earlier about Brown et al.’s (2014) argument when I was younger, so I did not have to hate and fear math, feeling that I was not as smart as my Chinese peers:

Rereading text and massed practice of a skill or new knowledge are by far the preferred study strategies of learners of all stripes, but they’re also among the least productive. By massed practice we mean the single-minded, rapid-fire repetition of something you’re trying to turn into memory, the “practice-practice-practice” of conventional wisdom. Cramming for exams is an example. Rereading and massed practice give rise to feelings of fluency that are taken to be signs of mastery, but for true mastery or durability these strategies are largely a waste of time. (Brown et al., 2014)

So, if memorization is a waste of time, what else are we doing that does not serve us in society? There are many ways we delude ourselves into thinking there is only one way to operate. My grandma kept reinforcing in me a sense of empowered thinking. Yet, my mom’s thinking

followed the Chinese and colonial learning. At times, I felt confused. However, I kept strong in my culture. But culture too is developed by peoples' whole way of thinking and living. I felt stupid because my mom reinforced cultural norms related to math. Yet, Grandma reinforced my intelligence rooted in my Indigenous culture. It is hard to have such conflicting messages because we end up swimming in the messages and beliefs we hear. Again, I wish I could have learned the argument below earlier:

Many people believe that their intellectual ability is hardwired from birth, and that failure to meet a learning challenge is an indictment of their native ability. But every time you learn something new, you change the brain—the residue of your experiences is stored. It's true that we start life with the gift of our genes, but it's also true that we become capable through the learning and development of mental models that enable us to reason, solve, and create. In other words, the elements that shape your intellectual abilities lie to a surprising extent within your own control. (Brown et al., 2014, p. 7)

I am not discussing how my amazing brain could help me learn. I am only astonished here about how many misconceptions peoples have in learning knowledge via a social norm or cultural interpretation, like the dichotomous use of p-value. I am only questioning why so many students and educators have grown up in a kind of education system that teaches us certain misconceptions without examining or at least having dialogues with each other first. Similarly, how I was taught about doing math was not dialogical, and this made me extremely anxious and afraid of doing math. This anxiety and fear, later on, went with me into the statistics courses I attended.

My First Statistics Course in 2008, Taiwan

What are these statistical models? How did they come about? What do they mean in real life? Are they true descriptions of reality?... In dealing with these questions, it is necessary to distinguish among three mathematical ideas: randomness, probability, and statistics. (Salsburg, 2001, Location No. 134)

I only dream I would have read these words when I took my first statistics course in the Department of Teaching Chinese as a Second Language in Taiwan. Such knowledge about

statistics would have shown me that math formulas were also about exploring some interesting contextual concepts. I was 26 years old and an editor in a book company in Taipei, Taiwan, where I was responsible for editing and proofreading Chinese/English textbooks and dictionaries. I was also a graduate student who studied Teaching Chinese as a Second Language and Linguistics at the most prestigious normal university in Taiwan. At the time, I never thought that I would ever touch math again; one reason that I chose to study Chinese in college was because Mom and Dad convinced me that “I was not smart enough” to pursue any subjects that might deal with math. I was convinced that I was good at Chinese and social studies but not mathematics.

It was my first statistics course. It was in a rainy morning in the center of Taipei, Taiwan. The statistics course was not explicitly listed as a statistics class in the graduate program; instead, it was named 研究方法 (pronunciation: *Yan Jiu Fang Fa*)—translated to English: *Research Methods*. This textbook in this course showed mainly how to do statistics in quantitative research methods which covered 13 chapters of the book. Only one chapter described 質化研究 (pronunciation: *Zhi Hua Yan Jiu*)—*Qualitative Research*. I remember how my anxiety disorder exploded during class when the professor was instructing us to memorize the selected mathematical formulas for the quiz the following week. I remember thinking:

“I thought this course is about research methods.”

“Why is all this about math?”

“I am not sure if I can pass this class if we have a math quiz every week.”

I passed the course with a C. I barely passed each week’s math quiz. I barely passed the math test in the mid-term exam, an exam about only how to quickly find z-scores, standard deviations, and p-values by mathematical formulas without using calculators. Also, I barely passed the final

exam, which was a larger scale of a math test about statistics. After the course, I wrongly believed that quantitative research was about math and statistics and that qualitative research was only about that one chapter in our textbook; I thought that it was about doing ethnography.

I passed the course, but I feared statistics. That fear confirmed that I was not good at math; thus, I was not smart. I passed my first statistics course in graduate school, but I was afraid of statistics because they reminded me of my fear of my math classes growing up. The fear of statistics came from the dark claw that could incite my emotional storm when math and statistics made me feel unintelligent compared to the highly-resourced others who were non-Indigenous.

The Dark Claw, My Emotional Storm, Statistics, and Math

“How do I describe this fear coming from the dark claw and my emotional storm?” The stronger me asked.

“I don’t want to describe it. Could I not? I don’t want to give the fear its full breath by detailing it in paragraphs. We might summon it again....! Do we have to?” The timid me responded.

“But we have to convince my dissertation committee that this fear is real,” said the stronger me.

“Really! It is real. Can you just tell them that? I don’t want to wake the fear.” The timid me asked.

“Okay! Let me try it! If it’s still not enough to convince them that it is real, I can talk about our *rights for opacity* (Linder & Stetson, 2009) again and tell them how we would like to resist the full transparent explanation of our fear from their Western academic gaze. I want to share with them as they are our friends and academic mentors not because

they could conceptualize and evaluate our differences from them. I believe they would understand our resistance. How does this sound?" The stronger me answered.

"Okay! Sounds doable," said the timid me.

"But I could only use a poem to describe it because I do not want to give the fear its full breath! A poem may seem fragmented, but this is how fear creates fragmentation inside of us."

"Okay! Be careful. I'll see you on the other side. Be safe coming back from the dark clawed fear!"

"I will!" responded the stronger me.

Poem: Statistics Only Are Numbers to Then Crumble

Statistics only
are numbers
to then crumble.

But when it invades my mind,
math is its mines.

Their power
Their shimmer
Their cluster
of explosion
making me shudder.

Bang!

"Why can't you be good at math?"

"You are so slow!"

Bang!

“It’s okay you don’t get this math.”

“We are Indigenous.”

“No wonder! But good that you are studious.”

Bang!

“It’s okay that you are not good at math like the Chinese are.”

“It’s okay that you are not smart like the Chinese are.”

“Chinese! Chinese! Chinese!”

Bang!

“I want to be like the Chinese.”

“I want to look like the Chinese.”

“I want to be smart like the Chinese.”

“I want to have what the Chinese have.”

“A normal childhood without poverty, alcohol, fights, and a constantly ill mom!”

“A normal teenage year without self-doubt, racism, and an overly self-conscious dad!”

“Enough money to pursue higher education without marathon-like works and time
spending!”

Explosions cracking the bottom of the lake of my consciousness

Submerging a dark claw

Stirring the quiet water

into a great storm

full of rage

bitterness

confusion

injustice

fury, yells, blasts!

Wailing~!

“Why are you even here in the world!”

“You are nothing!”

“You have nothing!”

“You deserve nothing!”

“Your father has nothing.”

“Your mother has nothing.”

“All you have is lingering in sorrow.”

Sorrow of losing

Sorrow of floating

in the pain of

poverty

family trauma

debts

self-doubt

striving

but

falling

Wailing~!

Unrooted have you ever been
as stripped naked into this being
the Indigenous who
crying and laughing
in the meantime
how have peoples passing
by
staring
at you
looking
into your soul
that aches
in pulses.

And you can't distinguish:
is it crying or laughing?

Wailing~!

How unvalued peoples have been
conditioned to consider your being
for how your love, kindness, empathy, communion, wisdom, and laughs have been
too loud and naïve
to be efficient for the fast-paced world.

What a pity have you never owned
your indigeneity

speaking your tongues
wearing your Indigenous dresses
weaving, planting,
cleaning skulls of enemies.

Swirling!

Emotions twisting together into a storm
while the dark claw celebrates how my strength will decay.

It keeps stirring the storm full of rage evoking dismay

Yelling out my smallness in the world

“You came from nothing!”

“You will go back with nothing!”

“You were taught you were nothing, poor, and unintelligent.”

“You can try to strive and fight for the justice you imagined!”

“Eventually you will go back to dust!”

“You Indigenous peoples will always lose.”

“The winner has already won!”

Standing

small

in the storm

Came a voice of despair

“It’s all in vain! Don’t try anymore! Don’t compare!”

Fear began wrapping

me
around
a sense of nowhere
to belong
to hope
to love
to share
and
to pray

When I Feared Statistics, I Was Fearing the World as An Indigenous Woman

Grandma said that the strongest and smartest Tayal woman is one who learns the world (various kinds of knowledge) to share, love, be kind, be humble, and be flexible when appreciating one another's value and abilities even though Chinese peoples teach us to possess, be cold, be proud, and be strict when judging one another's achievements.

Grandma, I fear a lot because whenever negative emotions come along, great fear comes along, too. These are the times that the dark claw, lurking under my consciousness, comes out and harvests its fields of uncertainty and self-doubt. However, peoples often say that I am brave. Mom said that I was courageous when I fought against her will and chose to study languages in college instead of going to law or medical school. I know! She wanted me to climb out of poverty as a Taiwanese Indigenous woman, and she wanted me to not end up like her with little education and money. Being a doctor or lawyer is a fast way to have a reputable and stable life as an Indigenous person in society. Dad said that I was courageous to marry a foreign man and move to a foreign land (I know! I know what he meant now). Albert and Yoyo (my younger

brother and sister) said that I was brave to go against Mom's will a lot of times (but Mom was really controlling).

Grandma! There are a few times I have been brave, but many times, I fear. Behind the courage peoples see in me, I am full of fear. I always appear brave when I adventure, but I fear greatly while going through it as I do not have much money, time, resources, and privilege to uphold my bravery; nor does my self-confidence sustain long in the adventure to endure possible negative emotions associated with the adventure.

Many times, my courage comes from my fear. I fear the world because it tends to not share nor love. It is not kind nor humble. It is cold, proud, and strict in its way. In academia, we sometimes call this way "colonial way," but I would just call this an inhumane way. It is an inhumane world that strips us of our land, our place, and our sovereignty. It is a cruel world that has taught me Indigenous peoples are unintelligent, lazy, criminal, inferior, and forgettable. It made Mom and Dad carry huge debts because they were generous to share their money and property with those in need. It made us move over 20 times as I was growing up because Chinese landlords did not trust Mom and Dad because they were Indigenous. It made Mom and Dad think that we Indigenous peoples were not good at math, business, and managing properties compared to Chinese peoples. It made Mom sick for a long time because of the long-term effects of poverty. It caused fights between Mom and Dad because of our dire finances. It made Dad have low self-esteem as an Indigenous man. It made Mom and Dad beg others for my tuition, which is required for public schooling in Taiwan. It made Mom bitter, jaded, and stern. It made Mom once say to me, "You are the burden of our family! Because of you, we don't have enough money." It made Mom never compliment me. It made Mom never say, "I love you." It made Mom smile less. It made me doubt, "Has Mom ever been proud of me?"

Before doing this dissertation, whenever I studied statistics, a negative emotion about my poor math ability appeared, the dark claw emerged and stirred the emotional storm inside me, and the emotional storm shouted out all the words mentioned above (among other negative words that erode my self-confidence), thus throwing me off the cliff where despair and hopelessness awaits. I told myself that if there was no hope and strength in my earning love and joy, I would not fear the despair and hopelessness down the cliff.

My fear of statistics before this study, essentially, was my fear of math. My fear of math came from my fear of the world as a Taiwanese Indigenous student and woman. Since Mom and Dad used to say, “We Indigenous peoples are just not good at math,” I internalized their belief about “being not good at math because I am an Indigenous student.” Therefore, before finishing this dissertation, my fear of statistics came from my fear of math, and my fear of math came from how we Taiwanese Indigenous could be cruelly treated by the cold world. I feared the cold world where we could be laughed at due to our skin tone and be kicked out of our apartments many times (Landlords would say, “No offense! It’s just business!” I often think that this sentence truly is destroying humanity. What a sad world!). I saw Mom and Dad fighting a lot due to poverty. I heard Mom saying that I was not smart enough. I also heard Mom and Dad saying, since the time I was only seven years old, “Ching, you are Indigenous, so you need to study harder than those Chinese peoples. You need to prove that we Indigenous peoples are not lazy. You need to study harder and harder so you can prove that we Indigenous peoples can also be highly educated, thus being smart and successful.”

All this mentioned above generated my fear of the world as an Indigenous student and woman and gave the dark claw power to summon the emotional storm inside me whenever the dark claw was awakened by math and statistics. Grandma, help me to tell Yaya (my Indigenous

language for mom) and Yava (my Indigenous language for dad): Sometimes, I wish I could just be a Chinese kid growing up so I would not have so much pressure. Yaya and Yava, I wish I could be like Matt (my husband) growing up in a middle-class White family in the U.S., thus exploring the world without any strings attached when I was younger. Yaya, I wish you could be happier before you died. I wish you were here now so I might be able to soften your heart a little bit. Yaya, I wish you could be here so I could talk about Indigenous critical theories with you.

