IOWA STATE UNIVERSITY
Digital Repository

Creative Components

Iowa State University Capstones, Theses and Dissertations

Fall 2020

Mathematics Unit Plan for Social Justice

Taj R. Lyve

Follow this and additional works at: https://lib.dr.iastate.edu/creativecomponents

 Part of the Science and Mathematics Education Commons, and the Secondary Education Commons

Recommended Citation

Lyve, Taj R., "Mathematics Unit Plan for Social Justice" (2020). *Creative Components*. 697.
https://lib.dr.iastate.edu/creativecomponents/697

This Creative Component is brought to you for free and open access by the Iowa State University Capstones, Theses and Dissertations at Iowa State University Digital Repository. It has been accepted for inclusion in Creative Components by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.

Mathematics Unit Plan for Social Justice

by

Taj R. Lyve

A Creative Component submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
MASTER of Education

Program of Study Committee:

Ji Yeong I
Anne Foegen

Iowa State University

Ames, Iowa

2021

For Thomas Lyve

FOREWORD

I first met (Tia) Taj (they/their/them) as my graduate advisee and student in the summer of 2018 when Taj started the master's program with mathematics licensure recommendation at Iowa State University. I remember they came to my office and shared their life. Taj stopped by my office from time to time without appointments and asked if I had time to talk with them. We talked about Taj's health condition, assignments, career goals, previous experience, and family. I always enjoyed talking with Taj and felt grateful that they were very open to me.

I remember Taj smiled when they shared the news that they finally adopted their son.
I remember Taj was very passionate about being a teacher who can impact the current education for LGBTQ students who might have the same struggle as what they got through.
I remember that I told Taj during the last meeting that many teachers will appreciate Taj and find their work helpful because implementing social justice to learn mathematics is highly demanding for mathematics teachers but challenging to all.

I also feel sorry that I could not have helped Taj more. I still think what I should have done more for them. I know I will remember Taj and their legacy. Taj's memory will remind me how I can be a better teacher educator and supporter for all students.

Taj's creative component, entitled "Mathematics Unit Plan for Social Justice," was almost complete when Taj left us. I called for volunteers among secondary mathematics preservice teachers, including Taj's peers, to complete the work. Four volunteers, Courtney Tompkins, Brittney Fredericks, Holden Gray, and Louise Tsafack Mila, collaborated to put flesh on the bone of the social justice lesson plans based on the skeleton Taj made.

I dream Taj's legacy becomes a seed that will blossom beautifully among all students.
And I wish Taj's name is remembered for a long time.

Ji Yeong I
Assistant Professor
School of Education
Iowa State University

ABSTRACT

Constructing lesson plans for middle school teachers focusing on social justice will lay the groundwork for the future textbook. The lesson plans will show students of color the power that mathematics has and its value in the world around them with hope to increase the interest of students of color in mathematics. In particular, the focus of this unit plan will be on seventh grade probability and statistics. Instead of using the generic examples that are given, the lessons in the proposed unit plan will focus on topics such as the police shooting incident rates with racial groups.

The theoretical backgrounds for this project include many important theories such as ethnomathematics, rehumanization, culturally relevant pedagogy, and culturally sustaining pedagogy. For this project, I am utilizing Reading and Writing the World with Mathematics (RWWM) as the main framework. RWWM can be used for mathematics education research with various social groups with explicit discrimination that could deal with race; lesbian, gay, bisexual, transgender/transsexual, and queer/questioning (LGBTQ) issues; and other such differences. Based on the investigations of the discriminatory actions, I utilize mathematics to validate the claim I want to make through this project. Finally, I believe teachers can make connections of mathematics in the students' lives and communities by using the RWWM framework in their mathematics lessons. RWWM will be used in the final lesson designed with the context of police shootings. In the lesson, students will examine police shootings by race and then will be asked to debate a position using the data and previous lessons. There has been little research on this topic in the mathematics education field.

TABLE OF CONTENTS

Part 1: Theoretical Background

Introduction

Many youths of color go through school and study mathematics without seeing a person who looks like them unless it is referring to some popular sports, and mathematics textbooks or curricula they experience in school usually do not portray their group and focus on rote memorization. Instead of the current commercial/traditional textbooks there should be a textbook which has examples related to People of Color (PoC) and has images of PoC beyond the stereotypical images, such as popular sports athletes. The hope is to get PoC, particularly Black children, to develop an interest in mathematics that would go beyond primary school. There is a large push for more diversity in mathematics programs at the college level but by that time people may build negative perspectives about mathematics. Encompassing PoC in middle or high school stands a better chance of obtaining the goal of reaching an interest in mathematics prior to college.

Middle school years are formative years where students are beginning to find their identity and develop their independence. So, it is more paramount for youth of color to see images that resemble them, an area where mathematics has failed them tremendously. The fact that Katherine Johnson was not known to the level she is now until the movie *Hidden Figures* came out is an atrocity and a detriment to our youth, not just of color.

I recall when I grew up that mathematics was culturally White. Mathematics having been culturally White probably did not impact me as much as other children of color as I was raised in a White family, but it did have a negative impact on me nonetheless. As a result, I probably would not have pursued my interest in mathematics if it were not for my eighth-grade math teacher Mrs. Mata. Mrs. Mata was the first teacher to tell me that I had talent in mathematics and

to strengthen it and the first non-White teacher of mathematics that expanded my view of who could do mathematics. The emphasis of this creative component is establishing a unit plan or section of a textbook for teachers geared towards Black students based on social justice issues with examples and activities students are able to relate to.

Purpose

Originally, I wanted to create a textbook for middle school students of color in which the examples were related to them and contained true images of PoC, and not just in popular sports. But seeing how that is not a possibility for me given time, it was then decided that lesson plans for teachers was tenable, however. Focusing on teaching mathematics for social justice leads to the ability to create these lesson plans and still have a meaningful way to make mathematics more accessible to students of color without creating the textbook.

Constructing lesson plans for middle school teachers focusing on social justice will lay the groundwork for the future textbook. The lesson plans will show students of color the power that mathematics has and its value in the world around them with hope to increase the interest of students of color in mathematics. In particular, the focus will be on seventh grade probability and statistics. Instead of using the generic examples that are given, such as flipping a coin, they will focus on topics such as the incarceration ratio of parents by race, being pulled over and how it is not random by race, or how lower income neighborhoods have more liquor stores and fewer grocery stores than their wealthier counterparts.

Theoretical Perspectives

Students need to see both themselves and the outside world with mathematics (Gutiérrez, 2018). The current education system is designed such that they only see the outside world void of themselves or mathematics. Education is not neutral, nor is it a universal endeavor. So why

would mathematics be? Indeed, mathematics teachers bring in their own culture, and how they form their classroom says much to the students (Gutiérrez, 2018; Larnell, Bullock, & Jett, 2016). The posters teachers choose to hang, if they include people, let the students know who and which cultures are of importance. Having just White -- or white appearing -- mathematicians tells students of color that there is no one of importance of color and places mathematics as a White subject. It is best to have a variety of mathematicians from history. With the addition of the teacher's culture to the classroom, dehumanization of both students and the teacher occurs, and it can be stopped with the practice of rehumanizing mathematics (Gutiérrez, 2018). Dehumanization sometimes occurs when schools allow students to feel as though they cannot do mathematics. One such way is how teachers are trained to find misconceptions that students may have with the content, yet this is under the guise that the student has a misconception in the first place instead of just conceptions. They become misconceptions because we are expecting the student to conform to the dominant lesson structure of thinking.

So instead of looking at students' conceptions as misconceptions one could also begin to rehumanize mathematics by respecting the students' culture and history which helped to form their conceptions in the first place. This can be done in various ways: getting to know students beyond the classroom (Davis & Martin, 2008; Leonard, Brooks, Barnes-Johnson, & Berry, 2010), becoming familiar with the history of their culture and traditions (Gutiérrez, 2018), not just learning about superficial culture such as food, but including relevant historical figures related to the subject, for example, Kathrine Johnson--known as a calculator for NASA, who helped with the first manned space launch to name just one of her accomplishments. Since students' cultures are being represented we have rehumanization, affirming students' funds of knowledge (Gutiérrez, 2018; Paris, 2012). The concept of Funds of Knowledge comes from Moll

and Gonzalez (1994) and refers to the accumulated knowledge developed culturally over time that has become essential to the households or individuals of that culture. In mathematics, this includes elements such as the vast backgrounds youth of color bring to the classroom (Gutiérrez, 2018), algorithms from other countries, examining the history of mathematics and the many cultures that played in its development and preservation, and ethnomathematics (Gutiérrez, 2018). Furthermore, providing students with an opportunity to see the histories or ancestors in their cultural community while learning the history of mathematics may allow students to go beyond merely seeing the world to see themselves in it as well. Humanizing mathematics by adding the culture, history, or current events that are important to youth of color brings the true power dynamic out (exposes the White dominant culture) and has the potential to highlight debates and divergent answers. Having debate and divergent answers in mathematics is important because mathematical thought grows from the debate and multiple different views which we are wanting our students to accomplish. Rehumanizing mathematics changes math from a noun to a verb. Mathematics is going from just a name to something active and involved. Looking at various pedagogies to tackle the issues of rehumanizing mathematics in the classroom is a start to making our classrooms inclusive and welcoming for students of color so they can be motivated and hopefully interested in mathematics.

Asset and resource-based pedagogies sought to combat deficit approaches which were already in play (Paris, 2012). The research in resource-based pedagogy pursued interventions and innovations in curriculum moving education from deficit approaches present for decades. Deficit approaches viewed the communities of color and their students as deficiencies, that is, the languages, literacies, and culture that the students brought to the classroom were something to be

overcome in the deemed dominant or legitimate language, literacy, and culture. A lasting element from resource pedagogies is funds of knowledge.

Culturally relevant pedagogy (CRP; Ladson-Billings, 1995, 2009) is about incorporating students' lives into the instruction. That is, integrating their languages and cultures in, and with that comes social justice issues. Such projects as the Algebra Project (AP; Moses & Cobb, 2001) have moved under CRP to combine mathematics and social justice issues to empower youth of color with the knowledge beyond the remedial rudimentary mathematics that was happening previously and is still occurring. CRP could foster students who achieve high academically, demonstrate an understanding of cultural competence, and are critical of social order (Ladson-Billings, 1995; Paris, 2012).

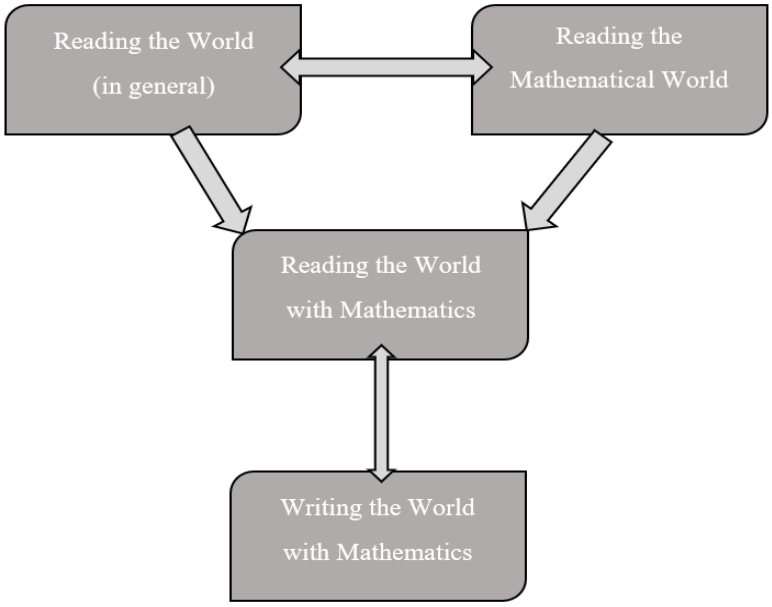
In combining CRP and social justice pedagogy (SJP), Leonard, Brooks, Barnes-Johnson, and Berry (2010) documented one school where students were able to learn area and perimeter in conjunction with the Underground Railroad. They approached the concepts by having the students create quilt squares about themselves—which invested the students and related their learning back to the Underground Railroad. The quilt squares were used to teach area and perimeter. Because of this personalization that involved the students with the project, they could learn the abstract mathematical concepts. In their study (Leonard et al., 2010), another school used students' home location to teach the coordinate plane, slope, and longitudinal and latitudinal lines—with degrees—by utilizing Google maps. From this exercise students were able to learn about the coordinate place which could be placed over the map.

Specifically, culturally sustaining pedagogy (CSP) goes beyond previous asset-based pedagogies. CSP does not just challenge the educational environment on a cultural and linguistic level to combat deficit views; it was designed to change with the cultures and languages it

serves, instead of being a stagnant entity like its predecessors, such as culturally relevant or culturally responsive pedagogies (Paris, 2012; Paris & Alim, 2014).

Finally, the Reading and Writing the World with Mathematics (RWWM) Framework consists of four stages (see Figure 1). The first stage, Reading the World, is where one looks at injustices occurring in the world and looks deeper—beyond the surface—at the issues. The second stage, Reading the World with Mathematics is where one utilizes mathematics to understand the issues bringing the findings first to their inner circle and then to their community making connections along the way. The third stage, Writing the World, is the work that is done outside of mathematics for change. The last one, Writing the World for Mathematics is where learners find the work done outside of mathematics transforming it by means of conscious, practical work.

Figure 1. *RWWM Map (Gutstein, 2016)*



For this project, I am utilizing RWWM as the main framework. RWWM can be used for mathematics education research with various social groups with explicit discrimination that could deal with race; lesbian, gay, bisexual, transgender/transsexual, and queer/questioning

(LGBTQ) issues; and other such differences (Gutstein, 2016). Based on the investigations of the discriminatory actions, I utilize mathematics to validate the claim I want to make through this project. Finally, I believe teachers can make connections of mathematics in the students' lives and communities by using the RWWM framework in their mathematics lessons. RWWM will be used in the final lesson designed with the context of police shootings. In the lesson, students will examine police shootings by race and then will be asked to debate a position using the data and previous lessons. There has been little research on this topic in the mathematics education field.

Methods

Context Choice and Target Students

In shaping the unit plan I had a desire to develop social justice focused lessons that teach seventh-grade students concepts of probability and statistics. The social justice topic did not require much thinking: people shot to death by the police separated by race. But the topic would not work for the whole unit because then some artificial connections between context and mathematical concept could be made. Finally, I resolved to let the unit plan have one major social justice context and have the other lessons work to build it up or to it. The recent series of police violence to Black people and the Black Lives Matter movement have been circulated and well known via mass media and social media. Students will be motivated by this well-known topic and this topic would work well with probability and statistics because there is real data about police shootings. After I figured out the unit plan structure and context, I began to develop a unit plan for an imaginary class. The target class for this unit lesson is an urban classroom with a predominant student makeup of Black students. That is not to say that it cannot be taught in another classroom makeup. I just expect more resistance or discomfort from students of color if they are in a predominantly White class. If the class is not predominantly Black but is of students

of color that would work as well since this impacts all students of color and is closely related to them.

I have not identified any students with special needs in this imaginary class because it will require other sets of supports that are out of scope of this project. I would assume that a class would have some English Language Learners (ELLs) and will prepare for that, but otherwise, I will assume that the class make-up is of students who are on grade level in understanding and comprehension. Differentiation for other student populations will be mentioned and discussed at the end of the unit plan.

Standards and Math Topics

I have followed the CCSSM for the seventh-grade probability and statistics units, so that is the target audience. Once the probability and statistics cluster (CCSS.MATH.CONTENT.7.SP) in the Common Core State Standards of Mathematics (CCSSM: National Governors Association Center for Best Practices, & Council of Chief State School Officers, 2010) and Social Justice Standards (JU.6-8.13 and AC.6-8.17; Chiariello, Edwards, Owen, Ronk, & Wicht, 2016) were examined further the unit could be broken into three lessons. The unit objective would be that students will be able to determine the mean, median, mode, range, mean absolute deviation, interquartile range, spread of a data set, define probability in regards to chance of events being likely or unlikely and that probability lies between 0 and 1, and percentage of independent/dependent events occurring – how to recognize random samples. The unit overview would look something like Table 1.

Table 1

Unit Plan Outline

Lesson		Day	Math Topic
1	7.SP.A.1 7.SP.A.2 7.SP.B.3 7.SP.B.4	1	Interpret data using mean, median, mode, and range
		2	Interpret data using Development of mean absolute deviation (MAD), interquartile range (IQR), and spread
		3	Interpret data using Box and Whiskers and Dot Plot
2	7.SP.C.5 7.SP.C.6	4	Probability of chance, likely events, unlikely events, approximate probability of chance
		5	Probability of chance, likely events, unlikely events, approximate probability of chance
		6	Farkle Game
		7	Lesson 1 & 2 Assessment
3	7.SP.C.7 7.SP.C.8	8	Data collection, random sampling, modeling, and percentage
		9	Dependent probabilities
		10	Summative unit - non-traditional assessment
		11	Summative unit - non-traditional assessment

Considering Common Core State Standards for Mathematics (CCSSM), there was difficulty fitting each standard everywhere I wanted to place it. Thus, I looked online for some lesson plans and found a few lessons that were well-suited to the CCSSM, but none of them fits into my idea. Thoughts about a debate as an assessment began, so I spent some time on how to conduct one. Inquiring how to conduct a debate was done in part because there was uncertainty about how to conduct a debate and if having one in a math classroom would be different. I continued to look for ideas to keep from doing stereotypical activities such as coin toss or rolling

a die. Discovering a full social justice topic which did not conflict with the math ideas already in place was challenging. To make the probability a little more interesting a scavenger hunt was found which gave the idea of making one for the lesson plan (Medori, 2020).

Expected Resistance

The possibility that the lesson plans are not read or interpreted in the manner intended could happen, in which case work will have to be done to look through the lesson plans and anticipate such occurrences as best as possible. Also building lesson plans which have not been implemented runs the risk for unexpected results to occur with the students. One thing I learned while working with children is they are surprising in many ways, and not always negative. When one gives them the room to explore they can come up with ideas beyond expectations which is astonishing to experience. Another concern foreseen would be if it were a predominantly White school, some resistance may occur or some students of color may feel uncomfortable during the lesson. Lastly, working with such intense topics could also make the students' parents uncomfortable. In this case, the reminder would be that police shootings are already happening and are a real issue in our society that middle school students encounter in their lives. Also, the lesson plan can be adapted to use other information if the teacher needs to.

Positionality/Conclusion

Having grown up away from half of who I am, turmoil in my identity brings me close to my desire for reaching students of color through images of PoC and social justice mathematics projects. Everyone should be able to see themselves expressed in their education, even in mathematics. All students should have the opportunity to see the beauty of mathematics and see how it can be applied to their lives. The hope is that the lesson plans will accomplish that goal. For me personally not having people that represented me only pushed me away until others told

me that was not the case. The goal is that there is a different story for other PoC or minorities going into mathematics.

References

Berry, R. Q., Conway, B. M., Lawler, B., & Staley, J. W. (2020). *High school mathematics lessons to explore, understand, and respond to social injustice*. Corwin.

Box and whiskers plot *(solutions, examples, videos)*. (n.d.). www.onlinemathlearning.com.

Chiariello, E., Edwards, J.O., Owen, N., Ronk, T., & Wicht, S. (2016) Teaching tolerance. [On-line]. Retrieved from https://www.tolerance.org/sites/default/files/2017-06/TT_Social_Justice_Standards_0.pdf

Davis, J. & Martin D. B. (2008). Racism, assessment, and instructional practices: Implications for mathematics teachers of African American students. *Journal of Urban Mathematics Education 1*(1), 10-34.

Grade 7 ≫ statistics & probability. (n.d.). Home | Common Core State Standards Initiative. https://www.corestandards.org/Math/Content/7/SP/

Gutiérrez, R. (2018). The need to rehumanize mathematics. In I. Goffney, M. Boston, & R. Gutiérrez (Eds.), *Rehumanizing mathematics for Black, Indigenous, and Latinx students* (pp. 1 - 10).

Gutstein, E. R. (2016). Our issues, our people--math as our weapon: Critical mathematics in a Chicago neighborhood high school. *Journal for Research in Mathematics Education 47*(5), 454-504. doi: 10.5951/jresematheduc.47.5.0454

Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education 34*(1), 37 - 73.

Gutstein, E. (2013). Whose community is this? Mathematics of neighborhood displacement. *Rethinking Schools, 27*(3), 11 - 17.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*, 465-491.

Larnell, G. V., Bullock, E. C., & Jett, C. C. (2016). Rethinking teaching and learning mathematics for social justice from a critical race perspective. *The Journal of Education 196*(1), 19-29.

Leonard, J., Brooks, W., Barnes-Johnson, J., & Berry, R. Q., (2010). The nuances and complexities of teaching mathematics for cultural relevance and social justice. *Journal of Teacher Education 61*(3), 261–270. doi: 10.1177/0022487109159927.

Mean Absolute Deviation Worksheet. (n.d.). Houston Independent School District / Houston ISD. https://www.houstonisd.org/cms/lib2/TX01001591/Centricity/Domain/4747/MAD%20Mean%20Absolute%20Deviation%20Worksheet%20Practice.pdf

Medori (2020). *Compound probability practice scavenger hunt activity* [On-line]. Retrieved from https://www.teacherspayteachers.com/Product/Compound-Probability-Practice-Scavenger-Hunt-Activity-FREEBIE-3802065

Moll, L., & Gonzalez, N. (1994). Lessons from research with language minority children. *Journal of Reading Behavior, 26*(4), 23-41.

Moses, R. P., & Cobb, C. E. (2002). *Radical equations: Civil rights from Mississippi to the Algebra Project.* Boston: Beacon Press.

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common core state standards for mathematics*. National Governors Association Center for Best Practices, Council of Chief State School Officers. Washington, D.C. Retrieved from http://www.corestandards.org/Math/Content/7/SP/

Paris, D. (2012). Culturally sustaining pedagogy: A needed change in stance, terminology, and practice. *Educational Researcher 41*(3), 93-97. doi: 10.3102/0013189x12441244.

Paris, D. & Alim, H. S. (2014). What are we seeking to sustain through culturally sustaining pedagogy? A loving critique forward. *Harvard Educational Review 84*(1), 85-100.

Part II: Unit Plan

Unit Standards

Content Standards

7.SP.A.1 - Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

7.SP.A.2 - Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates of predictions.

7.SP.B.3 - Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.

7.SP.B.4 - Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.

7.SP.C.5 - Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around ½ indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.

7.SP.C.6 - Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability.

7.SP.C.7 - Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.

7.SP.C.7.A - Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events.

7.SP.C.7.B - Develop a probability model (which may not be uniform) by observing frequencies in data generated from a change process.

7.SP.C.8 - Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.

7.SP.C.8.A - Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.

7.SP.C.8.B - Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., “rolling double sixes”), identify the outcomes in the sample space which compose the event.

7.SP.C.8.C - Design and use a simulation to generate frequencies for compound events.

Standards of Mathematical Practices (SMPs):

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Social Justice Standards:

JU.6-8.13 - Students will analyze the harmful impact of bias and injustice on the world, historically and today.

AC.6-8.17 - Students will recognize their own responsibility to stand up to exclusion, prejudice and injustice.

Learning Objectives

For this unit plan we will be looking at 3 clusters 7.SP. A, B, and C which consist of 8 standards – not including sub-standards. From this unit:

Students will be able to determine the mean, median, mode, range, mean absolute deviation, interquartile range, and spread of a data set, explain what probability is in regards to chance of events being likely or unlikely and that probability lies between 0 and 1, and percentage of independent/dependent events occurring – how to recognize random samples.

Specific/Lesson Objectives

L.O.1 Students will be able to show an understanding that statistics has the ability to be used to gain information about a population through examination of a sample of the population.

L.O.2 Students will be able to show that generalizations about the population from a sample are valid only if the sample is representative of that population.

L.O.3 Students will be able to show that random sampling tends to produce representative samples and support valid inferences.

L.O.4 Students will be able to use data from a random sample to draw inferences about a population with an unknown characteristic of interest.

L.O.5 Students will be able to generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.

L.O.6 Students will be able to informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.

L.O.7 Students will be able to use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations (Mean, Median, Mode, Range, MAD, IQR, and Spread).

L.O.8 Students will be able to describe that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood.

L.O.9 Students will be able to show that a probability near 0 indicates an unlikely event, a probability around ½ indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.

L.O.10 Students will be able to approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-term relative frequency, and predict the approximate relative frequency given the probability.

L.O.11 Students will be able to develop a uniform probability model by assigning equal probability to all outcomes and use the model to determine probabilities of events.

L.O.12 Students will be able to develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process.

L.O.13 Students will be able to explain that, just as with sample events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.

L.O.14 Students will be able to represent sample spaces for compound events using methods such as organized list, table, and tree diagrams. From all event describe in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event.

L.O.15 Students will be able to design and use a simulation to generate frequencies for compound events.

Calendar

Lesson One (LO 1~7)

Day One

- Daily Objective is to introduce mean, median, mode, and range.
- The class will start with an opener where the students explore on their own before the lesson begins. They will explore the subject matter through various means.
- The main activities of this lesson are the self-exploration and class discussion.
- Assessment will be done through an exit slip.