All the emotions above made me fear statistics, and my aforementioned experience in the first statistics course of mine enhanced this fear. The course was taught in a similar way to all the math classes I took before college, including memorizing, solving problems fast, and no questioning teachers' instructions. I did not learn that statistics were not just about math until I began studying in my Ph.D. program in the U.S., and before this, I had internalized my mom's, dad's, aunts', and uncles' messages of what smart means. For them, it means, "it's okay you are not as smart as the Chinese peoples, at least you study hard."

My First Statistics Course in My Ph.D. Program, USA

The first statistics course I attended in my doctoral program was in the 2018 Spring Semester. I had to take it because it was a mandatory course. I went into this course remembering how bad I was at math and afraid of many statistical concepts though I had learned statistics for over eight years before beginning my Ph.D. program. "Fake it until you make it, so the professor will not fail me," I said to myself that day. It was a late afternoon when I attended a statistics course in the Spring Semester of 2018. Before the class began, I felt anxious that my bad math might be exposed during class. The classroom was located in the basement of my department's building. Coming into the building from a typical smiling-sunshiny, winter Fort Collins day. I entered a bleak basement where my weakness in statistics might expose my naked

fear of math to the class. Time fast-forward to the end of the semester: I passed the course with huge relief of exasperation of living breath back into my decrepit math-filled carcass.

I did not remember much about the course content as most of the time I kept as silent as I could because I was afraid that my math was too bad to understand statistics. Also, most of the time in class I was dealing with my anxiety syndrome because I was so nervous about the class content, so I had to focus on breathing to calm myself down instead of visualizing three dimensions of regression analysis pictures.

Professor A, who taught the course, was kind, but I did not trust that he would think I was smart enough to learn statistics at that time, so even though he said that we could ask whenever and whatever we would like, I would still not venture to ask questions. I liked to pick a seat in the classroom where I could look outside the window and see the winter branches on the trees trying to grasp the canvas of Colorado's blue and sunny sky—to gain some peace in the battlefield of my mind.

After passing the first statistics course I attended in my Ph.D. program, I decided to take another statistics course the next semester as Professor A encouraged us to do so if we still had questions about statistics, even basic ones. I did have basic questions about statistics, and there were some math concepts that Professor A explained according to some statistical concepts that were intriguing to me such as standard deviation, statistical inference, and the least-square regression. However, the onset of my interest in exploring my learning of p-values in class began in 2019 in one of Professor A's courses when he first guided us to relearn the use of p-values and be aware of how the reception of p-values was polarized, and with this exploration, came the topic of this autoethnographic dissertation.

Statistics Could be About Subjectivity: Conversations With Professor A

One evening after Professor A's statistics course, Professor A and I started chatting about my research process. We talked on Zoom after one of our synchronous online classes during the 2020 Coronavirus Pandemic. It was just after seven o'clock in the evening and the sun outside my office room's window was dim, dully illuminating the purple dianthus and bright-yellow common daisy in the vase on my desk.

"How are you doing?" Professor A asked.

"I am doing fine. I am a little bit frustrated about the history of statistics that we discussed in class."

"How is that?"

"I said I am frustrated not because the content makes me frustrated. It's just that statistical methods in science look really subjective to me. There are many academic and epistemological conflicts involving political or personal hostility and favoritism when I learn the history of science and statistics. The story of Fisher and the origin of p-values and how p-values were used to determine whether a research intervention/treatment works or not seems like an academic preference and paradigmatic subjectivity. Why are we taught that statistical methods are objective? We have been taught that statistics are like science, the product of objectivity, which is not totally right," I kept venting.

"I wonder if students don't really want to learn what the dichotomous use of p-values means, as well," said Professor A in his typically pensive manner.

"I kind of have seen this in your classes. Many students seemed to not understand why p-values have to be complicated. I feel like some of them want the recipe of p-values more than understanding what p-values measure. But some of them do feel this is interesting.

Yet, again, even though all of us would like to understand what p-values are, most of us still need to go out and convince our professors, other scholars, and other scientists about the critiques of the dichotomous use of p-values. Yet, why even try? No one will listen to me; I am only a graduate student.” I was still venting.

“Um... I had students giving me feedback with terrible wording about not receiving traditional ways of statistics education. They complained about why I did not focus on teaching traditional ways of doing statistics,” said Professor A.

“Wow! That’s harsh.”

“Yeah,” sighed Professor A.

“How do you think you can find the balance? Teaching the dichotomous use of p-values or teaching students to use statistical significance?” I asked.

“Um..., it is tricky....” Professor A ruminated.

“Do you almost sometimes think that if some of the traditional ways of doing statistics are problematic, it would be wrong to teach them to blindly use statistical significance?” I tried to interpret Professor A’s rumination after a period of silence.

“I guess you can say that, but it is more complicated than that,” as he slowly articulated every word.

“I know, then you are caught up in the place where you either teach the established incorrect content just to get by in academia, or you hold to your principles of not teaching the problematic stuff but might risk being hurt by the feedback.” I felt frustrated for Professor A.

We talked for another hour but our conversation did not conclude with solutions of how we could save the statistics world. It was, is, had been, has been, will be, and will have been

impossible! And we both were too aware to consider ourselves “saviors” of any kind. I did not want Professor A to explain his teaching, nor did I want to pry into his emotions regarding my critiques, but I do know myself very well.

“This sounds like a power struggle for me. I would like to talk about it. I think what you teach about the p-values is critical, Professor A.” I said.

“Um..., I am not sure about that! I am just saying what I know. Also, I don’t really think everything is about power struggle, though,” responded Professor A.

“I still think it could be about power struggle. I would like to talk about it. At least, using p-values dichotomously could be an inequitable thing to do.” I said.

“Yes, it could be inequitable.”

Statistical Significance and Publication Significance

The above conversation with Professor A makes me believe that researchers often use p-values as they are “...the glue that binds together the entire research process” (Hubbard & Armstrong, 2006, p. 114). For many years, researchers, including myself, have believed that statistical significance could define scientific significance (Hubbard & Armstrong, 2006). We were taught, in traditional ways of doing statistics, that if our data could claim p-values smaller than 0.05 (mostly in the social sciences), our research might have scientific significance; therefore, we could have better publication significance. Who has been teaching us this? Some of our teachers, professors, textbooks, institutions, academic cultures, publication cultures, even, many prominent scientists in many fields have taught us this.

My Misunderstanding of Statistical Significance Due to Statistics Education

One day in 2018, in Professor A’s course, before I understood the issues of using statistical significance, I argued with Professor A:

“Professor A, what if I ran my data for a few months, I cleaned up my data, I studied my data, I went through and tagged the missing data as 99, 999, and 9999, I perused the data description, I tried to adjust my variables, and I tried whatever I could do, I still did not get the p-value right!”

“What do you mean the p-value is not right?” Professor A asked.

“I cannot get the p-value smaller than 0.05.”

After Professor A explained how a study might not need statistical significance to prove its research quality, the class joined the argument about this misunderstanding. I kept asking:

“Without a p-value, how do we decide whether, for example, a research intervention, works or not? And if we don’t have a specific tool to help us decide, then why are we doing statistical analysis?”

I was too fired up to slow down. Sensing that all my classmates were silent or bored, I noticed one of my classmates looking out the window, a ray of warm light massaged my classmate’s face, I continued in my line of questioning:

“My problem is that even if our data analysis shows a p-value greater than 0.05 instead of smaller than 0.05, also called ‘statistical significance’ (I said with air quotes), why can’t we just report it instead of manipulating the variables or other elements to get ‘statistical significance? Why can’t we just report that p-value is ‘not significant’ and move on to whatever we have to do next?” I asked.

“You are on something,” said Professor A.

Writing this, I realize that I did not understand how p-values were misused when I said that I could not get my p-value right (smaller than 0.05). I had not learned that p-values were not invented to quantitatively measure the magnitude of the difference between the sample

distribution and the true population's distribution. Therefore, I did not understand yet that even saying that research “has statistical significance” or “has no statistical significance” was problematic. This misunderstanding was derived from the statistics education I had learned for years before I relearned p-values. Therefore, before I become part of the misleading statistics education and perpetuate it, I need to nip it in the bud. However, can I make my peace with teaching “the bud” by resolving to point out the limitations and to encourage students to use a critical lens when considering the validity of statistics?

Critical Lens of P-Values Involving Subjectivity: Infusing Other Academic Experiences

I remember one day in class I asked Professor A:

“When we teach p-values using a critical lens and trying to tell students not to use the language of statistical significance, what other tools can we teach them to use to evaluate the research intervention’s effectiveness?”

“We can encourage them to use other statistical tools such as their research’s confidence interval, how they understand their descriptive data, and their expertise in empirical, academic, professional, or even personal experience combining the statistical results in research,” Professor A answered.

“But what if teaching them the critical lens of using p-values will negatively impact their academic products such as publications?” I asked again.

“I know! This is a great but hard question. I don’t know if I have a short answer for this,” Professor A calmly expressed his exasperation.

“I will still teach them about this, and my students will have to make their own decisions,” I replied.

“Yeah? Sounds good! So, it is more of an issue of policies than that of science.”

This was why I kept saying that statistics could be about subjectivity because the more accurate way of doing statistics, such as evaluating statistical inference, according to Professor A's thinking mentioned above, is to use our descriptive data, our expertise in empirical, academic, professional, or personal experience to explore a research intervention's effectiveness. All this sounds subjective to me, and it does not have to be considered "bad science."

Using Indigenous Critical Theories (ICT): Centering Myself in the Knowledge of P-Values

As an Indigenous student and woman, I trust my intuition and my thinking. I have an intuition/thinking inside of me that is learned from birth to now. It is this intuition that keeps me asking via one ICT concept—putting myself at the center of the learned knowledge (in this case, p-values):

"Why is it important to place myself at the center of learned knowledge?" I asked myself, rhetorically.

According to ICT, centering myself on the learned knowledge accompanies *challenging the mastery (claim/possession) of the knowledge* (Justice, 2016). It is important to place our Indigenous intelligence at the center of learning because locating ourselves at the center of knowledge proposes Indigenous excellence to offer the colonial world a wider network such as Indigenous knowledge or ways of knowing (Justice, 2016). Also, it is crucial to challenge the master (claim/possession) of the knowledge because, without this challenge, we would be unable to give up our pride (should we notice our greed to claim knowledge in order to possess it) in the process of knowledge-making, nor could we "...comprehend one another...to be okay with the mystery between us—and maybe even nurture it" (Justice, 2016, p. 24).

One day in 2018, I recalled the conversation I had with Professor A:

“If my p-values are not significant, does that mean that I need more data or that I might do something wrong in the process of my statistical analyses, and I need to check my data, my analytical procedure, and my variables?”

Writing this made me realize that I was misunderstanding science and statistics in 2018. Writing this, I realize that, for as long as I was in Professor A’s statistics courses, he had tried to guide us to unlearn the dichotomous use of p-values for not just p-values’ own sake. He was trying to remind us that even though sometimes peoples believe that scientific research can be considered science, it might be far from what science means if their approach can be incorrect (or unscientific).

Writing this, I realize that he was saying that the dichotomous use of p-values could not be scientific because the calculation of p-values only decides a qualitative part of the research. It means that p-values only could be used to explore a descriptive statistical range about how far a sample population is from the true population (Goodman, 2019; Salsburg, 2001). The numbers calculated from p-value mathematical formulas only suggest that where the statistical distributions of the sampled and the true population fall on; both distributions could be either close to each other, a little far from each other, quite a bit, or greatly far from each other. Researchers should decide their research interventions by using their expertise to evaluate the possible range of p-value numbers and decide the possible level of the effectiveness of research interventions; it is by no means that researchers could just use a numerical threshold to decide if the research interventions work or not. The more accurate way is to use p-values to first decide a range of effectiveness of the research interventions, researchers then employ their professional judgment with other statistical tools (e.g., confidence interval, effect size, their observation of descriptive data in research, etc.) to suggest *how effective* the research interventions could be

instead of “whether” the interventions are “effective or not” by a dichotomous number of a p-value. For me, it is a more qualitative process in doing research, thus, statistics could be about subjectivity.

Without centering myself in the conversations with Professor A, I would not discern my misunderstanding of p-values when I kept asking how to get “statistical significance” in research. Admitting that I thought wrongly about any knowledge I have learned as a doctoral student, educator, researcher, scholar, and professional in Western academia is humiliating. But as an Indigenous student and woman, it is liberating!

Discussion Summary: Centering Myself Into P-Values and Finding Its Subjectivity

In exploring how I made meaning of p-values in the statistics courses I attended. I first illustrated how my experience in my math classes growing up foregrounded my math anxiety. Without showing my math anxiety, my fear of statistics would have no grounding. This math anxiety was related to the math education I received growing up in Taiwan (such as memorizing formulas, solving problems fast, and not being able to ask questions). It also showed how my family taught me about being Indigenous—our math is not as good as the Chinese; thus, we are not as intelligent as the Chinese.

I then described my first statistics courses in Taiwan and the U.S. as a graduate student. On the one hand, I intended to compare the different pedagogies about math that the two professors employed; the difference in how I was taught the pedagogies is that statistics in Taiwan is about doing math tests quickly and accurately versus how statistics in my graduate program is not only about doing math. On the other hand, I showed how my math anxiety still existed in both courses related to doing math as the basis for understanding statistics. These two courses unveiled that my fear of statistics was derived from my math anxiety, that my math

anxiety was from being an Indigenous student, and that being an Indigenous woman and student meant encountering society's discrimination, racism, and even my own Indigenous family's subjection to these oppressions that are likely to cause emotional trauma. However, most importantly, the story of my first statistics course in my doctoral program in the U.S. helped the onset of my overcoming the fear of statistics. Professor A's kindness and humbleness allowed students like me to ask whatever questions regarding statistics and math, even if they might sound basic.

Lastly, I used my conversations with Professor A, and these conversations illustrated that using p-values can be a social norm as society believes that using statistical significance is canonical and "scientific." Therefore, as a social norm, even if it is dubious to use statistical significance, it would not be worth questioning it due to the prevailing and systemic academic power. Also, I made meaning of using statistical significance via my epistemology that utilized Indigenous critical theories' (ICT) centering my Indigenous self in the knowledge of p-values. Therefore, how I made meaning of p-values by centering myself in the conversations with Professor A led me to realize that statistics should include subjectivity instead of only objectivity as how society claimed. It could be subjective because p-value numbers should be used to evaluate the statistical range of *how effective* research interventions could be via researchers' subjective professional judgment.

Overall, centering myself into the knowledge of p-values by my conversations with Professor A enabled me to interpret my learning of p-values in a different way, a way where I noticed that my former misunderstanding of p-values, including looking for a statistical significance, was influenced not only by non-critical statistics education. For instance, statistical significance means research significance, but I cannot just accept how research significance

operates. Instead, I must critically question the historical status-quo methods that set the stage for research significance. I cannot simply sit idly and claim p-values as an objective tool to declare research as significant. How is it that researchers just continue a method that is based on social constructs that reify objective truth while using subjective thinking?

Findings of Research Questions 2: How Do I Make Meaning of P-Values in the Literature?

In the previous section, I concluded that my meaning-making of p-values in the statistics courses in my doctoral program revealed to me that the use of p-values is a social norm and that statistics could involve subjectivity. In this section, I address my in-depth interpretation of how the literature of p-values shows subjective certainty.

Canonical Use of P-Values Brings Certainty to Researchers

When using the word *certainty*, I relate it to using p-values as it is a definite number to be certain of a research intervention's effectiveness, thus making researchers feel comfortable proclaiming the research intervention's effectiveness (Amrhein et al., 2019). In other words, how researchers historically have come to know (epistemologically) that the nature of research reality (ontology) is bound to the fact that p-values should be used in a certain way, e.g., if a p-value's numerical number is smaller than 0.05, the research intervention/treatment works; otherwise, the intervention/treatment does not work and should be considered 'ineffective' in research (Goodman, 2019; Hubbad & Armstrong, 2006; Wasserstein et al., 2019)

In this section, I delved deeper into historical elements showing how past researchers had developed literature and studies proclaiming and practicing the canonical value and use of p-values in all realms of research in Western civilization.

Science, Objectivity, and Statistics

According to my exploration of research question 1 in the previous section, “How do I make meaning of P-Values in the Statistics Courses I Attended,” I concluded that statistics could engage in subjectivity. This conclusion was also supported by the following point discussed in the literature of this study: Statistics is not only about objectivity but also subjectivity. For instance, the history of statistics and science revealed the subjectivity in statistics as Ronald Fisher’s (the inventor of p-values) contribution to building the foundation of modern statistics (e.g., the canonical use of statistical significance) was a product of subjectivity, i.e., a group of European authoritative scientists one day in a conference arbitrarily decided that 0.05 could be the threshold of the statistical significance (Salsburg, 2001).

In another case in the literature review, I also commented that Fisher’s p-value canon was not only disseminated by Fisher’s excellent, objective, and inextricable math theories; this canon was also interpreted by Harald Cramér’s mathematical explanations to make p-value theories understandable by most scientists. Unfortunately, due to Fisher’s inability to explain his math formulas about p-values, most scientists still do not entirely comprehend what a p-value calculates (Salsburg, 2001).

All the above expresses how using p-values, thus using statistics, could involve subjectivity. That is to say, if science can involve subjectivity, would claiming *objectivity* be “unscientific”? What is unscientific? To answer this, I ask, “What is scientific?” In brief, according to my own understanding, any concept that aligns with the following description could define the term ‘scientific’:

It was believed that, with more and more precise measurements, the need for an error function would diminish. With the error function to account for slight discrepancies between the observed and the predicted, early-nineteenth-century science was in the grip of philosophical determinism—the belief that everything that happens is determined in

advance by the initial conditions of the universe and the mathematical formulas that describe its motions. (Salsburg, 2001, Location No. 131)

Thomas Kuhn, an American philosopher of science, over 50 years ago in his book, *The Structure of Scientific Revolutions* (Kuhn, 2012), explained that science also would be altered by paradigms:

Men whose research is based on shared paradigms are committed to the same rules and standards for scientific practice. The commitment and the apparent consensus it produces are prerequisites for normal science, i.e., for the genesis and continuation of a particular research tradition. (p. 11)

I interpreted these quotes about science this way: Science also contains much subjectivity more than its followers claim; thus, statistics analyzing science could be subjective and affected by paradigmatic biases such as, in this case, the overwhelming popular claim of statistical significance in modern science.

Referencing Goodman's (2019) Concept: Different Disciplines Have Different Jurisdictions of Statistical Significance

If science can involve subjectivity, is claiming *objectivity* “scientific”? Following the statistical revolution, scientific researchers started using statistical analysis to refine measurement errors in various scientific experiments; they then began using p-values to make statistical inference to decide the effectiveness of their research interventions (Salsburg, 2001). Theories of statistical inference were created to evaluate the true distributions of the collected data and the parameters, which also means measurement errors in research. However, as I mentioned before, after a group of European scientists arbitrarily decided to use a threshold of p-values (e.g., a p-value smaller or bigger than 0.05) to claim research's statistical significance or statistical insignificance, looking for “statistical significance” became a social norm to own

research or publication significance within academia in science and the social sciences (Salsburg, 2001).

I made meaning of the literature review by first referencing Goodman's (2019) concept: different disciplines have different jurisdictions of statistical significance. This concept drove me to ask why most researchers prefer to use p-values as they are the definite tools to objectively determine their research interventions' effectiveness. Besides the social norm of using p-values that I found in the statistics courses, I started questioning whether there is something deeper in the use of p-values.

Reporting Statistical Significance Is a Scientific Canon in Most Statistics Jurisdictions

When Goodman (2019) argued that different disciplines regarding teaching and using p-values have different jurisdictions of statistical significance, he confirmed that using statistics can be about subjectivity. He also argued that even though different disciplines taught different jurisdictions about using p-values, reporting statistical significance was still a scientific canon within these different jurisdictions.

Critiques of the dichotomous use of p-values are not new. In fact, since the 1980s, many statisticians have produced articles to warn researchers about the problems of reporting statistical significance as objectivity such as dichotomously using a numerical number to define a research intervention's absolute effectiveness; they have also encouraged researchers to recognize the need to learn the subjective meaning of p-values (Fidler, 2005; Hubbard & Armstrong, 2006; Thompson, 1996; Ziliak & McCloskey, 2011). However, most researchers still seem to only believe the dichotomous use of p-values. How could this be? From the literature review, I learned that European mathematicians from the 18th to 19th centuries developed math theories that became the foundation of statistics, and the statistical revolution overwhelmingly changed

how scientists conducted research, including from doing qualitative science observations to predominantly using statistical strategies to analyze experiments. Okay! With this, I understand why objectivity is crucial for the purpose of science (because it could offer scientific researchers quantifiable numbers to measure errors). I also understand that, due to the objectivity, researchers could justify the dichotomous use of p-values because they were created by Fisher's complex mathematical formulas and philosophy whereby researchers could feel a sense of certainty when using a mathematical framework (remember that I mentioned before that the statistical revolution, i.e., making mathematical theories a true way to conduct scientific experiments, made the statistical analysis a must in any scientific experiment). Okay, I understand why mathematical theories such as statistical analysis, are important to science and the social sciences because of the history of science and the statistical revolution. What about the options of observing research statistical inference? Why do researchers only use p-values in research to observe statistical inference? Why couldn't other tools observing research statistical inference be popularized? This question is explored in the following section.

Researchers' Misunderstanding of Statistical Significance: Good P-Values Perceived as Good Research Results

While most scientists believe that good probabilistic statistics can generate good probabilistic properties, thus creating good p-values, they have misunderstood or even twisted this concept to assert that p-values can be explained by quantity to employ their usage in research (Ziliak & McCloskey, 2011). For example, scientists erroneously believe that p-values can test "... (1) the results occurred because of chance, (2) the results will replicate, (3) the alternative hypothesis is true, (4) the results will generalize, and (5) the results are substantively significant" (Hubbard & Armstrong, 2006, p. 114).

About the aforementioned point (1): *p-values can test the research intervention's results because of chance* (Hubbard & Armstrong, 2006), I learned that Hubbard and Armstrong (2006) contended that one of the reasons that scientists misunderstand that p-values can test the research intervention's results is because they do not question Fisher's formula of p-values regarding how p-values' statistical philosophy of chance (e.g., if the distribution of the research population is assumed to be normally distributed, then the chance of having a good p-value could be scientifically and statistically sound, which means, unquestionable).

For the aforementioned point (2): "...the results will be replicated..." (Hubbard & Armstrong, 2006, p. 114), Hubbard and Armstrong (2006) were saying that researchers misunderstand that any scientific research method verified by a p-value to be statistically significant could be applied to another research population and the results could be replicated (Hubbard & Armstrong, 2006). For the aforementioned point (3): "...the alternative hypothesis is true..." (Hubbard & Armstrong, 2006, p. 114), Hubbard and Armstrong (2006) meant that researchers often are misguided by non-critical statistics education to believe if a p-value is significant (e.g., smaller than 0.05), the alternative hypothesis will be true, which means that the research intervention works. For the aforementioned point (4): "...the results will generalize..." (Hubbard & Armstrong, 2006, p. 114), Hubbard and Armstrong (2006) addressed the mislearning that if a research intervention is "statistically significant", the study's suggestions of the research intervention such as policy reform, educational practicum, alteration of drug use, etc. could be considered useful for the general population. In pointing out the aforementioned (5): "...the results are substantively significant" (Hubbard & Armstrong, 2006, p. 114), Hubbard and Armstrong (2006) were just emphasizing how strong researchers' misbelief in p-values is; it means that if the p-values are significant, the research interventions are substantively significant

in the realms of points (1) to (4) mentioned above. In essence, these points confirm how researchers tend to believe that a good p-value brings a good result, thus bringing good research. Why are p-values so popular to validate statistical inference? Hubbard and Armstrong's (2006) explanations helped me understand that researchers believe in p-values so much because they never question what p-values calculate due to the scientific canonical norm of teaching p-values.

Discussion Summary: Critiquing Objectivity From Using P-Values

I made meaning of p-values in the literature review by, first, exploring the history of statistics to understand why using p-values is considered crucial for scientific research. I found that evaluating p-values is important to scientific research because p-values are a range of sample parameters that can help researchers observe how the research data's statistical distribution deviates from the true population's distribution (Hubbard & Armstrong, 2006; Thompson, 1996). Therefore, when researchers try to designate a p-value as a quantitative function, the essence of this act becomes an incompatible conflict because the nature of p-values functions is a descriptive one instead of a numerical one; Ziliak and McCloskey (2011) called this unscientific. Unfortunately, the history of statistics and science explored in the literature shows that p-values have been canonized to determine a research intervention's effectiveness dichotomously by a group of authoritative scientists and their academic followers in the early 20th century, making a numerical threshold for p-values to decide if research is statistically significant or not.

What Might A P-Value Calculate?

A more truthful version of how to use p-values is to know that p-values were created to help researchers observe research data's range of deviation, such as research data's statistical distribution, from the true population, assumed in research, which means the population's statistical distribution (Gelman, 2016; Wasserstein & Lazar, 2016; Wasserstein et al., 2019).

Also, a p-value's number could only serve as a reference to a researcher about a possible numerical range of how research intervention works (Thompson, 1996; Wasserstein et al., 2019). It was *not* created by Fisher to be divided via a numerical threshold, *nor* should it be used as a binary to decide a research intervention or treatment (Salsburg, 2001).

Centering Myself in the Literature of P-Values

When centering myself in the knowledge of the literature as an Indigenous woman and student and referencing Goodman's (2019) concept of *different disciplines have different jurisdictions regarding p-values*, I explored why the dichotomous use of p-values is needed for research and learned its cruciality from the concept of a statistical distribution, which is a statistical and hypothetical entity whose true population can never be concretely observed/collected in statistical research (Salsburg, 2001).

Without putting myself in the knowledge and conversing with myself to learn the relationship between p-values and their history and statistical distribution, I could never comprehend a more truthful version of p-values by reading the statistics textbooks that I had studied over the prior 12 years. Therefore, with this understanding, I confirm, in tandem with my meaning-making of p-values, that statistics can involve not only objectivity but also subjectivity as it is invented to mostly seek objective solutions while being affected by politics, disciplines, and human decisions.

Findings of Research Question 3: How Do Research Questions 1 and 2 Help Me Address Inequities?

The previous section guided me to critique the oppression generated from using p-values dichotomously while discerning one rooted mentality behind the dichotomous use of p-values—humans like certainty as it brings comfort to us (Thompson, 1996; Wasserstein et al., 2019).