Day Two

- The daily objective is to introduce mean absolute deviation (MAD), interquartile range (IQR), outliers, and spread to the class.
- The class will start with an opener where the students will explore on their own the subject matter before it has been presented to them to get a feel for the day's lesson.
- The main activities for the day are self-exploration of the topic and class discussion.
- Assessment will be done through an exit slip.

Day Three

- The daily objective is to review and combine the two concepts covered in the last two days.
- The students will be given a worksheet that covers the two previous days' materials and work on that for the duration of class.
- The main activity of the day will be the worksheet.

- The assessment for the class is the worksheet the class worked on.

Lesson Two (LO 8~10)

Day Four

- The daily objective is to introduce probability to the class.
- The class will be introduced to probability through a marble guessing game.
- The main activities of the class will be the opener, the I do – We do – You do activity, and a worksheet.
- Assessment will be done through the worksheet.

Day Five

- The daily objective is to reinforce probability.
- Students will do a scavenger hunt where they have to solve the problem to move to the next card.
- The assessment will be the results from the scavenger hunt.

Day Six

- The daily objective is probability.
- Students will begin with an opener and then class will go into the birthday problem.
- The main activity of the day is the birthday problem.

Lesson One and Two Assessment

Day Seven – The daily objective is the traditional assessment of lessons one and two over probability and mean, median, mode, range, MAD, IQR, outliers, and spread.

- Students will be given a traditional assessment over lessons one and two.
- The main activity of the day is the traditional assessment.
- The assessment is the class objective.

Lesson Three (LO 11~15)

Day Eight –

- The daily objectives for today are random samples and dependent probability.
- Students will research on police shootings resulting in death divided by race.
- The main activity of the day will be collecting data and analyzing it.
- As for the assessment, the teacher will walk around and ensure that students are getting the data correctly and staying on task.

Day Nine

- The daily objectives for today are random sampling through continued research and to prepare for the debate.
- Students who did not get all their data the previous day will do that otherwise students will prepare for the debate.
- The main activity for the day is to prepare for the debate.
- The assessment will be done by walking around the class and seeing where students are on their work.

Day Ten

- Unit Assessment
- Students will debate.
- The main activity of the class is debates.
- The debates will be assessed according to the rubric.

Day Eleven – Lesson Three

- Unit Assessment
- Students will debate.
- The main activity of the class will be the debates.
- The debates will be assessed according to the rubric.

Lesson One (Days 1-3)

Standards

7.SP.A.1 - Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

7.SP.A.2 - Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates of predictions.

7.SP.B.3- Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.

7.SP.B.4 - Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.

Learning Objectives

L.O.1 - Students will be able to show an understanding that statistics has the ability to be used to gain information about a population through examination of a sample of the population.

L.O.2 - Students will be able to show that generalizations about the population from a sample are valid only if the sample is representative of that population.

L.O.3 - Students will be able to show that random sampling tends to produce representative samples and support valid inferences.

L.O.4 - Students will be able to use data from a random sample to draw inferences about a population with an unknown characteristic of interest.

L.O.5 - Students will be able to generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.

L.O.6 - Students will be able to informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.

L.O.7 - Students will be able to interpret mean, median, mode, range, mean absolute deviation (MAD), interquartile range (IQR), and spread for numerical data from random samples to draw informal comparative inferences about two populations.

Day One Activities

Materials

Needed will be a method to present the opener, slips of the exit ticket, handouts of the days data and work.

Worksheet 1-1, *Mean Opener* (1 per student – if you chose to handout instead of display)
Worksheet 1-3, *Mean Exit* (1 per student)

Required Prior Knowledge and Anticipated Misconception/Difficulty

Students should already know how to add, subtract, divide, count numbers, round numbers, and what average is. Students may have difficulty remembering what mean, median, mode each mean and not getting them confused with each other.

Launch/Act I (Time: 15 – 20 minutes)

- ❏ Begin with the *Mean Opener*. This can be handed out as a worksheet (1 per student) or displayed for students to work on in a journal. The questions are to get the students thinking about mean and the social justice topic -- Police shootings resulting in death divided by race. The questions the students will focus on are:
    1. Describe observations you made from the given information.
    2. Does the data raise any questions for you?
    3. What do you think the numbers from each year look like compared to the average? Explain your thoughts.
    4. What additional information do you think would be helpful to you?
- ❏ Some possible student responses to the questions are:
    1. On average White people are shot to death more than Black or African American.
    2. What is the data supposed to tell us?
       What does average mean?
       Why is there such a large difference between the numbers? I would have expected them closer together because of all the news out there.
       Why is there so much news about Black or African American people being shot when they are half as likely than a White person to get shot to death by the police?
    3. I would expect them to be around the same. This is because the average is the number that tells you the important value of the set.
       It'll be around the same given a window either way such that it could be within so far away from the average.
    4. The data.
       I don't know, I don't know what we are doing.
- ❏ Depending on students' answers you can respond accordingly or proceed to the guiding questions here.
    1. Given the minimum and maximum values:

The minimum for White was 390 and for Black or African American was 249 both in 2019.
The maximum for White was 521 and for Black or African American was 273 both in 2015.

How does this change your thoughts about the average (or mean) and your answers that you previously said? Does this give us any new information?

Possible Student Responses:

- ❑ Still more White people are shot to death by police than Black or African American people.
- ❑ There is still a large gap between the numbers, they are a little closer in 2019 but still noticeably apart.
- ❑ They are not the same over the years for White people but for Black or African American people they are close to the average.
- ❑ They do seem to be within some window around the average.
- ❑ The new information did not change my thoughts about average or my answers that I had previously said.
- ❑ It does give us new information because we didn't know that before, but I don't know what it has to do with the average.

Possible Teacher Responses:

- ❑ There is a gap between the number of White people shot to death by police versus Black or African American people shot to death with more White people being shot.
- ❑ It is true that they are not the same over the years, they do change from year to year but in a couple of days we will investigate that further.
- ❑ True, this is new information purely on the fact that you did not know it prior. The minimum and maximum don't necessarily have anything to do with average (or mean), but they give us new information about the data that one could gain.

2. So, we have the minimum, maximum which tells us the span (or range) and I can tell you there are no repeating numbers (this is called the mode) in the set and that the middle number (the median) is 477 for White and 260 for Black or African American. So, we know how much the data spans or ranges (maximum – minimum), the average or mean, that there are no values that repeat or the mode, and the middle values or the median. Do we know anything else? (We know how many values are in the data set – the number of years.) What is important about these numbers? Why would we want to know any of them?

   Possible Teacher Responses

   - ❑ The data tells us if there are any clusters (the existence of repeating variables – the mode) and where the data is centered (average – mean

and if there are no outliers then it would then be around the middle number – median).

3. Where are some places in which you have seen any of these? Why are these values of importance for police shootings? What does the data tell people?

Possible Student Responses or Actions

- ❏ On television like the news.
- ❏ Sports.

Possible Teacher Responses

Exploration: Act II (Time: 25 minutes)

- ❏ Have the students, working in pairs up to groups of four depending on class size, find the other five racial groups (American Indian & Alaska Native, Asian, Native Hawaiian & Other Pacific Islander, Unknown, and Hispanic) and find the number of each racial group that was shot to death by police for the years 2013 to 2019.
- ❏ Once they have the data they then are to find the mean, median, mode, and range for each racial group.

Year	American Indian and Alaska Native	Asian	Native Hawaiian & Other Pacific Islander	Unknown	Hispanic
2019	13	16	9	207	170
2018	21	12	10	155	178
2017	27	12	5	37	217
2016	23	13	6	21	180
2015	11	27	4	12	184
2014	10	16	4	83	173
2013	4	17	2	186	164

Answer key

	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian and Pacific Islander	Unknown	Hispanic
Mean	464.14	260.57	15.57	16.14	5.71	100.14	180.857
Median	477.00	260.00	13.00	16.00	5.00	83.00	178.000
Mode	-	-	-	12, 16	4.00	-	-
Range	131.00	25.00	23.00	15.00	8.00	195.00	53.000

- ❏ Now that the students have had time to find the data and do the calculations, we can begin to ask them questions. First give them the assumption that the population is 322,534,286.
    - ❏ Now that we have all this information what assumptions can be made about people shot to death by police?
        - ❏ A small number of people are shot to death by the police in comparison to the population.
    - ❏ If it is representative of the population what assumptions could we make with the given data?
        - ❏ Then the population distribution is White, Black or African American, Hispanic, Unknown, then American Indian and Alaska Native with Asian, and Native Hawaiian and Other Pacific Islander being the smallest which sounds about correct. The unknown group is mysterious so it could fall in several places since it probably contains parts of other groups like with biracial people.
    - ❏ If it is not representative of the population, what assumptions could we make with the given data?
        - ❏ Then the police shootings are not fair between racial groups.
        - ❏ (Looking for the students to see disproportionality in the police shootings without getting to that material yet).

Summary/Act III (Time: 10 minutes)

- ❏ With enough time for the students to complete, hand out the *Mean Exit* worksheet and collect before they leave for their next class or end of day. There should be one per student and worked on independently.

- ❏ The key points or important ideas for the day were for the students to learn about mean, median, mode, and range as well as to get them thinking about the disparity with people (by race) being shot to death by police. The years 2013 through 2019 were looked at and the mean, median, mode, and range were taken for seven different racial groups.

Day Two Activities

Materials

Needed will be a method to present the opener (MAD Start), slips of the exit ticket (MAD Exit), and access to Desmos.

Worksheet 1-4, *MAD Start* (1 per student if you chose to use)
Worksheet 1-5, *MAD Exit* (1 per student)

Required Prior Knowledge and Anticipated Misconception/Difficulty

Students should already know how to add, subtract, divide, count numbers, round numbers, and what average is. Students may have difficulty finding and understanding mean absolute deviation.

Launch/Act I (Time: 20 minutes)

- ❑ Begin with the *MAD Start* -- you can either display it or give a handout to each student -- to get students thinking about MAD, IQR, and outliers. (I used an example not related to the social justice topic so that they could see data sets of even and odd numbers of values.) After about five minutes bring the class together and work through together seeing if any students got anything and to explain their reasoning.

  Given the following sets *A* and *B*, find the mean absolute deviation (MAD), first quartile (Q1), third quartile (Q3), interquartile range (IQR), and outliers if any.

  $A = \{5, 7, 5, 5, 5, 2, 15, 10, 15, 1\}$

  and

  $B = \{13, 9, 13, 10, 11, 7, 9\}$

  Answer Key

	Set A	**Set B**
MAD	3.80	1.76
Q1	5.00	9.00
Q3	10.00	13.00
IQR	5.00	4.00
Outliers	None	None

- ❑ After the class has worked on the MAD Start worksheet for about five minutes, start going over the material as a class seeing if any students got correct answers or were on the correct path.

Mean Absolute Deviation Worksheet

	Set A	Distance from Mean	Absolute Value			Set B	Distance from Mean	Absolute Value
	5	-2	2			13	2.714	2.714
	7	0	0			9	-1.286	1.286
	5	-2	2			13	2.714	2.714
	5	-2	2			10	-0.286	0.286
	5	-2	2			11	0.714	0.714
	2	-5	5			7	-3.286	3.286
	15	8	8			9	-1.286	1.286
	10	3	3					
	15	8	8					
	1	-6	6					
Mean = 7		**Sum**	38.0		**Mean = 10.286**		**Sum**	12.286
		Count	10.0				**Count**	7.000
		MAD (Mean)	3.8				**MAD (Mean)**	1.755

- ❑ Want the students to observe the variance between sets A and B just to get them introduced to variance.
- ❑ Some guiding questions you could ask are (and you may have already asked questions to this affect):
  - ❑ Now that we have found these numbers, let's figure out what they tell us. Looking at the mean absolute deviation (MAD) we calculated, what do you think it could possibly tell us?

    Possible Student Responses
    - ❑ I don't know
    - ❑ How far things are from the mean.

Possible Teacher Responses

- ❏ Well let's look at this more deeply. We took the positive difference of the mean with the data set to create a new set. Next, we took the mean of the new data set. This new mean tells us what? -- It tells us the average distance the data is from the mean of the data set.
- ❏ That's correct. MAD tells us how far the data points are from the mean on average or how spread out the data is. The variability of the data set.

❏ How about the quartiles, which is quartile one and three? We found those by looking at the lower and upper medians of the data sets. With the median, what do they all do to the data set?

Possible Student Responses

- ❏ It divides the data set up.

Possible Teacher Responses

- ❏ How does it divide the data set up?

❏ How can we tell if a number from a data set is an outlier or not? Were there any outliers in either of these data sets?

Act II - Part II (Time: 20 minutes)

❏ Have the students get onto Desmos (https://teacher.desmos.com/activitybuilder/custom/5f832c1b1bfced0b5ba6007b) as pairs and begin the activity where they will calculate the MAD, Q1, Q3, and IQR. You can monitor them through Desmos or by walking around the classroom and seeing how the students are doing.

	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Unknown	Hispanic
2019	390	249	13	16	9	207	170
2018	477	250	21	12	10	155	178
2017	491	260	27	12	5	37	217
2016	512	262	23	13	6	21	180
2015	521	273	11	27	4	12	184
2014	454	256	10	16	4	83	173
2013	404	274	4	17	2	186	164

❏ While they are working on Desmos, check their progress either by following how they are doing on Desmos or walking around the classroom.

- ❑ Once they have spent about 15 minutes working on Desmos, bring the class together and discuss the results so that everyone is on the same page.

	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Unknown	Hispanic
Q1	404.00	250.0	10.00	12.000	4.00	21.00	170.00
Q3	512.00	373.0	23.00	17.000	9.00	186.00	184.00
IQR	108.00	25.0	13.00	5.000	5.00	165.00	14.00
MAD	41.27	7.8	6.94	3.346	5.71	70.73	11.22
Outliers	-	-	-	27.000	-	-	217.00

- ❑ Something that the students can notice is that a comparison of Asian with American Indian and Alaska Native we can say that the mean number of American Indian and Alaska Native shot to death by police is about twice the variability of either race and on a box and whisker plot the two distributions are noticeable.
- ❑ Some questions for a class discussion are (the questions are to get the students thinking about connections from the math to police shootings):
    - ❑ Looking at the final results, what can we say about police shootings?
    - ❑ We have variability. Does anything stand out with that?
        - ❑ What do you think the high variability with Unknown individuals means?
    - ❑ Did you find any outliers?
        - ❑ If not let's look closer at the data.
        - ❑ If so, where?
    - ❑ What do the outliers tell us?
    - ❑ Why do you think there are outliers?

Summary/Act III (Time: 3 minutes)

- ❑ Near the end of class, with enough time, pass out the *MAD Exit* handout to each student to work on independently.
- ❑ The key ideas of the lesson were the concepts of mean absolute deviation and interquartile range along with variability of the data and how that can be seen in the police shootings.

Day Three Activities

Materials

Opener and daily worksheets.
Worksheet 1-6, *Matching* (1 per student – opener)
Worksheet 1-7, *Exploring Box and Whiskers A* (1 per student)
Worksheet 1-8, *Exploring Box and Whiskers B* (1 per student)
Worksheet 1-9, *Dot Plot Class Exploration* (1 per student)
Worksheet 1-10, *Dot Plot Continued* (as needed)

Required Prior Knowledge and Anticipated Misconception/Difficulty

Required knowledge would be the two previous lessons. Foreseeable difficulty for students is remembering what makes up the box and whiskers graph.

Launch/Act I (Time: 3 - 8 minutes)

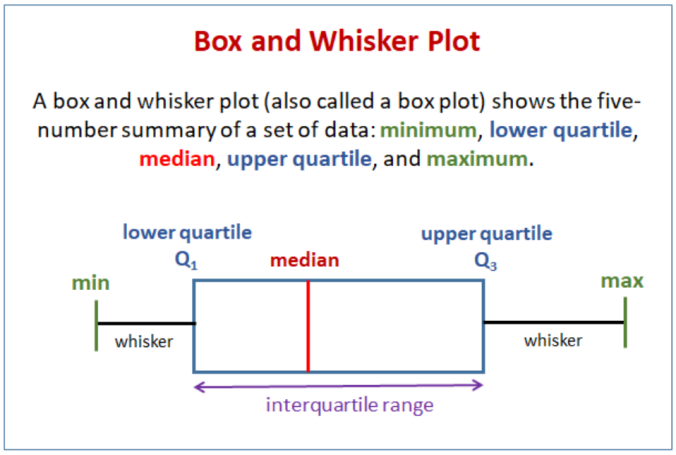
- ❑ Students will begin with the *Matching* opener which you can either pass to each student or display. This is to refresh their memory of the past few days and to get them thinking about the day's lesson.
- ❑ Once they have worked about three minutes bring the class together and go over the answers.

Explore/Act II - Part I (Time: 15 - 20 minutes)

- ❑ Now have the students use a box and whisker graph to interpret the data. Use the data they have been working with and graph American Indian and Alaska Native with Native Hawaiian and Pacific Islander or American Indian and Alaska Native with Asian.

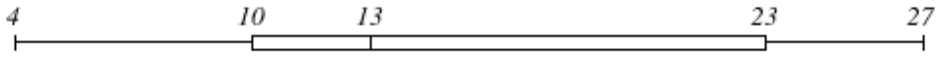
	American Indian & Alaska Native	Native Hawaiian & Pacific Islander	Asian
2019	13	9	16
2018	21	10	12
2017	27	5	12
2016	23	6	13
2015	11	4	27
2014	10	4	16
2013	4	2	17

	American Indian & Alaska Native	Native Hawaiian & Pacific Islander	Asian
Min	4	2	12
Q1	10	4	12
Median	13	5	16
Q3	23	9	17
Max	27	10	27

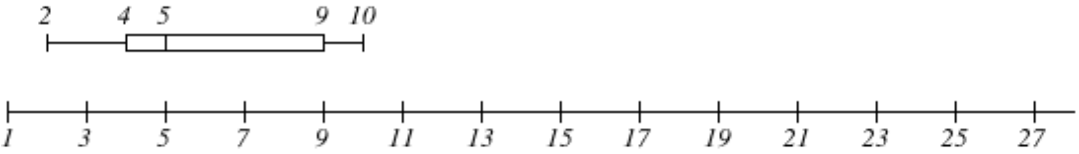


(Reference: Box and whiskers plot)

American Indian & Alaska Native

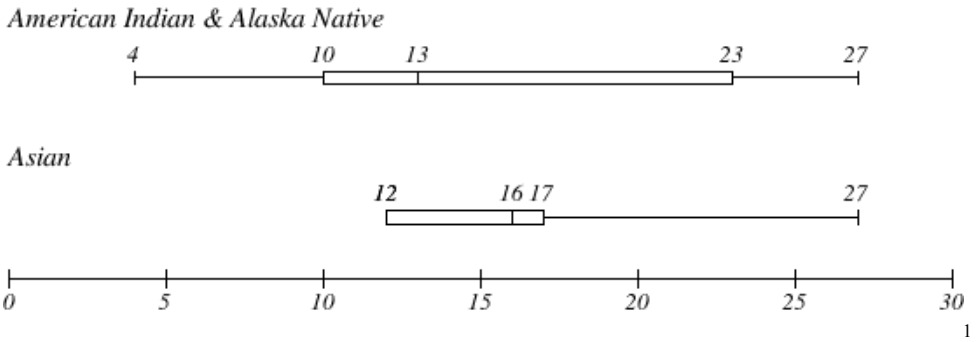


Native Hawaiian & Pacific Islander

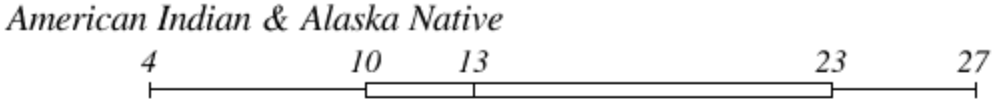


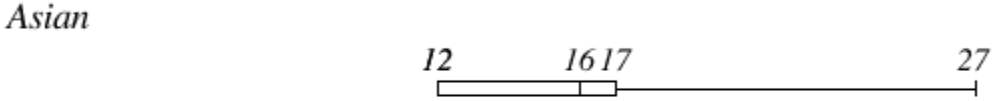
Shot to Death by Police

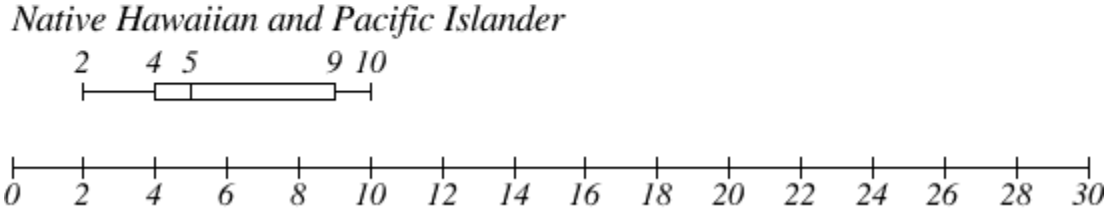
(http://www.imathas.com/stattools/boxplot.html)



[1]







- Some questions you can ask the class:
  - What information are we gaining from the graphs?
    - An overview of police shootings.
  - Are there any similarities between the two graphs?
    - Native Hawaiian and Pacific Islander looks like a smaller version of American Indian and Alaska Native.
  - What information do the boxes represent? What about the lines?
    - They show where most of the numbers lie (inside the box) or the number of police shootings for each group.
  - Do you think you could see any outliers this way? Explain your thoughts.
    - Yes, because if the lines go far away from the box then it probably is an outlier.
  - What about the variabilities of the two graphs, how do those appear to relate?

[1] From the previous lesson when it was mentioned about the variability of American Indian & Alaska Native in comparison with Asian, this is what that looks like with box and whisker plots.

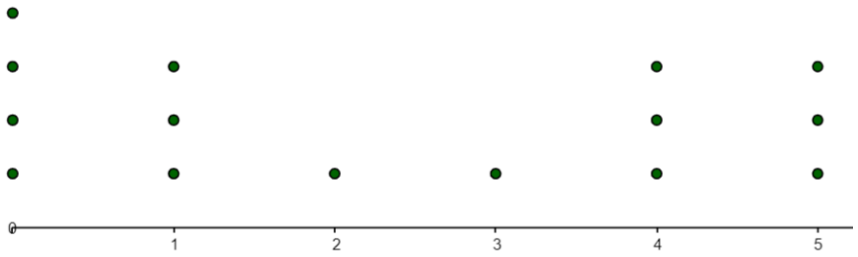
- ❏ American Indian and Alaska Native is double that of the Native Hawaiian and Pacific Islander. This can be seen by the numbers calculated yesterday and the boxes in the graph.
- ❏ Is this easier to visualize the data?
  - ❏ For some of the data it is. It doesn't give the mean or mode but does answer many other questions quickly.

❏ Students can then work in pairs to groups of four on a worksheet *Exploring Box and Whiskers*.

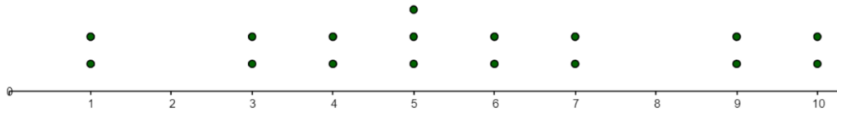
Act II – Part II (Time: 15 - 20 minutes)

❏ Next is dot plots. I have two data sets to present how to create dot plots. Let
A = {2, 4, 0, 1, 5, 1, 0 1, 5, 3, 5, 4, 0, 4, 0} & B = {6, 1, 3, 5, 10, 4, 4, 5, 10, 3, 7, 5, 9, 9, 7, 6}.
Then we have:

Set A -



Set B -



- ❏ Now with the police shootings, students can see how spread out the data is, but only a couple have repeating data values so the dot plots are going to be more spread out than vertical. For this, maybe they could collect data from their classmates such as how many pets they have or how many siblings they have and use that data to create dot plots.
- ❏ There are worksheets for the class to collect data and to answer questions about a given dot plot.

Summary/Act III (Time: 10 minutes)

❏ Students are asked to write what they learned from the Lesson One on their journals. They are encouraged to use any forms of communication, such as their first language, drawing, or symbols. Students write not only the math concepts they learned through the Lesson One but also their reflection about how much they feel they accomplish.

Lesson Two (Days 4-6)

Standards

7.SP.C.5: Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.

7.SP.C.6: Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.

Learning Objectives

L.O.8: Students will be able to describe that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood.

L.O.9: Students will be able to show that a probability near 0 indicates an unlikely event, a probability around 1⁄2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.

Day Four Activities

Materials

Students will need the worksheets for the day and a pencil or pen. The teacher will need a bag containing 100 marbles. The colors and amount of marbles of each color can be different, but in this lesson, we use 50 red marbles, 30 blue marbles, and 20 yellow marbles. The teacher will also need enough number cubes for each student to have 2.

Worksheet 2-4, *Vocabulary Organizer* (1 per student)
Worksheet 2-5, *Probability Practice* (1 per student)

Required Prior Knowledge and Anticipated Misconception/Difficulty

Students should be able to summarize numerical data sets in relation to their context and find measures of variability (range and interquartile range). In addition, students will need to know how to do simple arithmetic and convert between decimals, fractions, and percentages. Students may have difficulty understanding how probability can be quantified using fractions, decimals, and percentages (e.g. "What does it mean for something to happen 50% of the time?").