Most researchers would prefer believing in the objectivity of p-values, even enshrining p-values' doctrine as objective sanctification for science, because we gravitated toward the comfort that hypnotizes us by the sugar-coating certainty. In this case, making p-values all about objectivity is more comforting for us than challenging the problem inherent in its current use. If we intentionally choose to live just a little bit more soberly, we might notice that "trusting in objectivity" is the sugar that has coated *uncertainties* all over via multiple layers of disguise, which is a concrete certainty that brings "a good life." Amrhein et al. (2019) encouraged us to embrace uncertainty because it is the nature of science:

Again, we are not advocating a ban on *P* values...or other statistical measures—only that we should not treat them categorically. This includes dichotomization as statistically significant or not, as well as categorization based on other statistical measures such as Bayes factors.... One reason to avoid such 'dichotomania' is that all statistics, including *P* values and confidence intervals, naturally vary from study to study, and often do so to a surprising degree. In fact, random variation alone can easily lead to large disparities in *P* values far beyond falling just to either side of the 0.05 threshold. For example, even if researchers could conduct two perfect replication studies of some genuine effect, each with 80% power (chance) of achieving $p < 0.05$ and the other $P > 0.30$. Whether a *P* value is small or large, caution is warranted.... [Therefore],...we must learn to embrace uncertainty. (pp. 306-307)

How I made meaning of research questions 1 and 2 in the study led me to recognize inequities generated from using p-values, and this recognition assists in addressing these inequities. I continued exploring these inequities via Indigenous critical theories' (ICT) concept of *challenging the mastery of knowledge by centering my Indigenous self in the middle of the learned knowledge*. In this case, *the mastery of knowledge* that I challenged was Western ways of learning, teaching, and using p-values that claim concrete certainty that brings life wellness.

In addition, ICT's concept urged me to use my Indigenous ways of learning taught by my grandma. She taught me to learn the world to love and be kind, which led me to empathize when locating myself at the center of the knowledge of p-values, statistics, and scientific research. This

has meant that I have needed to learn and unlearn the use of p-values, statistics, and scientific research. In other words, I have taken many quantitative research classes which have taught me math and the methods of utilizing p-values through Western epistemological foundations. Yet, I have realized that in learning the Western way of quantitative research, I come back full circle to my Indigenous roots of knowing. This has helped me to deconstruct the meaning of research and why it is important to critically challenge the status quo since I recognize I have not been seen or part of this Western developed reality but instead my thinking has been rendered invisible or non-existent. Doing this helped me interpret the inequities generated from p-values via what I found in exploring research questions 1 and 2 in the study:

1. Using p-values is a social norm.
2. Statistics involve not only objectivity but also subjectivity.

Therefore, the essence of the inequities I found through my meaning-making of research questions 1 and 2 was based on my learning of p-values, which is canonized as the credible research methodology. But how does the canon create injustice?

Dichotomous Use of P-Values Hurts Taxpayers and the Unemployed

Let me share a concrete story about an inequity generated from the dichotomous use of p-values:

Testing economic hypotheses in no particular dimension yields a spaced-out economics, and points to the wrong policies. Consider, for example, an article in *the American Economic Review* in the 1980s that estimated benefit-cost ratios in an Illinois experiment concerning unemployment insurance.... In brief, the experiment paid a cash bonus for giving an unemployed person a job.... In the control group the workers were paid the same subsidy, only this time the check was mailed directly to their homes. The main benefit of the training subsidy from the point of view of the state of Illinois was the reduction in unemployment benefits needed once the worker is back in employment. To this should be added, among other things, the benefit in the self-respect of the worker and the amount her labor adds to state economic output. But suppose we consider only the simplest case accounting, as it appears the authors did. The “cost” of the experiment was

the dollars of tax money spent on the subsidy. So a benefit-cost ratio of 4.29 means that the state saved \$4.29 for each dollar it spent.

Here is how the authors interpreted their findings: “The fifth panel...shows that the overall benefit-cost ratio for the Employer Experiment is 4.29, but it is not statistically different from zero. The benefit-cost ratio for white women,... however, is 7.07, and is statistically different from zero.... The 7.07 ratio “affects,” they said, the 4.29 did not. This is a mistake. The best guess of the researchers was that the state got sampling error alone. But that does not mean it is to be taken as zero.... By reporting that the 4.29 was not “significant,” and therefore supposing that it was in fact zero, and therefore not telling the policymakers that they should use it, the economists hurt the taxpayers of Illinois...and the unemployed. (Ziliak & McCloskey, 2011, pp. 98-99)

When the Employer Experiment in the quote above concluded that using p-values dichotomously, “...The fifth panel...shows that the overall benefit-cost ratio...is not statistically different from zero” (Ziliak & McCloskey, 2011, p. 99), it meant that the treatment of benefit-cost ratio is not statistically significant; it then led policymakers to believe that the treatment of the experiment, including the intervention of paying a cash bonus for giving an unemployed person a job to overall workers was not effective, thus, deciding not to pay cash bonuses for giving the unemployed jobs (Ziliak & McCloskey, 2011). On the other hand, the experiment above showed that “The benefit-cost ratio for white women...is statistically different from zero” (Ziliak & McCloskey, 2011, p. 99). This meant that the treatment of the research to White women is effective. These results led economists to not advocate for policymakers to fund the overall unemployed workers’ insurance benefits in Illinois. This was a mistake because this decision evaluated the study’s results as solely created by a “numerical,” “dichotomous,” and “misused” p-value (Ziliak & McCloskey, 2011).

While Ziliak and McCloskey (2011) concluded that “By reporting that [the p-value of the research treatment to the overall workers] was not [statistically] ‘significant,’ ...and therefore not telling the policymakers that they should use it, the economists hurt the taxpayers of Illinois...and the unemployed” (Ziliak & McCloskey, 2011, p. 99), I was making this

aforementioned story personal to me as this is an inequity for me; it is unfair and unjust. This experiment was conducted to decide if the state of Illinois should fund the unemployed while the funding came from the taxpayers. Too often, such experiments show half the story based on the statistics. The White women benefitted, while the other unemployed peoples were ignored by researchers, which then led to policymakers leaving a key group of peoples out of benefits. How often does such research leave vulnerable groups of peoples behind?

Not only is the above research inequitable, based on how the researchers and policymakers interpreted the data, but I see myself in this research. If dichotomous p-values can leave a group that needs such subsidies out of receiving important benefits even after they pay their taxes so that they can receive such assistance during a difficult time in their life, does not it mean the arbitrary power of researchers and policymakers can decide the subsistence of peoples' existence? This makes me angry because I am a taxpayer and I have seen too many terrible stories about being unemployed, and my family and I have been ignored and viewed as inferior in a country that benefits and deems Chinese peoples as superior. My mom and dad lived through policies where they could barely survive because we are Indigenous. My dad had a terrible accident, and even though he was found to not be at fault, it is my dad who had to pay for the accident. I still remember my uncontrolled rage when I found out that the policemen collaborated with the plaintiff's family to destroy the video evidence that would have proved the accident was not my dad's responsibility. I still remember when my dad begged the judge to vindicate him:

“I am Indigenous, I cannot afford four hundred thousand dollars for this; it is not my fault; I barely make 8 thousand dollars a year; the scooter ran into me when I was stopped!”

My dad begged, trying to make the judge know that it was not his fault.

“The man is in a vegetative state now, so even though he hit you, you still need to take some responsibility to help his family. Also, there is no proof that he was the one who hit you,” said the judge.

“He hit me! The policemen have the video; they just don’t want to show it. I don’t have that much money. Please consider that I am Indigenous and I don’t have that much money,” pleaded my dad.

“It is because you are Indigenous, so you need to be more careful,” said the judge, coldly.

“But how can I pay this much money?” Dad asked.

“Your retirement will be confiscated if you cannot pay for it.”

“...” My whole family was speechless!

“We don’t have money to hire ‘a really good lawyer’ to appeal!” My whole family felt hopeless.

Mom died after this accident. Mom had always been ill but a fighter who survived from one emergency room to another. I thought that time Mom’s heart attack was really serious so it killed her. “No, she said she just didn’t want to fight for her life anymore after the accident! It was too hard, and she said that she gave up!” Dad told me with calm resignation.

Any inequity is personal to me because I have encountered some of them since I was in my mom’s womb. As a Taiwanese Indigenous child who grew up in Taiwan, inequities were the food my parents often put on our dinner table; it means no money for the next meal, no rent for the next month, no tuition for the next semester for PK-20 education, and no pride to ask for a decent-paying job. Living in inequities means that the peoples in power could make the rules and bend them to benefit the peoples in power and continue to harm us who are deemed inferior to

them; whether the peoples in power recognize they hurt peoples or not, they always have options and privilege to justify their deeds and tell themselves and others, “No offense! It’s all business!”

Why are inequities personal to me? They are personal to me because inequities are the meritocracy¹² that ensures that I will likely spend more time than I need to graduate from graduate school in the U.S. because English is my second language. I now live in a meritocratic society that views my social standing based on the effort, ability, and hard work I use to advance my standing in life. The problem with meritocratic ideology is that it assumes we all start at the same starting point and equally compete to succeed or fail. Yet as an immigrant daughter of day-laborers in a meritocratic society, it is assumed that, for instance, I can achieve and become just as successful as the daughter and heir of Walmart. All I have to do is work hard and prove myself but if I do not succeed, it means that I have not put forth enough effort, preparation, or ability compared to the daughter of Walmart. The fallacy of such individual meritocratic myths is that it ignores societal structures that privilege colonial institutions/oppressors, heterosexist, classists that wield power and policy to further the wealth and power structure. I was never on the same playing field as the daughter of the Walton’s whose father had policies that fostered the creation of his wealth. I came to the U.S. and accrued debts as I am doing my best as a hard-working immigrant woman to become educated, but my education is at the cost of time. Also, as a second language learner, I constantly feel that I must prove myself to meet the “Standard English’s” precision necessary in American research. For instance, I was asked to hire a “native English” editor to proofread my dissertation manuscript which would cost me at least 2,000

¹² Sandel (2020), an American political philosopher, explained that meritocracy is a fair state where individual effort and talent can predict social positions, but it “...has a corrosive effect on the way we interpret our success...” (p. 25). Further, Sandel (2020) argued that a meritocratic state ...reflects the tendency of winners to inhale too deeply of their success, to forget the luck and good fortune that helped them on their way. It is the smug conviction of those who land on top that they deserve their fate, and that those on the bottom deserve theirs, too. (p. 25)

dollars to do so (even though many “native English” scholars already proofread it). How is this fair when I cannot even make 2,000 dollars as a graduate teaching assistant a month upon my medical debts in this country?

Of course! The power would tell you, “No offense! It’s just business! We are doing this for you to have the best quality of your education; we want you to thrive so we want your manuscript ‘perfect!’”

It is my struggle to live in a country where research makes policies that sorts those who can and those who can’t into a mythological meritocratic unequal and inequitable system that was never built for me as an Indigenous immigrant woman. Indeed! The issue of meritocracy is much more complicated than my stories. It requires more than a book to talk about it.

Discussion Summary: The Dichotomous Use of P-Values Jeopardize Human Lives

In exploring my learning of p-values via the statistics courses and the literature in the study, I have learned how science has been revolutionized by statistical philosophy and become a field that uses statistical inference to validate most of the scientific research: it involves not only objectivity but also subjectivity. Making meaning of research questions 1 and 2 by placing myself in the learned knowledge and challenging what is commonly understood as scientific knowledge when I try to master it, I understand how inequities can be generated from the dichotomous use of p-values such as academic bias, job loss, and unjust policy decisions. What is worse is that serious consequences of this practice of inequities may be the cost of human lives due to data fudging for statistical significance as in the following story:

Merk was in 2005 the third-largest drug manufacturer in the United States. Its painkiller Vioxx was first distributed in the United States in 1999 and by 2003 had been marketed in over eighty countries.... In that year [2003] a seventy-three-year-old woman died suddenly of a heart attack while taking as directed her prescribed Vioxx pills. Anticipating a lawsuit the senior scientists and company officials at Merk, newspaper accounts have said, huddled over the statistical significance of the original clinical trial.

The clinical trial was conducted in 2000, and the findings were published three years later in the *Annals of Internal Medicine* (Lisse et al., 2003). The scientific article reported that “five” [note the number, five] patients taking Vioxx had suffered heart attacks during the trial, compared with one [note the number, one], a difference that did not reach *statistical significance*....

Therefore, Merk claimed, given the lack of statistical significance at the 5 percent level [$p > 0.05$], there was no difference in the effects of the two pills...they said, despite a Vioxx disadvantage of about 5 to 1. Then the alleged fraud: the published article neglected to mention that in the same clinical trial *three additional takers* of Vioxx, including the seventy-three-year-old woman whose survivors brought the problem to public attention, suffered heart attacks. It appears that the scientists, or the Merck employees who wrote the report, simply dropped the three observations. (Ziliak & McCloskey, 2011, pp. 28-29)

This story contains a much more complex interpretation than just one side of the story.

However, as Ziliak and McCloskey (2011) mentioned, the perpetuation of academic and scientific publication due to “statistical significance” (the dichotomous of p-values) is one case; the cost of human lives should be a “case” that should draw researchers’ attention to at least start relearning statistical inference and be less certain about claiming “statistical significance” in research, especially if this claim takes lives and harms peoples due to human error and/or justifiable statistics.