Launch: Act I (Time: 5 minutes)

- Students will play a marble guessing game. The teacher will explain that they have a bag containing 100 marbles. Each marble is either red, blue, or yellow. The students' goal is to guess how many of each color are in the bag.
- **Physical Event**: Students will take turns drawing a single marble out of a bag containing 100 red, blue, and yellow marbles. After each draw, the marble will be returned to the bag. The teacher will keep a tally visible of how many of each color were drawn.

Exploration: Act II (Time: 45 minutes)

- **Drawing**: Students will return to their seats and have time to draw a picture of what they think the inside of the bag looks like and also write out their answers to the following questions:
    - Which color marble was drawn the most out of the bag? Why do you think that is?
    - Do you think a person is equally likely to draw any color marble? Why or why not?
- **Informal Language**: Students will discuss their drawings and the following questions with their partner. Afterwards, the teacher will choose some groups to present their drawings, predictions, and answers to the questions.
    - What are you trying to find? How did you go about trying to find it?
    - What are all the possible colors of marbles someone could draw from the bag? Could someone draw a green marble?
    - Did you and your partner guess the same amount of each color marble? If so, why were they the same? If not, how are they different?
    - Using your predictions, if you drew 60 marbles out of the bag (replacing the marble each time), how many times do you think you would draw a blue marble? Explain your prediction.

        - Some possible student responses are:
            1. Groups might describe the difference in their member's guess quantitatively (i.e., "Their guess for the number of blue marbles was 10 lower than mine.").
            2. Students might just guess numbers for the last question.
        - Some possible teacher responses are:
            1. Ask, "How does the likelihood of drawing a certain color marble differ between your two predictions?". "If your predictions were correct, which would result in a higher likelihood of drawing a blue marble? Why?"
            2. Ask, "Based on what marbles our class drew, what color marble do you think you would draw the most out of the 60? Which color do you think you would draw the least of?" "Using that information, come up with some numeric predictions."
- **Formal Language**: While students are presenting, the teacher will document which words and phrases students use to describe the scenario. After passing out worksheet 2-4, *Vocabulary Organizer*, the teacher will write these phrases on the board along with the formal mathematical phrases and have students work with their partners to decide which phrases line up with which formal terms. The mathematical ideas to watch for during the presentations are:
    - *Event* – The subset of the sample space that we want to find the probability of (e.g. "We want to find the probability of drawing a blue marble.").
    - *Probability* – The expected outcome of an event represented as a fraction, decimal, or percentage (e.g. "Out of 100 draws, we expect you will draw a blue marble 30 times.").
    - *Sample Space* – The set of all possible outcomes of the event (e.g. "We can either draw a red, blue, or yellow marble.").
    - *Experiment* – A procedure that can be repeated and has a set of outcomes (e.g. "We are pulling a single marble out of a bag, checking the color, then replacing it.").
    - *Outcome* – A possible result of an experiment (e.g. "We drew a yellow marble this time.").
    - *Complement of an Event* – All the possible outcomes that are not the event in question (e.g., "If we don't draw a blue marble, the only other possibilities are drawing a red marble or a yellow marble.").
        - Some possible student responses are:
            1. Students might think that if an event's probability is 50%, then that event will happen exactly 50% of the time.
            2. Students might have the misconception that probabilities can only be represented as percentages.
        - Some possible teacher responses are:
            1. Remind the student that probabilities are just expectations. These events are random, so they do not always follow the expectation exactly.
            2. Most everyday probabilities are expressed in percentages (weather, the lottery, etc.), but expressing some probabilities as fractions and decimals helps us calculate other important probabilities.
- **Symbolic Representation**: Students will fill out the rest of their vocabulary organizer while they watch a video that provides more examples of probabilities. The video citation is provided below:

mathantics. (2019, May 15). *Math Antics - Basic Probability* [Video]. Youtube. https://www.youtube.com/watch?v=KzfWUEJjG18

- After the video, the teacher will pass out worksheet 2-4 *Probability Practice*. The teacher will pass out two number cubes to each student. Students will work with their partners to complete the worksheet.

Summary: Act III (Time: 5 minutes)

- Students will end the lesson by completing an exit ticket. The questions for the exit ticket are:
    - What are 3 things you learned today?
    - What are 2 things you found interesting?
    - What is 1 question you still have?

Day Five Activities

Materials

Needed will be the three worksheets to the scavenger hunt and the teacher created clues to the scavenger hunt.

Worksheet 2-1, *Iowa Population Probability* (1 per student)
Worksheet 2-2, *United States Population Probability* (1 per student)
Worksheet 3-2, *Shot by Police Probability* (1 per student)

In addition, students will need a device capable of conducting research on the internet. This can be school laptops, school iPads, or students' own personal smartphones. Expectations must be set accordingly prior to the use of the technology.

Required Prior Knowledge and Anticipated Misconception/Difficulty

Students should be familiar with multiplying and dividing numbers. Students may have difficulty remembering how to find the probability of a certain event given its context.

Launch: Act I (Time: 10 minutes)

- Begin by explaining the students' activity for the day. The students will participate in a scavenger hunt where they will explore probabilities associated with population and police shootings. After completing a step of the scavenger hunt, the group will explain their thinking to the teacher and a new clue will be given to help them find the next step of the hunt. Before the hunt, students will then discuss some questions in their groups and then share their responses to the class. The questions the students should focus on are:
    - What are some examples of using probability to solve real world problems?
    - How does probability relate to police shootings?
- Some possible student responses are:
    1. Students may be unable to come up with an example of using probability to solve real world problems.
    2. Students might say something along the lines of, "We can calculate the probability that someone will be shot by police."
- Possible teacher responses:
    1. Give the example of the weather forecaster predicting a 90% chance of rain tomorrow. Ask, "How does knowing the probability of it raining tomorrow help us?".
    2. Ask, "Why is that important to know?" or "Why would knowing that information be helpful?".

Exploration: Act II (Time: 35 minutes)

- At this point, the students will be arranged into groups of 4 to begin the scavenger hunt. Each group will be given their first clue and they will use it to find their first challenge.
- Challenge 1

- The first scavenger hunt clue will lead students to worksheet 2-1, *Iowa Population Probability*. Students will make sure everyone in their group receives a copy of the worksheet. Students will work in their group to use the data on the worksheet to calculate the probability any randomly selected person from Iowa is of a certain racial identity for each of the given years. After this, students will respond to the questions and share their responses with the teacher in order to obtain the clue for the next step of the scavenger hunt.
- Some possible student responses are:
    1. Students might not understand which numbers they need to divide in order to calculate the probabilities.
    2. The group might question why the probability of selecting a person who identifies as white is so much more likely than selecting someone of another racial identity group.
- Possible teacher responses:
    1. Refer back to the example of a bag of red and blue marbles. "In this new context, which population is our blue marbles and which population is our total marbles?"
    2. Ask, "How do you think this lack of diversity affects Iowans?"

- Challenge 2
    - The second clue will lead students to worksheet 2-2, *United States Population Probability*. During this step, students will conduct their own online research to determine the population of each of the listed racial identity groups in the United States for each of the given years. Using their data, students will calculate the probability any randomly selected person from the whole United States is of a certain racial identity for each of the given years. After this, students will again respond to the questions on the worksheet and share their responses with the teacher. It is important for the teacher to monitor students while they are gathering data to ensure the data is accurate.
    - Some possible student responses are:
        1. Students might not know how to begin looking for the data they need.
    - Possible teacher responses:
        1. Direct students to the US census website. This is a good place to start.
- Challenge 3
    - The third clue will lead students to worksheet 2-3, *Shot by Police Probability*. Students will work in groups to use the given data to calculate the probability that any randomly selected person from the United States was shot to death by police for each of the given years. Students will then combine this data with the data from worksheet 2-2 to calculate the probability that any randomly selected person belonging to each of the listed racial identity groups was shot to death by police for each of the given years. After this, students will again respond to the questions on the worksheet and share their responses with the teacher.
    - Some possible student responses are:
        1. Students might calculate each probability assuming they are selecting random people from the whole US population rather than selecting people from within each individual listed racial identity group.

2. Students might conclude that police shootings are not an issue because the probabilities they calculate are so close to zero.

- Possible teacher responses:
  1. Remind the student that we want to find the probability a randomly selected person *from each* racial identity group was shot by police. Ask, "If we randomly chose a person who identifies as white in the year 2017, what is the probability they were shot by police?".
  2. Remind students that, although these probabilities appear small, the population of the US is so large that these numbers have a real and tangible effect. In addition, the main idea of the lesson is to have students compare the probabilities between the listed racial identity groups. Ask questions that foster comparisons, such as, "How many more times likely is it that a randomly chosen person who identifies as black is shot by police than a chosen person who identifies as white?".

Summary: Act III (Time: 10 minutes)

- Students will return to their seats and groups will be encouraged to share their responses and reactions to each of the scavenger hunt steps. The purpose of this class discussion is to encourage students to reflect on the mathematics they have learned that day and how it relates to interpreting data about police shootings. Some possible questions to guide the discussion include:
  1. How easy or hard was it to find the population data you needed for the second step of the hunt?
  2. Did the probabilities you calculated surprise you? Why or why not?
  3. Why do you think the probabilities are the way they are?

Day Six Activities

Materials

Students will be arranged into groups of 4. Each group will be provided with a piece of poster board for their presentation. Students will also need pencils and paper.

Required Prior Knowledge and Anticipated Misconception/Difficulty

Students should be familiar with multiplying and dividing numbers. Students should also be familiar with the concept of probability and be able to calculate simple probabilities. Students may need to be reminded that, if we want to find the probability of multiple events occurring, we can multiply their probabilities.

Launch: Act I (Time: 10 minutes)

- Begin by explaining that the goal of the day is to work in groups to solve the birthday problem. Ask students so questions to get started:
    - Has anyone heard of the birthday problem?
    - What do you think the birthday problem is?
- Once students share their experience and thoughts about the birthday problem, pose the actual problem to them by writing it on the board. Alternatively, copies of the problem can be printed out and given to students. It is important to ask students what probabilities the question is asking them to calculate.
    - "Assuming every day of the year is equally likely to be someone's birthday, how many people do you need in a group to have a 50% chance that at least two people will share a birthday?"
    - The question is asking us to calculate the probability that a certain number of people in a group share the same birthday.
- Have students get into groups of 4 and explain the group roles. Give students 2 minutes to decide which role is assigned to each group member. The group roles are:
    - Facilitator - This person is in charge of ensuring each group member has a chance to speak and have their questions answered.
    - Recorder - This person is in charge of organizing all the results of their group and ensuring each group member's idea is documented.
    - Resource Manager - This person is in charge of gathering materials for their group. Additionally, this person is in charge of collecting questions your group has and asking the teacher.
    - Captain - This person is in charge of making sure their group's mathematical statements are backed up by mathematical reasoning. Additionally, this person is in charge of ensuring the discussion stays on topic.

Exploration: Act II (Time: 35 minutes)

- Have the resource manager of each group collect a sheet of poster board for their group.
- Give groups about 10 minutes to discuss the problem and possible solutions. Each group should create a poster (including a picture) that shows their thinking about the problem. While groups are

working, the teacher should walk around and listen to the strategies and ideas of each group. The teacher will use this information to determine the order in which the groups will present. The purpose of these presentations is to give the class a more well-rounded view of the birthday problem and what strategies might be useful for solving it. Students are not expected to have a final answer at this point.

- Groups will present their poster to the class and both the teacher and other students will ask questions about their thinking.
    - Possible student responses are:
        1. Students might think that the answer is around 183 people because there are 366 possible birthdays and 183 is half of 366.
        2. Students might not know how to begin.
    - Possible teacher responses are:
        1. Ask students to clarify what probability this actually represents. Remind students that any two people in the room have the potential to share a birthday.
        2. Ask students if they can find a related probability that might help. "What's the probability that two people in a room share the same birthday? What about three people?".
- Introduce the rule of subtraction to students as a tool that might help them solve the birthday problem. Give the example of finding the probability of rolling a 1 on a 6-sided number cube. The purpose of this example is to show students that they can find probabilities by calculating the complement probability. The important point for students to take away is that the probability of an event and its complement always add to 1.
    - In this scenario, what is the probability of rolling a 1?
    - What is the probability of not rolling a 1?
    - What is the probability of either rolling a 1 or not rolling a 1?
    - How can we use this to help solve the birthday problem?
    - What is the converse of the statement in the birthday problem?
        - Possible student responses:
            1. Students might think the converse of the birthday problem is "What is the probability that everyone in the room shares the same birthday?".
        - Possible teacher responses:
            1. Ask, "If everyone in the room shared the same birthday, would that satisfy the conditions of the birthday problem?".
- Allow students to continue working in their groups. During this time, each group will make another poster (or add to their original poster) that shows their strategies and progress in solving the birthday problem. Encourage students to use the newly learned subtraction rule in their strategies.
- Once again, groups will present their poster to the class. The teacher and other students will ask questions.
    - Possible student responses:
        1. Students might correctly define the converse probability for the birthday problem but not know how to calculate it.
    - Possible teacher responses:

1. Ask them to simplify the problem. “What is the probability that 2 people in a room don't share the same birthday? How many possible birthdays could person A have? With that in mind, how many possible birthdays could person B have?”.

- If no group finds the answer to the birthday problem, that is okay. Rather than give the class the answer, this is a good opportunity to encourage students to explore this problem on their own and see if they can figure it out.
- If time permits, using what they learned from the birthday problem, have students figure out the probability that two people in their class share the same birthday. After figuring out the probability, each student can share their birthday and see if two people in the class do indeed share the same birthday.

Summary: Act III (Time: 5 minutes)

- Students will end the lesson by completing an exit ticket. The questions for the exit ticket are:
    - What are 3 things you learned today?
    - What are 2 things you found interesting?
    - What is 1 question you still have?

Lesson Three (Days 8-11)

Standards

7.SP.C.7 - Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.

7.SP.C.7.A - Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. 7.SP.C.7.B - Develop a probability model (which may not be uniform) by observing frequencies in data generated from a change process.

7.SP.C.8 - Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.

7.SP.C.8.A - Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.

7.SP.C.8.B - Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event.

7.SP.C.8.C - Design and use a simulation to generate frequencies for compound events.

Learning Objectives

L.O.11 Students will be able to develop a uniform probability model by assigning equal probability to all outcomes and use the model to determine probabilities of events.

L.O.12 Students will be able to develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process.

L.O.13 Students will be able to explain that, just as with sample events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.

L.O.14 Students will be able to represent sample spaces for compound events using methods such as organized list, table, and tree diagrams. From all events described in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event.

L.O.15 Students will be able to design and use a simulation to generate frequencies for compound events.

L.O. 16 Students will be able to identify and use the standards for reliable data in order to gather credible data.

Day Eight Activities

Materials

Chromebook, or some type of device that students can use to research data.

Required Prior Knowledge and Anticipated Misconception/Difficulty

Students should be able to use search engines to find their desired data. They should identify statistical data that includes probability. Students might have tendency to trust any open resources without checking how reliable the data is.

Launch: Act I (Time: 10 minutes)

- In the launch of this lesson, the teacher will facilitate a discussion on what it means to gather statistics and information for a reputable source.
    - What would be an example of a place that you could get reliable information and statistics?
    - What are specific things to look for to make sure it is a good source of information?

- As a warm up activity, the teacher will lead the class through an online search to an unrelated subject (ex. Ice cream sales). This will give students an opportunity to see how to look for information.

Exploration: Act II (Time: 40 minutes)

- Students form groups. The number of people in one group could vary, but the teacher can guide students to choose a group of their interest.

- Students will then work to find data related to a social justice issue they feel passionate about. For example, students could look at data from police traffic arrests. Regardless of the data students select, they must be able to defend the credibility of the data that has been collected. The students should gather enough data points that they can draw conclusions from the data set, however you can differentiate this for different levels by the number of data points they need to collect. Fewer data points will be easier than a data set with over a 100 data points.

- Once the data has been collected, students need to find the probability that a certain event will happen. The teacher will continue to use their example data to first demonstrate to the students what should be expected of them. This will also look different for every student as the data they selected.

Summary: Act III (Time: 15 minutes)

- Students can start by finding some of the basic statistical measurements that they learned about in previous lessons. This could include mean, median, mode, standard deviation etc.

Day Nine Activities

In this lesson, students will be creating a probability model and presenting their data in a creative way. This may take a few additional days for students to prepare their data and then also present it.

Materials

Chromebook or other type of device to create an online presentation.

Required Prior Knowledge and Anticipated Misconception/Difficulty

Chromebook or other type of device to create an online presentation.

Launch: Act I (Time: 5 minutes)

- Explain to students that they will be presenting their data in a creative format. Provide students with a rubric of what they will need to include in their presentation.

Exploration: Act II (Time: 40 minutes)

- Walk students through the process of how they will create their probability model based upon their data that they have collected. Then students will do this for their set of data. There may be some changes and modifications that need to be made to the data they collect or the model based upon the data the student selected.

- Finally, students will create some type of presentation that includes their data, reasoning for credibility of data, and probability model for their data. Students will also then be able to draw conclusions and make comparisons. While the conclusions they draw may not be entirely accurate, the goal is to have students participating in the data analysis process. Students will also be encouraged to add graphics and other creative elements in order to bring the data and presentation to life.

Summary: Act III (Time: 20 minutes)

- Students will display and present their model they created as a group.
- After each group presentation, students have Q&A time and provide verbal and non-verbal feedback. For example, students anonymously write their feedback/comment on a post-it and attach it to the other groups' probability model.

Assessments

Daily Assessments

Daily assessments will be conducted through exit slips or class discussions or through that day's classwork. These formative assessments will help with knowing how the students are progressing and understanding the material and how to adjust the lesson if needed. For lesson one day one the formative assessment will be an exit slip, *Mean Exit*, that can be handed out near the end of class to see what students learned from the class's lesson. It is focused on mathematics and not the social justice aspect of the lesson. For lesson one day two the formative assessment will be an exit slip, *MAD Exit*, that can be handed out near the end of class to see what students learned from the class's lesson. It is focused on mathematics and not the social justice aspect of the lesson.

Content Assessments

There are two content assessments in this unit plan, a traditional assessment over the first two lessons and a non-traditional assessment over the final material which will overlap with the previous lessons some. The non-traditional assessment will be a debate. The rubrics can be found here:

Note. Assessments and Differentiation plans were not complete. We suggest the readers come up with their own design for the unit assessments and differentiation plans for diverse students who have various levels of prior knowledge in mathematics, language, and the given contexts.

Appendix: Worksheets and Keys

Worksheet 1-1 Mean Opener

Name: _____ Class: _____

On average from 2013 to 2019 the number of individuals shot to death by police (rounded to the nearest whole number) was 464 for White and 261 for Black or African American.

Questions:

1. Describe observations you made from the given information.
2. Does the data raise any questions for you?
3. What do you think the numbers from each year look like compared to the average? Explain your thoughts.
4. What additional information do you think would be helpful to you?

Worksheet 1-1 Mean Opener

Name: _____ Class: _____

On average from 2013 to 2019 the number of individuals shot to death by police (rounded to the nearest whole number) was 464 for White and 261 for Black or African American.

Questions:

1. Describe observations you made from the given information.
2. Does the data raise any questions for you?
3. What do you think the numbers from each year look like compared to the average? Explain your thoughts.
4. What additional information do you think would be helpful to you?

Worksheet 1-2 Police Search

Name: _____ Class: _____

Search for the remaining five racial groups shot to death by police from 2013 to 2019.

Now find the mean, median, mode, and range of each racial group. Recall that it may be helpful to rearrange the number in numerical order for finding median, mode, and range.

1. From the data you just calculated, what information do you observe from the means (averages)? Do you think they are reflective of the population?

2. Are the results the same or different from those that were seen with White and Black or African American? Why do you think that?

3. The ranges seem to vary over the different racial groups. What do you think of the different ranges and what they mean?

Worksheet 1-2 Police Search

Name: ___Worksheet 1-2 Answer Key_____ Class: _____

1. From the data you just calculated, what information do you observe from the means (averages)? Do you think they are reflective of the population?

   Answers will vary. Yes, because Whites are the largest population and then Black or African American and so forth. No, because Black or African American individuals are not greater than half the White population.

2. Are the results the same or different from those that were seen with White and Black or African American? Why do you think that?

   Answers will vary.

3. The ranges seem to vary over the different racial groups. What do you think of the different ranges and what they mean?

   Answers will vary.

Worksheet 1-3 Mean Exit

Name: _____ Class: _____

Given the data set {3, 6, 5, 4, 3, 7, 6, x, 1} answer the following questions.

- What would x need to be such that 6 is the mode of the set?

- Let $x = 15$, then find the mean of the data set.

Worksheet 1-3 Mean Exit

Name: _____ Class: _____

Given the data set {3, 6, 5, 4, 3, 7, 6, x, 1} answer the following questions.

- What would x need to be such that 6 is the mode of the set?

- Let $x = 15$, then find the mean of the data set.

Worksheet 1-3 Mean Exit

Name: ___Mean Exit - Answer Key____ Class: _____

Given the data set {3, 6, 5, 4, 3, 7, 6, x, 1} answer the following questions.

- What would x need to be such that 6 is the mode of the set?

  First let's put the data set in order and place the x with the 6's. {1, 3, 3, 4, 5, 6, 6, x, 7} shows that there are two 3's and 6's so for 6 to be the mode we need one more 6. So, $x = 6$.

- Let $x = 15$, then find the mean of the data set.

  Let's rewrite the data set with $x = 15$. {3, 6, 5, 4, 3, 7, 6, 15, 1}. Now to find the mean we need to find the sum and then divide by the number in the set. The sum is 50 divided by 9 gives 5.55556.

Worksheet 1-4 MAD Start

Name: _____ Class: _____

Given the following sets *A* and *B*, find the mean absolute deviation (MAD), first quartile (Q1), third quartile (Q3), interquartile range (IQR), and outliers if any.

$A = \{5, 7, 5, 5, 5, 2, 15, 10, 15, 1\}$

and

$B = \{13, 9, 13, 10, 11, 7, 9\}$

	Set A	Set B
Mean Absolute Deviation (MAD) (average of |mean – data|)		
First Quartile (Q1) (median of first half)		
Third Quartile (Q3) (median of last half)		
Interquartile Range (IQR) (Q3 – Q1)		
Outliers		

Worksheet 1-5 MAD Exit

Name: _____ Class: _____

Given the data set {5, 4, 3, 5, 3} answer the following questions.

- Find the mean absolute deviation (MAD) of the set.

- Find the interquartile range (IQR) of the set.

Worksheet 1-5 MAD Exit

Name: _____ Class: _____

Given the data set {5, 4, 3, 5, 3} answer the following questions.

- Find the mean absolute deviation (MAD) of the set.

- Find the interquartile range (IQR) of the set.

Worksheet 1-6 Matching

Name: _____ Class: _____

Match the words on the left with the definitions on the right.

Mean	• The first quartile subtracted from the third quartile.
Median	• A graph representing the first and third quartiles, minimum, maximum, and median.
Mode	• The value(s) that occur the most in the data set.
Range	• The average of the positive difference of the data set with the average of the data set.
MAD	• The average of a data set.
IQR	• The maximum subtracted by the minimum.
Dot Plot	• The number in the middle of the data set.
Box and Whiskers	• A graph that shows the data set using dots.