Ignorance is dangerous. The cases above said it all. I have no better words to describe the inequity that causes death. My meaning-making of research questions 1 and 2 revolved around my abhorrence of inequities as an Indigenous woman and student who aligns my own sorrow and anger when facing inequities with the ones generated from statistical significance; they all hurt, oppress, and threaten peoples’ rights, minds, and lives.

Lorde (1984) said that peoples who are oppressed are always asked to do a little more to be a bridge between oppression and humanity, so I see my role as a researcher seeking to bridge a gap by revealing how humanity must have different ways of operating and thinking so that research can be broadened away from a status quo of dichotomous thinking. My meaning-

making of research questions 1 and 2 also resonates with Lorde's (1984) call for putting an end to silence by talking about inequities in the U.S. to heal our oppressed, mental, emotional, and spiritual beings. In this case, I am putting an end to silence by critiquing the use of p-values in the U.S. to heal myself from the "me" who used to resonate with the following lies about the dichotomous use of p-values.

Findings of Research Question 4: How Do Research Questions 1, 2, and 3 Help Me Overcome My Fear of Statistics?

At first, I planned this study to examine my learning of p-values and the inequities generated from them as an Indigenous woman and graduate student without talking about my fear of statistics. However, in reflecting upon my meaning-making of the statistics courses and literature for this dissertation research by deeply centering my Indigenous self in the knowledge of p-values and empathizing with other researchers who use p-values dichotomously, I sensed some positive emotions toward math and statistics that I did not have before, that is, feeling brave enough to ask my professors about statistical questions and gaining a sense of achievement by facing and figuring out these questions: all this makes me feel strong and smart.

Centering My Indigenous Self in Knowledge Offers Strength

How I was falling into the trap of using statistical significance as the only way to determine a research treatment/intervention's effectiveness was expressed in my meaning-making of p-values in statistics courses. This trap suggested that I was blindly choosing the most common way of deciding a research treatment's effectiveness instead of wanting to know the more truthful version of reporting my research (shown in one of my discussed questions to Professor A: If we don't report statistical significance, what other tools could help us decide the statistical significance of the research?).

Locating Myself Again in My Misunderstanding of P-Values

In 2018, one afternoon, again, in Professor A's statistics course. The sun outside was still smiling and jumping through the green leaves. I wanted it to jump into the classroom, but it stayed outside as our conversation continued:

“If we don't use p-values, are there other tools to decide how to measure statistical significance?” I asked Professor A again in the course after my classmates shared their thoughts.

“What we need to debunk is that if you are asking for other tools instead of p-values to decide statistical significance, we are falling into the trap again of misunderstanding what statistical significance really means. Statistical inference was not invented to measure the quantity. If we believe that statistical inference only can prove whether there is a difference between the distributions of the sampled and the true populations and cannot attest to the magnitude of differences (the significant difference) between the two distributions, we will know that asking and using statistical significance for how close/far between the two distributions is problematic,” replied Professor A.

“But I still want to know how we could decide statistical significance in my research; otherwise, why am I bothering to go through the whole trouble to research? I don't want to waste my time to do research and end up knowing that it's all a waste because my p-value could not claim statistical significance!” I vented.

See! I fell into the trap of dichotomous thinking of p-values. Professor A kept trying to help the whole class recognize that dichotomous understanding and the use of p-values can be dangerous. Statistical inference was created and designed mathematically to be more used to

describe a statistical range, not to reveal a statistical threshold. I sensed that the class was not comfortable with the idea of not having a clear-cut tool.

Class ended. I started wrapping up my notes while classmates were saying goodbye. I was going through a huge crisis in my life, so after that class, my train of thought stopped thinking statistics and went directly to how I was going to handle the crisis which might cost me my financial stability, my families' relationships, and my sanity as an immigrant woman in the U.S. My brain got stretched too much during statistics class. I wrapped up my stuff slowly and dragged myself out of the classroom. Every step going forward, an emotional cloud puffed up under my foot. I remember that, after walking out of the classroom, I felt that I was immersed in black clouds that my feet generated with each step.

Did I Just Argue With My Statistics Professor? Did I Become Smarter and Stronger?

Hold on! Writing the previous section, I just realized that I was arguing with my professor in a “statistics course.” Does this mean that I became strong (and the dark claw did not appear)! I guess so. Wait a minute, I just realized that I can now distinguish my misunderstanding about p-values from what I used to think, unlike most researchers in the literature and in my statistics courses. Something is going on. Did I become smart? I guess so.

This is a huge realization for me, even bigger than my relearning p-values. If I did not explore deeper by placing my Indigenous self, wanting to challenge my own mastery knowledge of p-values while empathizing with other researchers, I could have ended up not comprehending anything Professor A said. If I were not an Indigenous student, would I question the use of p-values as I am now doing? It would be such a shame if I never understood more truthful elements about p-values. I was enthralled thinking about this while recognizing a sense of achievement that made me feel stronger and smarter.

Challenging My Own Mastery of Knowledge About P-values

Centering my Indigenous self in the knowledge of p-values offers strength to me about how to deconstruct the knowledge of p-values. I do not want to claim any new knowledge that I own about this dissertation, according to Indigenous critical theorists' encouragement.

If someone asks me to “show” why this dissertation is important to society, they are asking me to claim the mastery of the knowledge and to explain why, “as an Indigenous student and woman,” the knowledge I explore or create should be “taken seriously” in Western academia. In fact, as an Indigenous student and woman, I do not want to claim this importance just to prove to colonial gazers and power why my voice should be taken seriously. If Fisher did not have to explain his convoluted math that few peoples could understand to be considered a great figure in Western academia, why should I (not to mention that I don't want to be a great figure and stay in academia for Western colonialism)? If this dissertation could help society start being aware of inequities generated from p-values and begin abandoning using p-values dichotomously, it would be wonderful. If not, at least, I spoke to myself and found my own foundation realities about my learning and relearning of p-values.

Reviewing What A P-Value Calculates and What Statistical Inference Is

I remember that, for the last decade, I have spent countless nights wherein I felt sleepy and dumb when I could not understand a thing about how on earth a p-value's math formula was created and iterated as the canonical way of research. If I have figured out a little bit of truth of p-values, it was due to the times I spent interpreting my meaning-making of the literature in this study by talking to myself, walking back and forth thinking about my conversations with myself in the kitchen, yelling at the authors in my statistics textbooks, writing down the conversations with myself, and imagining being a statistician walking up and down the stairs, and trying to

believe that I could get it. The night that I figured out one point about what p-values could calculate was the night that I started feeling that maybe I am not as unintelligent as I thought!

A p-value was created to show the statistical deviation of a sample data's statistical distribution from the true population's distribution which could never be physically observed and collected (Thompson, 1996), thus being considered an abstract and imagined parameter. Also, the data's distribution, most of the time, in scientific research, could shed light on a research intervention's or treatment's effectiveness of the sample data (Fidler, 2005; Fisher, 1925, 1928, 1954; Sawyer & Peter, 1983; Thompson, 1996; Wasserstein & Lazar, 2016; Wasserstein et al., 2019; Ziliak & McCloskey, 2011). Therefore, observing the p-value could help researchers estimate their research interventions' effectiveness by observing how far the sample data's statistical distribution deviates from the true population's distribution (abstract and imagined). This process is known as statistical inference.

A-Ha! I Got What P-Values Calculate Regarding Statistical Distribution

Among many ways of evaluating statistical inference, p-values are used to observe how the sampled data's statistics could deviate from the true population's parameter. The concept of statistical distribution after the statistical revolution has evolved to become a popular issue of debate in the field of statistics because the debate of the nature of statistical distribution (a true entity or an abstract idea about a population) fostered the development of statistical inference (Fidler, 2015; Salsburg, 2001).

Karl Pearson and Ronald Fisher held different attitudes about statistical distribution (Fidler, 2015; Salsburg, 2001). Pearson viewed statistical distribution as true and concrete data to analyze, but Fisher opposed Pearson's view and thought that the true distribution could never be observed; it was an abstract mathematical formula that could only be used to estimate parameters

of the true population's distribution (Salsburg, 2001). Salsburg (2001) stated that in the 1930s, Fisher won the argument; therefore, his invention of statistical significance was supported with the following reasoning:

Since the statistic is random, it makes no sense to talk about how accurate a single value of it is. This is the same reason it makes no sense to talk about a single measurement and ask how accurate it is. What is needed is a criterion that depends upon the probability distribution of the statistic, just as Pearson proposed that measurements in a set have to be evaluated in terms of their probability distribution and not their individual observed values. (Salsburg, Location No. 1062)

“Since the statistic is random...” (Salsburg, 2001, Location No. 1062). A-ha! This sentence helped me understand why Fisherians claimed that the true population's distribution could never be observed. In other words, any sampled data has to be considered randomly collected so that it can offer statistical information that is not biased, meaning that the probability rendering the statistical information will not favor any possible occurrences in research (in an ideal condition). This also answered one of the questions I had pondered for years before this dissertation:

“Why do we have to suppose our population in statistics is not a real thing? Why can't we just say our population is like a real entity?”

The following dialogues 1 and 2 show how I answered my own questions above by talking to myself:

Monologue 1:

“Because statistics never can represent any true population that a researcher studies and the sampled data can never entirely represent the true population, thus when using statistics, one ought to always *suppose*.”

“Okay! Do you have an example?”

“For instance, if I would like to predict the doctoral completion rate (DCR) in the U.S. from 1900-2000. Do I have adequate time, money, resources, or sanity to collect *all* universities’ data during *all* these periods? Obviously, the answer is no. Even if I do have all the aforementioned requirements to do so, I then will not need to use statistics as I would be conducting a census. Therefore, if I am a scientist in this research, I have a scientific tool, statistics, to help me reach my goal. I could collect some random samples in random periods of time as my sampled data. Could this sampled data represent the true DCR from 1900-2000 at all universities in the U.S.?”

“Of course not.”

“Right! So, I have to find a way to predict DCR from 1900-2000 at all universities in the U.S. My sampled data’s statistics might show that my sample could represent the true DCR mentioned above; the statistics might show that my sample could represent the true DCR just a little bit; or they might show that my sample is far from representing the true DCR.”

“So, statistics scholars should believe that there is a way to try to predict the true DCR— if one sampled data could not do it, then *imagine* that we collect an abundance of data (or infinite data), observe their distributions, and do a prediction about the true DCR if we have to.”

“That is to say, as every sampled data is randomly collected (in an ideal condition), cannot represent the true DCR, and is collected from the population I research, statistics could *only* help me *suppose (imagine)* how the thousands of sample data points will estimate the true DCR, which are displayed and calculated through their distributions—if one accepts the concept of the Central Limit Theorem.”

“What is the Central Limit Theorem?”

“For random sampling with a large sample size n , the sampling distribution of the sample mean y is approximately a normal distribution” (Agresti & Finlay, 2009, p. 93).

Monologue 2:

“Statistical inference’s theory derived from the idea regarding how we can use our sample data to estimate the true population’s numerical elements; however, as the true population’s parameter cannot be ‘physically’ observed (nor collected), a statistical inference can only be used as a utilization to estimate how close or how far the sampled data can represent the true population. Remember what Professor A explained in one of his statistical courses?”

“So do you mean that sample data might be far from representing the true population?”

“Yes, simply put! Of course, according to the Central Limit Theorem (CLT), we have learned that if you want your sample data to be able to represent the true population, you might need to take more samples. Also, we have learned that from CLT, if you could collect thousands of data points or even infinite data (yet not from the true whole population), then your sampled data might be a lot closer to representing the true population. Remember what Professor A talked about?”

“So statistical inference is a test of how far or closely a sample distribution can represent the true population’s distribution. If the sample distribution could represent the true population's distribution, it means that the distribution of the collected sample data is similar to the true population’s distribution, so a researcher could say that, for example, *the research intervention* might not work (using the concepts of statistical inference and the Null Hypothesis Statistical Testing, NHST). On the other hand, if a researcher cannot

prove that the distribution of their sample data is similar to the true population's distribution, they can conclude that the research intervention might work (rejecting the NHST).”

“Yes, this is the shorter way I could confirm this—and remember! This is the dominant version of teaching how to use p-values.”

Wait a minute! Did I just answer my questions about p-values that have persisted for years? I guess so, and I think this helped dissipate my fear of learning statistics because I just realize that, among the countless nights in figuring out what a p-value could calculate, including right now when I am writing, I do not feel too dumb and timid to the point that the dark claw starts summoning my emotional storm. All this makes me feel stronger and smarter.

Discussion Summary: I Have Not Felt the Dark Claw's Emergence

In the process of finishing this study, I have become unafraid of dealing with concepts of math and statistics by studying them countless times and trying to paraphrase the concepts and explain them to myself. All this has led me to know that I could relinquish and shed my old thinking that I am not smart enough and that Professor A's kindness and humility also helped me so that I was not afraid to ask questions. Most importantly, in the process, I have not felt the dark claw's emergence (at least not the frequency that I remember from earlier in my studies before conducting this study)! In addition, conceptually, my dialogues with myself in the process of this dissertation have assisted me in concretizing the distribution of the sample data and the true population's distribution, and this does make me consider this possibility: I am smart!

CHAPTER FIVE: CONCLUSION

This study shows that the dichotomous use of p-values, including using statistical significance to determine a research intervention's effectiveness, has developed into a constructed social norm and that it not only involves objectivity but also subjectivity; however, other researchers' meaning-making of the dichotomous use of p-values might reveal other issues different than mine. My story is one that I stand upon as I have examined how statistical p-values influence research.

Summary of the Study

This empowering autoethnography emerges out of my learning, unlearning, and relearning about how to use p-values; I am renewed in knowing and trusting in my internal spirit of learning; I am aware of the study's limitations; I am aware of my own meaning-making of using p-values and how I have taken my readers on a journey through the crevices of my own thinking to discover a new horizon within my Indigenous intelligence. This study shows how I arrived at understanding the dichotomous use of p-values, including using statistical significance to determine a research intervention's effectiveness as a socially constructed research norm.

The motivation of this autoethnography started from my study notes and questions in the statistics courses I attended in my doctoral program. It was then narrowed to focus on issues of p-values because Professor A reminded me that my questions about statistics regarding Null Hypothesis Testing, statistical distribution, and the history of statistics and science all revolved around the issue of p-values. Further, while Professor A guided me to relearn p-values, I decided to focus on studying the dichotomous use of p-values for this dissertation because I began noticing how the dichotomous use of p-values has caused inequities in society.

As the inequities generated from the dichotomous p-values became personal to me due to my marginalized identities as an Indigenous student and woman in Western academia, I decided to use autoethnography as the research method so I could center my voice to represent myself instead of relying on others to represent my interests; therefore, the method helped me reveal the inequities of using p-values dichotomously such as academic bias, epistemological and research oppression, jeopardized jobs, and even premature mortality. Using autoethnography also helped me display my personal connection to learning the dichotomous use of p-values fueling the inequities that I abhorred growing up as an Indigenous student and woman.

The purpose of this study is to share how my learning and exploring of p-values have assisted me in overcoming my fear of statistics. I interpreted my meaning-making of inequities generated from the dichotomous use of p-values with the following elements: the epistemology located in Indigenous critical theories that encouraged me to challenge the mastery/possession of knowledge by centering my Indigenous self in the knowledge of p-values (Justice, 2016) and critical constructivist paradigm that assisted me in disclosing my multiple and cross-cultural identities to analyze the power structure in statistics education. Four research questions guide this study: (1) How do I make meaning of the dichotomous use of p-values in the statistics courses I attended? (2) How do I make meaning of the dichotomous use of p-values in the literature of this study? (3) How do research questions 1 and 2 help me address inequities discussed in this study as an Indigenous woman researcher? and (4) How do research questions 1, 2, and 3 help me overcome my fear of statistics?

Summary of Findings and Research Experience

In essence, exploring research question 1 led to my understanding of my meaning-making of p-values. This question initiated the direction of this dissertation regarding the issue of

the dichotomous use of p-values. In other words, how I made meaning of the dichotomous use of p-values in the statistics courses I attended in my doctoral program involve Goodman's (2019) concept, using p-values is a social phenomenon; ICT's concept of centering my Indigenous self in the learned knowledge; the in-depth narration of my fear of math and statistics that are derived from my emotional trauma; and my constant questions and conversations with Professor A.

Overall, my interpretation from the conversations in the statistics courses, regarding that, using p-values is a social norm and that statistics involves subjectivity, sheds light on the direction of my studies of the literature for this dissertation, which is addressed by research question 2.

In exploring research question 2, I made meaning of the literature by exploring the history of statistics, science, and p-values to view Western ways of learning, teaching, and researching to uncover why statistics are crucial to scientific research. I then located myself at the center of using p-values for understanding why using p-values is overwhelmingly needed in scientific research. Objectively, I found that it is needed because the true population could never be collected in most scientific research; thus, a p-value could help a researcher to observe how far the research data deviates from the true population (e.g., how effective a research intervention/treatment could be). Yet, subjectively, the fact that Fisher (also an advocate for the eugenics movement at his time) as one of the most brilliant and prominent mathematicians in colonial statistics helped p-values become the most popular golden rule of statistical inference.

All in all, in exploring research question 2, I interpreted the literature through my Indigenous roots by centering myself in the knowledge and using my Indigenous ways of learning that my grandma asked me to be empathetic, and this supports my argument in my meaning-making of p-values discussed in the statistics courses in my doctoral program. In other

words, my primary argument is that statistics involve not only objectivity but also subjectivity. Moreover, being empathetic urged me to put myself into others' shoes and realize one human mindset behind why most researchers prefer to use p-values dichotomously. Of course, I am aware that more complexities could affect researchers' use of p-values. In my meaning-making of p-values in the statistics courses and literature, the conflict between objectivity and subjectivity is what predominantly emerges from my interpretation of the study.

My meaning-making of p-values in exploring research questions 1, 2, and 3 has helped me articulate the connection between the inequities generated from the dichotomous use of p-values, including academic/research biases, jobs/lives being jeopardized, and the inequities I have faced growing up. This connection primarily shows how I have suffered from inequities as an Indigenous student and woman, including poverty and low self-confidence due to my parents' losing their jobs and facing discrimination and racism as Indigenous peoples in Taiwan. Thus, internalizing the discrimination and racism taught me one core message analyzed in this autoethnography: We Taiwanese Indigenous peoples are not good at math. This core message displays the beginning of my fear of statistics that I needed to learn math; in learning math, I felt unintelligent because I am an Indigenous student; and in dealing with this feeling of unintelligence, I tended to fall into the trap that made me emotional to the point that I felt hopeless. This core message also illustrates how my experience of fearing math and statistics connects to how I was taught the following points in colonial statistics education. They are involved around the idea that statistics are about objectivity: (1) learning statistics is to learn how to objectively solve scientific problems; (2) being good at math could help me be good at statistics; and (3) p-values smaller than 0.05 means that my research is statistically significant. All these interpretations allowed me to discover that Western, canonical, and colonial statistics

education is not fair nor just to students, as my stories have shown that all these inequities are personal to me.

In addition, one finding in this study is that most researchers use statistical significance due to human desire for certainty in life. Finding this and considering my grandma's teaching about learning the world to love, share, and be kind, etc., I still wonder: Is believing in certainties used in statistical significance embedded in people's perception of stable living? However, what happens when one's certainty is jeopardized and there is no way to support a stable living? If using p-values dichotomously can harm human rights and lives, shouldn't it be considered an issue of research and epistemological oppression? Also, could a more holistic analysis that embraces multiple perceptions of reality be healthier for everyone?

Lesson Learned: What Could Be Right About P-Value Education?

Exploring the results of the dissertation surprisingly helped me find my confidence in learning statistics and made me feel strong and smart as I untangled the statistical questions that persisted for years seen by my constant dialogues with the literature, myself, and Professor A, an authoritative figure with whom I might have been afraid of communicating. Yet, it should be noted that the results of the study taught me a lesson about how I could use p-values more truthfully, and this lesson might illuminate how society could learn, teach, and disseminate p-value education more accurately. You see! I come from a country where we do not ask questions of our professors. Our professors are looked at as all-knowing and we cannot interrogate them. In fact, we must show respect to professors in Taiwan. What a contrast in my learning from Taiwan to the U.S. In Taiwan, if I were ever to ask my professors the questions I have asked in this research, I may have been thrown out of the university, never to return. However, my inquisitive Indigenous mind would not allow me to stop questioning. My immigration journey to the U.S.'s

driven-to-equity education has afforded me the privilege to learn, question, stay open to unlearning, and relearn (though I am still fighting the White power in higher education such as meritocracy, unreasonably expensive tuitions, capitalist salary gaps, and colonial academic expectations, etc.). My questions about p-values found in this study were spoken aloud and graciously entertained, talked about, and answered through many conversations with my professor in Colorado.

What could be right is that educators and scientists do not teach their students that statistical significance is the only way to judge the efficacy of any research intervention, application, or recommendation. Instead, p-values may reflect struggles in cultures, power structures, epistemologies, institutions, and academic bias regarding the education of statistics.

What could be seen by Western researchers is that there is an “objective” way to arrive at statistical significance to judge the efficacy of any research intervention, application, or recommendation. In other words, there is a rigid interpretation without other ways to examine research. However, I argue that this rigid view of p-values may ignore struggles in cultures, power structures, epistemologies, institutions, and academic bias regarding the education of statistics. Therefore, I also argue that the right thing for educators and scientists to do is not teaching statistical significance as the only way to predict the effectiveness of any research intervention.

What could be changed about using p-values is that they should be employed as a subset among other statistical methods. What could be right about using p-values is that p-values ought to be taught in statistics textbooks as they are not a set of standardization to validate the quantity of “how much” statistical significance should be, meaning that they could only attest to whether

there exists a large statistical distribution between the sample data and the true population (Ziliak & McCloskey, 2011).

What could be right is that scientists do not consider statistical significance as an authority to claim the objectivity of research. In fact, the essence of the statistical significance is more philosophical, qualitative, and ontological than scientific, quantitative, and truthful than most scientists would like to believe (Ziliak & McCloskey, 2001).

Comparisons of the Findings to the Literature

Overall, my interpretation of using p-values in this autoethnographic study is different than the literature that analyzes issues of dichotomous use of p-values. The findings of my autoethnography show a sociological interpretation of using p-values, which is rare in the statistical literature. Specifically, findings like my personal narratives reflecting upon statistical literature in this autoethnography are absent in most literature discussing the issue of the dichotomous use of p-values. These findings make me feel that I am a strong woman like a Tayal woman. Among Taiwanese Indigenous various tribes' legendary stories, Tayal women were the most intrepid among the tribes and least challenged. I never got my Indigenous facial tattoo, so I often do not consider myself strong; I never liked to ask questions in classes growing up, especially in math-related classes for fear of revealing my unintelligence; therefore, asking many questions and arguing with my professor, who is an authoritative figure though he is kind, is a new me, a stronger me that I never thought could exist.

The literature explored in this study does not ponder how a researcher makes meaning of their learning of p-values; whereas, the findings in this autoethnography illuminate a researcher's qualitative meaning-making to understand statistical concepts considering they are not only math, abstract, and objective (like most researchers do in the literature). This conclusion helps me

realize a point, a point that is the biggest contribution of this study for me: It is not that I am too dumb for math or statistics; it is that math and statistics are often too objective to allow me to access them; in other words, I am smart and I don't have to fear statistics anymore.

Value and Belief: Learning to Empathize

The value and belief that I hold when conducting this dissertation always refer to my grandma's teaching about learning the world to empathize, illustrated by how I converse with myself again:

“But you need to put yourself in their shoes? Why did they need to get their research published by using statistical significance?” I asked myself.

“Who doesn't want their research to be published in academia?” I answered.

“You are not getting it; you are still outside of their world.”

“Um..., because they want to be significant!” I answered again.

“Closer! But why do they want to be significant?” I asked myself again.

“Because we are humans, and we like to be considered great by others.”

“One way to think of it! What else? Try to think of this in another way: What would happen if your research never got published in academia?” I asked again.

“Wow! I hope this is just a hypothetical question. I do not want this to happen to me.”

“Again, what would happen if your research cannot get published in academia if you don't report statistical significance?”

“I might never get any professorship or research jobs that I like because my CV looks too weak?” I answered and felt an unpleasant nausea twisting inside my stomach due to a little bit of anxiety in me while thinking about this “hypothetical scenario.”

“Okay! What else?” I asked again.

“Do I have to answer? I don’t like this question and I don’t want to imagine it,” I pleaded.

“You said you want to put yourself into the researchers’ shoes, right?”

“Okay! I might be unemployable or if I am employed, I may lose my academic job and not be able to do what I like for a living; it would lead to the inability to pay my rent or mortgage, and finances would be tight; but most importantly, I would not be able to do research, my deep passion and this would lead me to possibly lead an unstable life. I would lose out on the opportunity to represent and honor myself and my family and to prove my values in this world; I would not be able to do what I like while feeling intelligent.”

When I put myself into researchers’ shoes and try to empathize, I remember Amrhein et al. (2019) said that society prefers the *certainty* suggested by reporting research’s statistical significance because concrete benefits for human wellness from research provide more comfort, and this comfort disguises certainty in the costume of objectivity. Wanting comfort is not wrong. Most of the time, like many researchers, I want to get concrete benefits from my research, as well. I am not trying to convince researchers to not seek comfort. I am only offering a question for all of us, who are entrenched in Western academic disciplines, to ponder upon the question via our moral responsibility to integrity: If our comfort is at the expense of hurting someone, will we still want the costume of certainty as it pertains to p-values? I am asking all of us to learn the world to empathize, like what my grandma taught me: We want to have all the skills and knowledge to contribute to our society, especially to have the ability to know who is suffering and the ability to suffer with them by offering companionship or assistance when they go through hard times.

My Overall Reactions

My overall reactions to this study lie in my hope that my learning process of this dissertation can contribute to society in challenging the Western, canonical, and colonial statistics education regarding p-values.

Grandma said that we Tayal peoples live together, struggle together, and prosper together. Often when I asked Grandma why she did certain things, she always said that she did it for our families and society. She learned how to work in the field and relentlessly cultivated her husband's lands; she learned Mandarin to assist with her children's education; she learned the Bible to further her community's understanding of Western Christianity; she studied Mandarin characters to help her grandchildren with their Chinese homework; she learned to watch Chinese news on TV to have more topics to discuss with my dad; she learned knitting to make sweaters for us; she learned painting for our community's art exhibitions; she learned how to cook for the village; she learned to take a bus or train to visit us in cities; and she went to college primarily to teach women how to learn Mandarin in our village. Learning for her was to struggle and prosper together with our society.