Worksheet 1-7 Exploring Box and Whiskers

Name: _____Worksheet 1-7 Answer Key_____ Class: _____

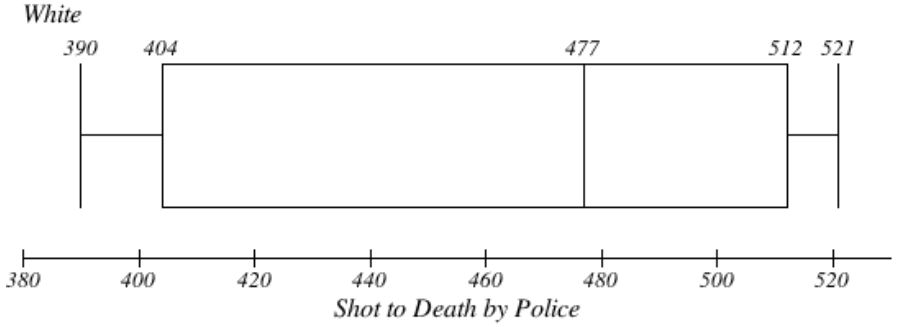
Draw a box and whiskers graph for the following racial groups:

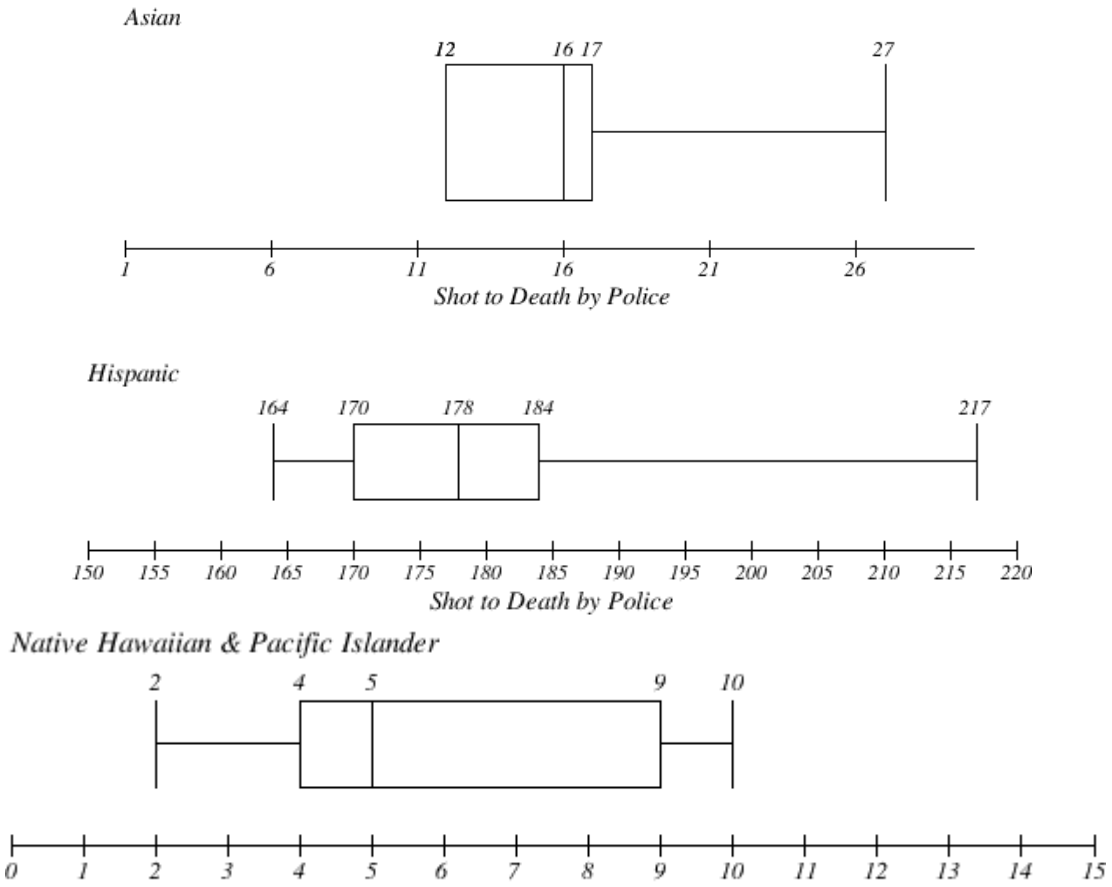
	White	Native Hawaiian & Pacific Islander	Asian	Hispanic
2019	390	9	16	170
2018	477	10	12	178
2017	491	5	12	217
2016	512	6	13	180
2015	521	4	27	184
2014	454	4	16	173
2013	404	2	17	164

Rearrange the data in order so that you can find the first and third quartiles, median, maximum, and minimum.

	White	Native Hawaiian & Pacific Islander	Asian	Hispanic
Min	390	2	12	164
Q1	404	4	12	170
Median	477	5	16	178
Q3	512	9	17	184
Max	521	10	27	217

Then draw the box and whiskers plot based on that information.





1. What is the interquartile range (IQR) of Black or African Americans and Unknown individuals shot to death by police?
   For Black or African Americans individuals the IQR is 165 and for Unknown individuals the IQR is 23.

2. Can you find any outliers?
   Yes. In one year, police shootings for Hispanics was 217 which was way above the norm. Also, police shootings one year were above the norm for Asians with 27 shootings.

3. What can you say about police shootings resulting in death by race?
   Except for the two racial groups with outliers the graphs show that the shooting is within expected range.

Worksheet 1-7 Exploring Box and Whiskers A

Name: _____ Class: _____

Draw a box and whiskers graph for the following racial groups:

	White	Asian	Hispanic
2019	390	16	170
2018	477	12	178
2017	491	12	217
2016	512	13	180
2015	521	27	184
2014	454	16	173
2013	404	17	164

Rearrange the data in order so that you can find the first and third quartiles, median, maximum, and minimum.

White	Asian	Hispanic

	White	Asian	Hispanic
Min			
Q1			
Median			
Q3			
Max			

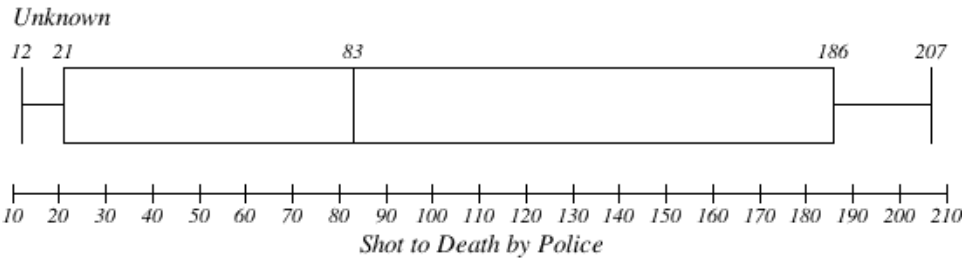
Then draw the box and whiskers plot based on that information. Recall that to plot the box and whiskers you start with the five points along the line (at the same height - not that far from the baseline) making sure the line is labeled. Once you have these you can then form the box portion which connects corresponding points Q1 and Q3 to the outside of the box. The median is the line inside of the box and the minimum and maximum connect to the box if they are not equal to Q1 or Q3.

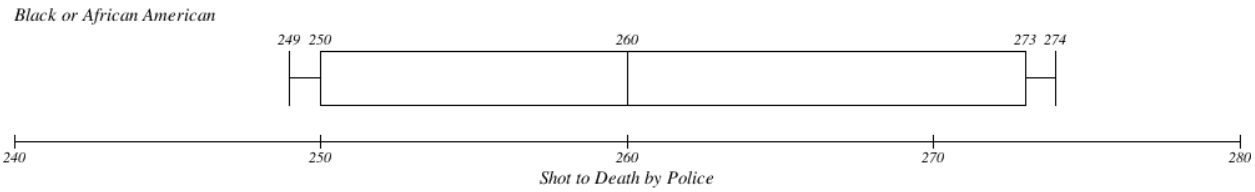
White Individuals Shot to Death by Police

Asian Individuals Shot to Death by Police

Hispanic Individuals Shot to Death by Police

Now given the box and whisker graphs answer the accompanying questions.





1. What is the interquartile range (IQR) of Black or African Americans and Unknown individuals shot to death by police?

The following questions are for the graphs that you drew and the ones given.

2. Can you find any outliers?

3. What can you say about police shootings resulting in death by race?

Worksheet 1-8 Exploring Box and Whiskers B

Name: _____ Class: _____

Draw a box and whiskers graph for the following racial groups:

	White	Native Hawaiian & Pacific Islander	Hispanic
2019	390	9	170
2018	477	10	178
2017	491	5	217
2016	512	6	180
2015	521	4	184
2014	454	4	173
2013	404	2	164

Rearrange the data in order so that you can find the first and third quartiles, median, maximum, and minimum.

White	Native Hawaiian & Pacific Islander	Hispanic

	White	Native Hawaiian & Pacific Islander	Hispanic
Min			
Q1			
Median			
Q3			
Max			

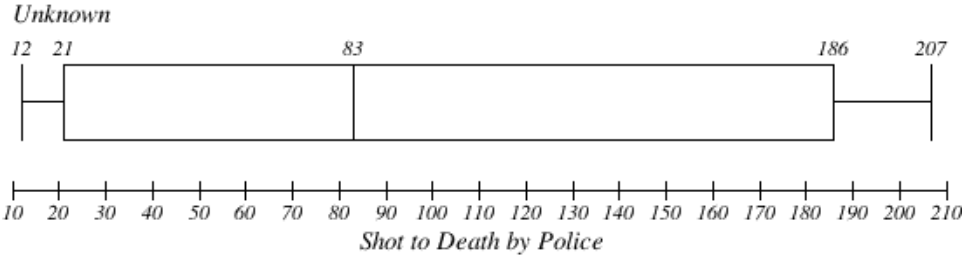
Then draw the box and whiskers plot based on that information. Recall that to plot the box and whiskers you start with the five points along the line (at the same height - not that far from the baseline) making sure the line is labeled. Once you have these you can then form the box portion which connects corresponding points Q1 and Q3 to the outside of the box. The median is the line inside of the box and the minimum and maximum connect to the box if they are not equal to Q1 or Q3.

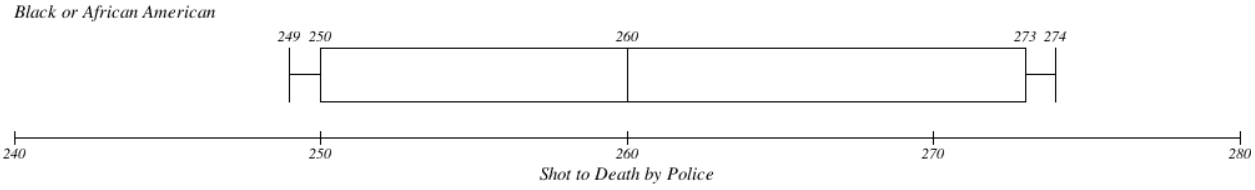
White Individuals Shot to Death by Police

Native Hawaiian & Pacific Islander Individuals Shot to Death by Police

Hispanic Individuals Shot to Death by Police

Now given the box and whisker graphs answer the accompanying questions.





1. What is the interquartile range (IQR) of Black or African Americans and Unknown individuals shot to death by police?

The following questions are for the graphs that you drew and the ones given.

2. Can you find any outliers?

3. What can you say about police shootings resulting in death by race?

Worksheet 1-9 Dot Plot Class Exploration

Name: _____ Class: _____

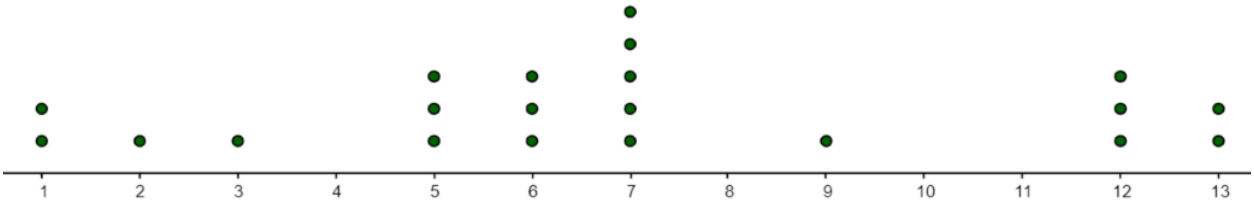
Create a dot plot for the class information that you have collected.

How Many Siblings Do You Have?					

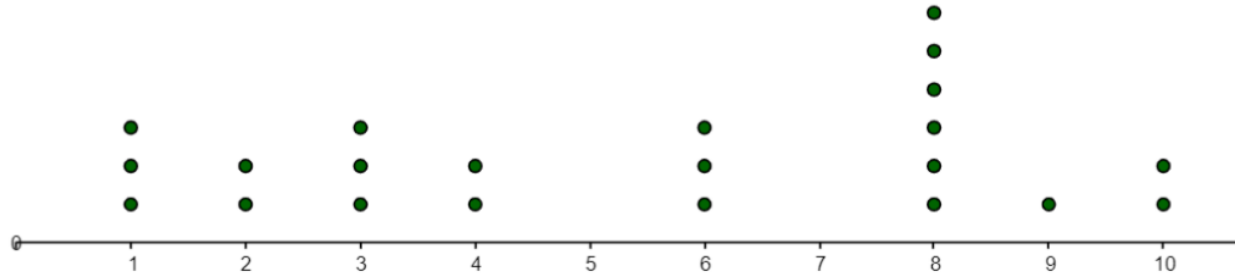
How Many Pets Do You Have?					

Worksheet 1-10 Dot Plot Continued

Name: _____ Class: _____



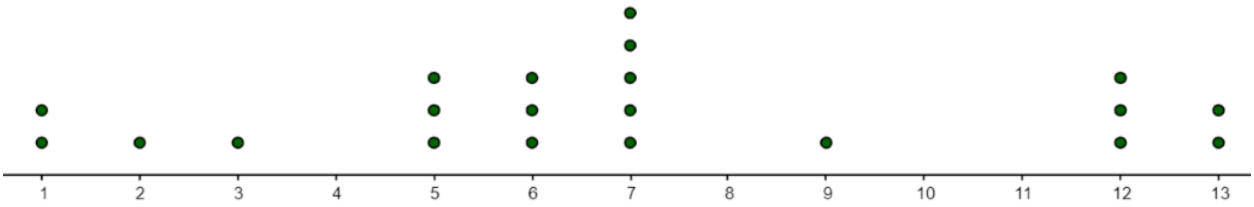
Find the IQR and mean of the above dot plot.