Also, my overall reactions to my meaning-making of the study could be seen through what my grandma taught me about how to be a strong and smart Tayal woman: learning the world to love, empathize, share, be kind, and be flexible. Making meaning of this study from the literature, Professor A, and my own experiences leads me to find that using statistical p-values for researchers could help them feel comfortable with the certainty they could gain in life such as research publication, academic achievement, job stability, etc. However, going back to my grandma's teaching of learning the world to empathize, to serve peoples, to live and struggle with them, I cannot use p-values dichotomously for only my own academic benefit.

My overall reactions to the study are also illustrated in my *challenging the mastery of the knowledge about p-values* (using Indigenous critical theories, Justice, 2016) via centering my Indigenous self in this autoethnographic dissertation. I have practiced reflexivity regarding the use of p-values through the history of statistics, my conversations with myself and my mentor in statistics, my studying literature, and my positionality as an Indigenous woman, doctoral student, and granddaughter of Yagi (my Indigenous language for Grandma).

Review of Theory and Research Positionality in Autoethnography

Indigenous critical theories (ICT) combined with the autoethnographic method's self-reflexivity provide me with an epistemological framework to counter the dominant and colonial narrative of learning and using p-values. This combination also helps me articulate my own history and community to respond to the European philosophy of knowledge-making by contemplating my place in Western intellectualism versus our Indigenous ways of knowing and locating my indigeneity to challenge the mastery (possession) of knowledge that colonial places occupy (Justice, 2016).

In writing this autoethnography, I keep asking myself:

“Why is contemplating our place in the Western intellectualism crucial to this study and me?”

As an Indigenous critical theorist and member of the Cherokee Nation, Daniel Heath Justice shed light on why contemplating our place in colonial intellectualism is crucial:

Locating ourselves more firmly in place does not, however, mean an inevitable looking inward. Indeed, it often necessitates looking outward, for every nation I know has protocols and traditions of exchange. We are therefore called to look across borders.... What conversation can Indigenous studies on coastal territories have with those in other regions with other contexts, histories, and networks of relationships? What exchanges, collaborations, and alliances are possible? Perhaps what we need are centers of Indigenous excellence across the hemisphere, each attentive to its specificities but offering something distinctive to the wider network. (Justice, 2016, p. 29)

Also, I constantly ask myself in this study: Why is challenging the mastery (claim/possession) of knowledge important to this study and me? Justice (2016) answered this for me before I even encountered his message below:

We have to do more than grudgingly acknowledge difference. We have to be willing to give up mastery for modesty, to find the spaces where we do comprehend one another but also to be okay with the mystery between us—and maybe even nurture it. Part of the way we do this is to see the world as more than just the stage and its costumed actors, but as the relationships, we build together, and the lives we live apart. (p. 24)

Finding spaces where we manage to understand one another while accepting the essential mystery caused by our differences (Justice, 2016), in some Indigenous studies, is a crucial way to not let the Western desire for transparency continue colonizing Indigenous peoples. Indigenous peoples have to be willing to reveal our knowledge, ways of knowing, cultures, ontologies, etc. for our own sake instead of to please a Western gaze (Lindner & Stetson, 2009; Chow, 1993), like Indigenous peoples are forever obligated to Western scrutiny/exhibition and are considered only living in museums and the past (Lindner & Stetson, 2009). Édouard Glissant, a French writer, poet, philosopher, and literary critic, who is widely recognized by Caribbean thought, called this *Indigenous rights of opacity* (Linder & Stetson, 2009), meaning that when Western science and other knowledge-producing practices demand Indigenous works to be transparent because Indigenous works are othered by the Western academia, Indigenous peoples resist this colonial control of demand by employing opacity (e.g., not entirely disclosing our Indigenous rituals, beliefs, practices, etc. just for the sake of colonial voyeurism). Linder & Stetson (2009) described this *opacity* as a conceptualization:

The seemingly innocuous exercise of understanding, for Glissant, represents an act of violence laid bare under that gaze of Western science and other knowledge-producing practices as the Other is rendered perfectly transparent, knowable and therefore controllable—created afresh within the conceptual schema of the observer.... Opacity can be one way of conceptualizing difference as not simply a fully transparent essence,

on the one hand, or an effect or articulation, on the other, but as something that produces effects in ways that are not predetermined or always easily understandable. The productiveness of opacity evades complete comprehension and control; we must continuously reconsider what we thought we had pinned down. (pp. 46-47)

When I say I am a Taiwanese Indigenous immigrant woman in the U.S., I am expressing one identity that is crucial to my roots—I am Indigenous in Taiwan; I am a transnational Indigenous woman in the U.S. While I have many identities in writing this dissertation, these identities also clash with each other. Using autoethnography allows me to contain my *Indigenous rights of opacity* (Linder & Stetson, 2009) to “...be willing to give up modesty [of colonialism], to find the spaces where we [colonial/Indigenous, dominant/marginalized, academia/graduate-student identities] do comprehend one another but also to be okay with the mystery between us [conflicts between the aforementioned identities]—and maybe even nurture it” (Justice, 2016, p. 24).

When I am using autoethnography in this dissertation, I am not just using a single academic identity when conducting research. Instead, I am expressing all my identities when doing research. Do I have to explain my identities in this dissertation? I think I do because I am conducting an autoethnography, and I choose to reveal more of my emotions when analyzing my learning experiences of p-values, hoping to provoke some emotions in society to take the proper learning of p-values seriously.

“Can I just identify myself as an autoethnographer who describes my learning of p-values in this study?” I asked myself.

“Why do I have to bring my Indigenous roots into this study?” I asked myself.

“I do not bring my Indigenousness only because I am Taiwanese Indigenous. Without the resentment coming from how many Indigenous peoples hate the terms ‘mastering’ and

‘possessing’ anything in the name of objectivity, certainty, and proprietary embedded in colonialism, I could not illustrate my argument that some peoples’ misuse of p-values might be the result of desiring to possess one certain kind of knowledge, so much so they could not deconstruct the knowledge,” answered myself.

“Without bringing my Indigenous roots into this study, how do I illustrate the way I recognize how I have overcome my fear of statistics is related to my being a Taiwanese Indigenous student who was conditioned by a colonial way of teaching math and statistics?”

However, I notice that being an Indigenous person and ethnographer sounds contradictory. Some Indigenous peoples dislike ethnographic works due to negative descriptions of Indigenous peoples around the world in some ethnographic studies. Can you blame us? It is common to know the conflicts between the Indigenous and the ethnographic. Yet, saying that I am an autoethnographer also means that I am a product of colonialism in academia. And saying that I am an Indigenous person in the study is a way that I maintain my resilience when crossing between my multiple identities and many worlds I do not entirely feel I belong to (being a teacher, student, sister, daughter, wife, partner, friend, scholar, in colonial knowledge, in Indigenous ways of knowing, in education, in academia, in families, etc.). But, like my Aleut professor studying Indigenous sovereignty used to say often: “Don’t forget that we Indigenous peoples are not anachronistic. Don’t forget we are also modern, as well.” He reminded me that I could get caught in identities when I need to, but I don’t have to get caught in identities when I don’t need to.

As autoethnography is a method that uses poststructural discourse to deconstruct fixed and dichotomous thinking (Leavy, 2019), using autoethnography as the method is appropriate. I

believe that autoethnography's deconstructive effects and juxtapositioning time and meaning in non-linear ways (Leavy, 2019) could help blur the boundaries of the modernist thinking of dichotomous learning of p-values.

Implications for Practice and Research

As I said earlier, according to Indigenous critical theorists' advocacy for not empathizing the mastery of any learned knowledge (Justice, 2016), I do not want to claim that this dissertation is a kind of new knowledge, thus owing credits by offering my explanations about what this study could contribute to society. Also, as I said earlier, anyone who keeps asking me to overemphasize the contribution of this study is asking me to fit in the colonial academia's rule as an Indigenous person. However, I am doing it as I have to mention the contribution of the study to prove that I could write an academic dissertation. I am doing it because I am a product of colonialization, which is "reasonable" to accept. Yet, the Indigenous me does find a way to compromise with the colonial me on writing this dissertation. Instead of using the word "contribution" to possess the knowledge I've learned in the study, I use the term "implications" to pinpoint the potential "contribution" of this study by listing the possible implications for practice and research.

Nonetheless, allow me to address one thing again. If I really want to claim one "contribution" of this study, it is that I have overcome my fear of statistics and math during the process of completing this dissertation.

To researchers, this dissertation exemplifies a core message of how they could use p-values if they are willing to relearn p-values. The history of statistics in this study might disconnect their ideas of "statistical significance" from Fisher's (the inventor of p-values) caveat of not using "statistical significance" to predict the effectiveness of a research intervention.

To institutions, professors, and students in academia, this autoethnographic Indigenous perspective might provide a means (embracing uncertainties) to understand Wasserstein et al.'s (2019) encouragement of *moving to a world beyond $p < 0.05$* (p. 1):

We can make acceptance of uncertainty more natural to our thinking by accompanying every point estimate in our research with a measure of its uncertainty such as a standard error or interval estimate.... How will accepting uncertainty change anything? To begin, it will prompt us to seek better measures, more sensitive designs, and larger samples, all of which increase the rigor of research. (p. 3)

I hope that scholars do not decide if their research interventions work or not merely by p-values smaller than or bigger than certain numbers such as 0.05 or 0.01. I hope they also use other statistical elements such as confidence intervals, effect sizes, and descriptive data information to decide if their research interventions work or not. I hope that scholars and researchers could stop teaching p-values as an erroneous concept in statistics classes such as using p-values to claim the statistical significance in the research. I hope that scholars, researchers, and institutions (e.g., statistics textbook publishing companies) can start teaching a more holistic and nuanced version of history about p-values (e.g., p-values were not invented to predict the definite effectiveness of a research intervention via a threshold of a number) so that future generations of researchers can have a chance to choose an appropriate use of p-values.

With this study, I do not mean to entirely disregard the use of statistical significance. However, it does not require me to be a statistician to carry a little burden of challenging the dichotomous use of p-values. I do hope that more scholars and researchers who do studies in science and the social sciences (especially those who make executive decisions about the results) could see the problem of using p-values dichotomously. I hope that scholars and researchers will consider the shortcomings of p-values in terms of what they can and cannot argue. For instance, I hope they know that they can still report p-values in their research, but they also need to be

aware of the limitation of reporting the p-values. I hope they know that Fisher did not invent p-values to predict the effectiveness of the research intervention. In other words, I hope that they do not claim if their research is significant or insignificant only because of p-values smaller or bigger than 0.05 or 0.01.

Also, I hope that researchers stop blindly believing that “p-values smaller than 0.05 or 0.01” means that their research is significant if they are willing to ponder my argument of about one core message in this study: using p-values is a social phenomenon.

I hope that researchers can begin listening to my voice, as well as other Indigenous and nontraditional voices, in this study, especially the researchers in education because I am a researcher and educator. I believe that change can begin with listening. Without the willingness to be open and to listen, the dichotomous use of p-values will continue being practiced in research and education.

Final Thoughts

This autoethnographic dissertation is crafted to interpret inequities generated from the dichotomous use of p-values while expressing how these inequities relate to the inequities I have personally encountered as an Indigenous woman and graduate student in Western academia. The first two research questions ask how I make meaning of the dichotomous use of p-values in the statistics courses I attended in my doctoral program and the literature review, and the results to both questions reveal the following:

1. Using p-values is a social norm that can create research and epistemological oppression wherein peoples believe that using statistical significance can bring significance to research, thus research publication.

2. P-values can involve not only objectivity but also subjectivity. However, it has been objectively canonized as a tool to decide a research treatment's effectiveness via its dichotomous function (smaller than 0.05 or bigger than it) while ironically its nature is more of a qualitative trait, meaning that it shows a descriptive sample parameter.

In the process of exploring research questions 1 and 2 in the study, inequities are discussed in this autoethnography, including academic bias (e.g., the preference of publishing research that reports statistical significance, teaching students to only use statistical significance to decide the efficacy of research, and academic power and the power struggle of challenging the dichotomous use of p-values). Moreover, these inequities are personal to me as an Indigenous woman and student as it all sounds familiar when Western academia has promoted statistics as an objective tool that defines research certainty—a concrete comfort that researchers use to claim their research's significance.

Being an Indigenous woman researcher and student who studies statistics and also listens to and acts upon my grandma's Indigenous ways of learning (learn the world to empathize), I explore my meaning-making of the p-values by using Indigenous critical theories' concept: challenging the mastery of knowledge via centering my Indigenous self in it. Without doing this, this autoethnography might not connect the dichotomous use of p-values to the deepest desire human beings hold: gaining certainty and shunning uncertainties for the comfort of the wellness of life. Therefore, I argue, using statistical significance could bring researchers certainty; whereas, challenging the concept of statistical significance might bring researchers uncertainties, whether they understand this or not.

Grandma! Can This Dissertation Be My Tayal Facial Tattoo?

As a researcher, there might be times that I imagine how I could put my “significant research” in my professional files by claiming statistical significance (like what my dear friends who are research experts often suggest) and prove a thing that makes my scholarship significant enough in academia. Wanting to be significant is not wrong and can be noble. However, choosing to do research at the expense of peoples’ jobs and lives by ignoring a more truthful, holistic, and cross-cultural way of doing research does not sound okay to me. How do I teach myself, others, and my students about this? Being an Indigenous woman, this tendency of owning a significant scholarship by trampling on others’ human rights so I can be proud of “myself” (end of the story) sounds too colonial and unlike what my grandma taught me: The strongest and smartest Tayal woman is one who learns the world (various kinds of knowledge) to share, love, be kind, be humble, and be flexible to appreciate each other’s value and ability even though colonial worlds teach us to possess, be cold, be proud, and strictly judge one another’s achievements.

“Well, Grandma, I might end up being the last of the last in academia if I don’t claim my research significance. Actually, I might end up giving up entirely on academia. Peoples want concrete certainty and objectivity to see my achievement. Statistical significance can give them that as it is in the social norm.” I said aloud to my grandma.

“Is that going to make you peaceful and complete as a human being and Tayal woman?” I imagined Grandma asking me.

“I don’t know, Grandma! It’s more complicated than that. I need to take many things into account: my education, my career, my job, my experiences in different cultures, making a living, supporting my family, my future house, my future children’s education, Dad’s

health, Albert's and Yoyo's careers, Matt's career, Matt's many current jobs, Matt's and my retirement funding, and so forth." I answered.

"I know! That's what 'civilized' peoples have 'infiltrated' us with and told us what a good life is and how it should be complicated, Savi (the Indigenous name that my grandma called me)! That's why we don't see many Indigenous peoples in the world become 'successful' peoples among these civilized. We are too simple!" Again, I imagined that Grandma would answer me in this way. She used to tell Dad that he became too complicated when he decided to leave our Indigenous village and went into cities to seek a better life and education for me and our family.

"Grandma, I am lost. I often feel stranded between the civilized and the essence of the Indigenous. Am I wrong to pursue what I want to do for my education and career as I never had a lot of resources to do so? Should I regret going across the Pacific Ocean for the person I married—an exciting adventure that also creates sorrow in me? Was I wrong to think that staying in our village would make me so insignificant?" I asked.

Grandma did not answer. Only one sentence whispers in the back burner of my mind that Grandma used to say:

"Yavagansama (our Creator) encompasses all the complexity!"

This is my quest to determine whether researchers should claim significance in research, yet engage in a problematic and narrow reductionist use of a statistical method by using only statistical significance to claim the effectiveness of research's treatment or intervention.

Concluding this, a thought dawned on me:

“How I make meaning of this dissertation shows how I continually put my ways of knowing and my Indigeneity at the center of the knowledge I learn (Justice, 2016), and now I feel strong and smart.”

“Grandma, could this dissertation be my Indigenous Tayal facial tattoo?”

REFERENCES

- Adams, T. E., Jones, S. H., & Ellis, C. (2015). *Autoethnography: Understanding qualitative research*. Oxford University Press.
- Agresti, A. & Finlay, B. (2009). *Statistical methods for the social sciences* (4th ed.). Pearson.
- Akintunde, O. (1999). White racism, white privilege, and the social construction of race: Moving from a modernist to postmodernist multicultural education. *Multicultural Education*, 7(2), 2-8. <https://eric.ed.gov/?id=EJ600574>
- Allen, C. (2012). *Trans-Indigenous: Methodologies for global Native literary studies*. University of Minnesota Press.
- Amrhein, V., Greenland, S., & McShane, B. (2019). Retire statistical significance: Valentin Amrhein, Sander Greenland, Blake McShane and more than 800 signatories call for an end to hyped claims and the dismissal of possibly crucial effects. *Nature*, 567, 305-307. <http://www.igienistionline.it/docs/2019/10nature.pdf>
- Anderson, G. L., & Barrera, I. (1995). Critical constructivist research and special education: Expanding our lens on social reality and exceptionality. *Remedial and Special Education*, 16(3), 142-149. <https://doi.org/10.1177/074193259501600303>
- Anderson, L. (2006). Analytic autoethnography. *Journal of Contemporary Ethnography*, 35(4), 373-395. <https://doi.org/10.1177/0891241605280449>
- April, C.-C. (2010). Do thyself no harm: Protecting ourselves as autoethnographers. *Journal of Research Practice*, 6(1), 1-13. <http://jrp.icaap.org/index.php/jrp/article/view/213/183>
- Aragon, A. (2016). Ignored by the board: Disruption school closure and illuminating White racism through counterstorytelling. In N. N. Croom & T. E. J. Marsh (Eds.), *Envisioning critical race praxis in higher education through counter-storytelling* (pp. 107-138). Information Age Publishing, Inc.
- Brown, P. C., Roediger III, H. L., & McDaniel, M. A. (2014). *Make it stick: The science of successful learning*. The Belknap Press of Harvard University Press.
- Chang, H. (2008). *Autoethnography as method*. Left Coast Press.
- Chow, R. (1993). *Writing diaspora: Tactics of intervention in contemporary cultural studies*. Indiana University Press.
- Cramér, H. (1999). *Mathematical methods of statistics*. Princeton University Press.

- Denzin, N. K., & Lincoln, Y. S. (Eds.). (2018). *The Sage handbook of qualitative research* (5th ed.). SAGE.
- Denzin, N. K., Lincoln, Y. S., & Smith, L. T. (2008). *Handbook of critical and Indigenous methodologies*. SAGE.
- Ellis, C., Adams, T. E., & Arthur, P. B. (2011). Autoethnography: An overview. *Forum: Qualitative Social Research*, 12(1). <http://www.qualitative-research.net/index.php/fqs/article/view/1589/3095>
- Fidler, F. (2005). *From statistical significance to effect estimation: Statistical reform in psychology, medicine and ecology* [Doctoral dissertation, The University of Melbourne]. Semantic Scholar. <https://www.semanticscholar.org/paper/From-statistical-significance-to-effect-estimation-Fidler/bcedae5b5300b0ca8f129f58a4246fa1d15bf469>.
- Fisher, R. A. (1925). *Statistical methods for research workers*. Oliver and Boyd.
- Fisher, R. A. (1928). *Statistical methods for research workers* (2nd ed.). Oliver and Boyd.
- Fisher, R. A. (1954). *Statistical methods for research workers* (12th ed.). Hafner.
- Fisher, R. A. (1966). *The design of experiments* (8th ed.). Hafner Pub. Co.
- Geertz, C. (2017). *The interpretation of cultures: Selected essays* (3rd ed.). Basic Books.
- Gelman, A. (2016). The problems with p-values are not just with p-values. *The American Statistician: ASA Statement on P-Values and Statistical Significance*, 70(3), 1-2. https://stat.columbia.edu/~gelman/research/published/asa_pvalues.pdf
- Gill, J. (1999). The insignificance of null hypothesis significance testing. *Political Research Quarterly*, 52(3), 647-674. <https://doi.org/10.1177/106591299905200309>
- Gliner, J. A., Morgan, G. A., & Leech, N. L. (2017). *Research methods in applied settings: An integrated approach to design and analysis* (3rd ed.). Routledge.
- Goodman, S. N. (2019). Why is getting rid of p-values so hard? Musings on science and statistics. *The American Statistician*, 73(sup1), 26-30. <https://doi.org/10.1080/00031305.2018.1558111>
- Guba, E. G. (Ed.) (1990). *The paradigm dialog*. SAGE Publications.
- Herrmann, A., & Adams, T. E. (2020). Expanding our autoethnographic future. *Journal of Autoethnography*, 1(1), 1-8. <https://doi.org/10.1525/joae.2020.1.1.1>

- Hubbard, R., & Armstrong, J. S. (2006). Why we don't really know what statistical significance means: Implications for educators. *Journal of Marketing Education*, 28(2), 114-120. <https://doi.org/10.1177/0273475306288399>
- Jones, S. H., Adams, T. E., & Ellis, C. (Eds.). (2016). *Handbook of autoethnography*. Routledge.
- Justice, D. H. (2016). A better world becoming. In A. Moreton-Robinson (Ed.), *Critical Indigenous studies: Engagements in first world locations* (pp.19-32). The University of Arizona Press.
- Kuhn, T. S. (2012). *The structure of scientific revolutions* (4th ed.). University of Chicago Press.
- Lapadat, J. C. (2017). Ethics in autoethnography and collaborative autoethnography. *Qualitative Inquiry*, 23(8), 589-603. <https://doi.org/10.1177/1077800417704462>
- Leavy, P. (Ed.) (2019). *Handbook of arts-based research*. The Guilford Press.
- Lin, H. (2020). Second language, body, and race—a poetic analysis of international doctoral students' experiences at a university. *International Journal of Qualitative Studies in Education*, 1-18. <https://doi.org/10.1080/09518398.2020.1783015>
- Lindner, K., & Stetson, G. (2009). For opacity: Nature, difference and indigeneity in Amazonia. *TOPIA: Canadian Journal of Cultural Studies*, 21, 41-62. <https://doi.org/10.3138/topia.21.41>
- Lisse, J. R., Perlman, M., Johansson, G., Shoemaker, J. R., Schectman, J., Skalky, C., S., Dixon, M. E., Polis, A. B., Mollen, A. J. & Geba, G. P. (2003). Gastrointestinal tolerability and effectiveness of rofecoxib versus naproxen in the treatment of osteoarthritis. *Annals of Internal Medicine*, 139(7), 539-546. <https://doi.org/10.7326/0003-4819-139-7-200310070-00005>
- Lorde, A. (1984). *Sister outsider: Essays and speeches*. Crossing Press.
- McLean, J., & Ernest, J. (1998). The role of statistical significance testing in educational research. *Research in the Schools*, 5. https://www.researchgate.net/publication/252326990_The_Role_of_Statistical_Significance_Testing_In_Educational_Research
- Merriam-Webster Dictionary. (2021). Inequity. <https://www.merriam-webster.com/dictionary/inequity>
- Moreton-Robinson, A. (2016). *Critical Indigenous studies: Engagements in first world locations*. The University of Arizona Press.
- Pratt, M. L. (1991). Arts of the contact zone. *Profession*, 33-40. <https://www.jstor.org/stable/25595469>

- Reed-Danahay, D. (2009). Anthropologists, education, and autoethnography. *Reviews in Anthropology*, 38(1), 28-47.
<https://www.tandfonline.com/doi/abs/10.1080/00938150802672931>
- Salsburg, D. (2001). *The lady tasting tea: How statistics revolutionized science in the twentieth century*. Holt Paperbacks. [https://www.amazon.com/Cult-Statistical-Significance-Economics-Cognition-ebook-dp-B07PH91LCL/dp/B07PH91LCL/ref=mt_other? encoding=UTF8&me=&qid=1620867627](https://www.amazon.com/Cult-Statistical-Significance-Economics-Cognition-ebook-dp-B07PH91LCL/dp/B07PH91LCL/ref=mt_other?encoding=UTF8&me=&qid=1620867627)
- Sandel, M. J. (2020). *Thy tyranny of merit: What's become of the common good?* Farrar, Straus and Giroux.
- Sawyer, A. G., & Peter, J. P. (1983). The significance of statistical significance tests in marketing research. *Journal of Marketing Research*, 20(2), 122-133.
<https://doi.org/10.2307/3151679>
- Scheurich, J. J., & Young, M. D. (1997). Coloring epistemologies: Are our research epistemologies racially biased? *Educational Researcher*, 26(4), 4-16.
<https://doi.org/10.2307/1176879>
- Schreier, D., Hundt, M., & Schneider, E. W. (2020). *The Cambridge handbook of world Englishes*. Cambridge University Press.
- Solorzano, D., & Yosso, T. (2002). Critical race methodology: Counter-storytelling as an analytical framework for education research. *Qualitative Inquiry*, 8(1), 23-44.
[https://journals.sagepub.com/doi/abs/10.1177/107780040200800103?journalCode=qixa#:~:text=Critical%20race%20methodology%20is%20an,theory%20\(see%20note%204\).](https://journals.sagepub.com/doi/abs/10.1177/107780040200800103?journalCode=qixa#:~:text=Critical%20race%20methodology%20is%20an,theory%20(see%20note%204).)
[https://journals.sagepub.com/doi/abs/10.1177/107780040200800103?journalCode=qixa#:~:text=Critical%20race%20methodology%20is%20an,theory%20\(see%20note%204\).](https://journals.sagepub.com/doi/abs/10.1177/107780040200800103?journalCode=qixa#:~:text=Critical%20race%20methodology%20is%20an,theory%20(see%20note%204).)
- Thompson, B. (1996). AERA editorial policies regarding statistical significance testing: Three suggested reforms. *Educational Researcher*, 25(2), 26-30.
<https://doi.org/10.2307/1176337>
- Wasserstein, R. L., & Lazar, N. A. (2016). The ASA statement on p-values: Context, process, and purpose. *The American Statistician*, 70(2), 129-133.
<https://doi.org/10.1080/00031305.2016.1154108>
- Wasserstein, R. L., Schirm, A. L., & Lazar, N. A. (2019). Moving to a world beyond $p < 0.05$. *The American Statistician*, 73(1), 1-19. <https://doi.org/10.1080/00031305.2019.1583913>
- Ziliak, S. T., & McCloskey, D. N. (2011). *The cult of statistical significance: How the standard error costs us jobs, justice, and lives*. The University of Michigan Press.