Find the MAD of the above dot plot.

Worksheet 1-10 Dot Plot Continued

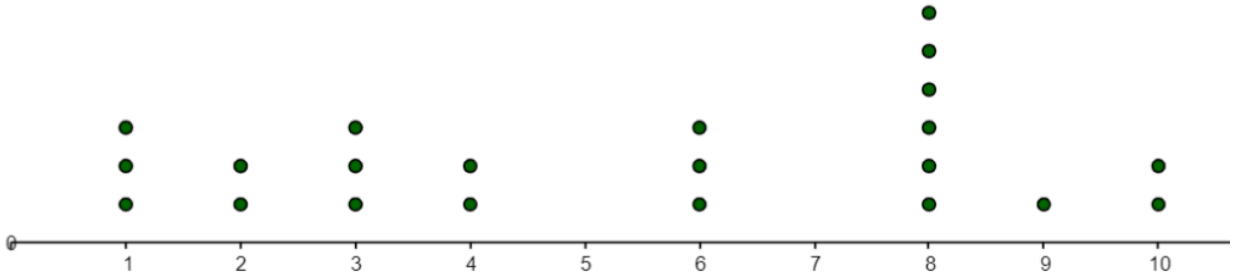
Name: _____Answer Key_____ Class: _____



Find the IQR and mean of the above dot plot.

IQR = 5.5

Mean = 6.952



Find the MAD of the above dot plot.

MAD = 2.7355

Worksheet 2-1 Iowa Population Probability

Name: _____ Class:_____

Below is a table showing the population of Iowa by racial identity groups.

Population of Iowa by Racial Identity Group

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019	2,684,701	125,861	9,771	75,672	1,406	60,177	197,482
2018	2,695,583	113,562	9,710	79,643	2,945	63,229	191,473
2017	2,701,250	103,989	7,825	80,937	5,604	60,360	185,746

1. Using the data in the table above, calculate the probability a random person selected from Iowa would be a part of each listed racial identity group for the years 2017, 2018, and 2019. The table below might be helpful for organizing your data.

Probability that a Randomly Selected Person from Iowa Identifies as the Racial Identity Group

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019							
2018							
2017							

2. What do you notice about the data? What conclusions can you draw?

3. What questions do you have about the data?

Worksheet 2-1 Iowa Population Probability

Name:_____**Key**_____ Class:_____

Below is a table showing the population of Iowa by racial identity groups.

Population of Iowa by Racial Identity Group

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019	2,684,701	125,861	9,771	75,672	1,406	60,177	197,482
2018	2,695,583	113,562	9,710	79,643	2,945	63,229	191,473
2017	2,701,250	103,989	7,825	80,937	5,604	60,360	185,746

1. Using the data in the table above, calculate the probability a random person selected from Iowa would be a part of each listed racial identity group for the years 2017, 2018, and 2019. The table below might be helpful for organizing your data.

2. What do you notice about the data? What conclusions can you draw?

Answers will vary. Some conclusions drawn might be that the probability of randomly selecting a person who identifies as white is much larger than any other racial identity group or some variation.

3. What questions do you have about the data?

Answers will vary.

Probability that a Randomly Selected Person from Iowa Identifies as the Racial Identity Group

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019	0.8509	0.0399	0.0031	0.0240	0.0004	0.0191	0.0626
2018	0.8541	0.0360	0.0031	0.0252	0.0009	0.0200	0.0607
2017	0.8587	0.0331	0.0025	0.0257	0.0018	0.0192	0.0590

Worksheet 2-2 United States Population Probability

Name: _____ Class:_____

1. Using the internet, find the populations of each of the listed racial identity groups in the United States for the years of 2017, 2018, and 2019. Record your findings in the table below.

Population of the United States by Racial Identity Group

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019							
2018							
2017							

2. Using the data you have gathered and recorded in the table above, calculate the probability a random person selected from the United States would be a part of each listed racial identity group for the years 2017, 2018, and 2019. The table below might be helpful for organizing your data.

Probability that a Randomly Selected Person from the United States Identifies as the Racial Identity Group

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019							
2018							
2017							

3. Compare your probabilities from Iowa and the whole United States. What are some similarities and differences between the probabilities you calculated?

4. What questions do you have about the data?

Worksheet 2-2 United States Population Probability

Name:_____**Key**_____ Class:_____

1. Using the internet, find the populations of each of the listed racial identity groups in the United States for the years of 2017, 2018, and 2019. Record your findings in the table below.

Population of the United States by Racial Identity Group

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019	196,789,401	40,596,040	2,236,348	18,427,914	565,473	9,142,601	60,481,746
2018	197,033,939	40,305,870	2,180,266	18,193,513	559,945	9142601	59,763,631
2017	197,285,202	40,129,593	2,145,162	17,999,846	546,778	18285202	58,846,134

2. Using the data you have gathered and recorded in the table above, calculate the probability a random person selected from the United States would be a part of each listed racial identity group for the years 2017, 2018, and 2019. The table below might be helpful for organizing your data.

Probability that a Randomly Selected Person from the United States Identifies as the Racial Identity Group

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019	0.5995	0.1237	0.0068	0.0561	0.0017	0.0279	0.1843
2018	0.6022	0.1232	0.0067	0.0556	0.0017	0.0279	0.1827
2017	0.5885	0.1197	0.0064	0.0537	0.0016	0.0545	0.1755

3. Compare your probabilities from Iowa and the whole United States. What are some similarities and differences between the probabilities you calculated?

Answers will vary. A possible similarity is that you are most likely to randomly select someone who identifies as white from both Iowa and the whole US. A possible difference is that you are more likely to randomly select a person who identifies as black from the whole US than from Iowa.

4. What questions do you have about the data?

Answers will vary.

Worksheet 2-3 Shot by Police Probability

Name: _____ Class:_____

1. Using your data about police shootings from the previous lesson, calculate the probability that a randomly selected person from each of the listed racial identity groups in the United States was shot by police in 2017, 2018, and 2019. The table below might be helpful for organizing your data.

Probability that a Randomly Selected Person from Each Racial Identity Group Was Shot by Police by Year

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019							
2018							
2017							

2. What do you notice about the data? Which racial identity group was most likely to be shot by police in each year? Which group was least likely?

3. What questions do you have about the data?

Worksheet 2-3 Shot by Police Probability

Name: _____ **Key** _____ Class:_____

1. Using your data about police shootings from the previous lesson, calculate the probability that a randomly selected person from each of the listed racial identity groups in the United States was shot by police in 2017, 2018, and 2019. The table below might be helpful for organizing your data.

Probability that a Randomly Selected Person from Each Racial Identity Group Was Shot by Police by Year

Year	White	Black or African American	American Indian & Alaska Native	Asian	Native Hawaiian & Pacific Islander	Other/ Unknown	Hispanic
2019	0.0000020	0.0000061	0.0000058	0.0000009	0.0000159	0.0000226	0.0000028
2018	0.0000024	0.0000062	0.0000096	0.0000007	0.0000179	0.0000170	0.0000030
2017	0.0000025	0.0000065	0.0000126	0.0000007	0.0000091	0.0000020	0.0000037

2. What do you notice about the data? Which racial identity group was most likely to be shot by police in each year? Which group was least likely?

Answers will vary. In 2019, people who identify within the "other/unknown" group were most likely to be shot by police. In 2018, people who identify within the "Native Hawaiian & Pacific Islander" group were most likely to be shot by police. In 2017, people who identify within the "American Indian & Alaska Native" group were most likely to be shot by police. People who identify as Asian were least likely to be shot by police in all three years.

3. What questions do you have about the data?

Answers will vary.

Worksheet 2-4 Vocabulary Organizer

Name:_____ Class:_____

Word	Definition	Example
Event		
Probability		
Sample Space		
Experiment		
Outcome		
Complement of an Event		

Worksheet 2-5 Probability Practice

Name:_____ Class:_____

1. Now since you know the amounts of the different color marbles in the bag, calculate the probability of pulling out each color marble. Write your probabilities in fraction, decimal, and percentage form. The table below might be helpful for organizing your probabilities.

Marble Color	Fraction	Decimal	Percentage
Red			
Blue			
Yellow			
Total			

2. If you pulled 1000 marbles out of the bag (replacing the marble each time), how many of each color would you expect to pull out? Explain your answer.

3. Roll a 6-sided number cube 10 times (both you and your partner). Record whether or not any threes were observed and record your results in the table below.

Roll	Any Threes? (Y/N)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

a. Using both yours and your partner's results, what fraction of the 10 rolls resulted in at least one three?

b. Combine your results with another group. What fraction of all the rolls resulted in at least one three?

c. Make a list of all the different possible outcomes that might be observed when two dice are rolled. (Hint: There are 36 different possible outcomes.)

d. What fraction of the 36 possible outcomes result in at least one three?

e. Suppose you and your partner were able to roll the two dice many thousands of times. What fraction of the rolls would you expect to result in at least one three?

Worksheet 2-5 Probability Practice

Name:_____**Key**_____ Class:_____

4. Now since you know the amounts of the different color marbles in the bag, calculate the probability of pulling out each color marble. Write your probabilities in fraction, decimal, and percentage form. The table below might be helpful for organizing your probabilities.

Marble Color	Fraction	Decimal	Percentage
Red	1/2	0.5	50%
Blue	3/10	0.3	30%
Yellow	1/5	0.2	20%
Total	1	1	100%

5. If you pulled 1000 marbles out of the bag (replacing the marble each time), how many of each color would you expect to pull out? Explain your answer.

   Red – 500
   Blue – 300
   Yellow – 200

   Explanations may vary. The main idea is if red marbles make up 1/2 of all the marbles, then we would expect about 1/2 of the marbles we pull out to be red. The same goes for blue and yellow marbles.

6. Roll a 6-sided number cube 10 times (both you and your partner). Record whether or not any threes were observed and record your results in the table below.

Roll	Any Threes? (Y/N)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

f. Using both yours and your partner's results, what fraction of the 10 rolls resulted in at least one three?

Answers may vary. The fraction should be centered around 11/36.

g. Combine your results with another group. What fraction of all the rolls resulted in at least one three?

Answers may vary. The fraction should be centered around 11/36.

h. Make a list of all the different possible outcomes that might be observed when two dice are rolled. (Hint: There are 36 different possible outcomes.)

(1,1)	(1,2)	(1,3)	(1,4)	(1,5)	(1,6)
(2,1)	(2,2)	(2,3)	(2,4)	(2,5)	(2,6)
(3,1)	(3,2)	(3,3)	(3,4)	(3,5)	(3,6)
(4,1)	(4,2)	(4,3)	(4,4)	(4,5)	(4,6)
(5,1)	(5,2)	(5,3)	(5,4)	(5,5)	(5,6)
(6,1)	(6,2)	(6,3)	(6,4)	(6,5)	(6,6)

i. What fraction of the 36 possible outcomes result in at least one three?

11/36

j. Suppose you and your partner were able to roll the two dice many thousands of times. What fraction of the rolls would you expect to result in at least one three?

11/36

Author Page

Tia “Taj” Lyve

Tia "Taj" Lyve nee Pilaroscia, was found deceased at the age of 38 in their Ames, Iowa home on November 4, 2020.

Taj was born on February 23, 1982, in Houston, Texas, as the only child to Tina Reimers. Taj graduated from Spring Woods High School in 2000, the first in their family to graduate from high school. Taj continued family firsts by graduating from the University of Houston-Downtown with a Bachelor's of Science in Applied Mathematics and another Bachelor's of Science in Applied Statistics in 2011. Taj attended a Post Baccalaureate program at Smith College in 2012. Taj was a Master's student at Iowa State University in the Math Education program and was scheduled to graduate in Spring 2021.

Taj worked as a dog groomer, school bus driver, support staff for the disabled, and as a math tutor. Taj enjoyed mathematics, scientific research, science fiction, animals, puzzles, volunteering, and being active in the LGBT and disability communities. Taj attended the Unitarian Universalist Fellowship of Ames.

Taj is survived by their only son, Thomas Lyve; grandmother Eve Yokeley of Texas City, Texas; cousins Madison and Skylar Zwernemann of The Woodlands, Texas; and many dear friends and esteemed colleagues. Taj was preceded in death by their uncle Jeff Zwernemann of Galveston, Texas; and their mother Tina Reimers of Texas City, Texas. Taj will be remembered as gentle, smart, and kind.

From the obituary for the memorial on Feb. 23rd, 2021.