Election Theory: Alternative Voting Methods In The Pennsylvania 2022 Senate Election

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Abstract: The single-ballot plurality voting system has remained the standard in the United States dating back to the 18th century. However, the nature of plurality rule has recently been contested by alternatives. While scholars have considered the impact non-plurality voting systems could have on election outcomes, a gap in knowledge remains pertaining to how these systems will affect partisan vote distribution in multi-party elections. This study utilizes a survey approach modeled after the ballots used in Pennsylvania's 2022 Senate election in order to determine how voter support for each candidate may change as a result of non-plurality voting methods being used. The findings of this research suggest that although it is subjective to each system, alternative voting in general tends to increase voter support for third-party candidates in comparison to plurality, with anti-plurality voting in particular displaying a significant decrease in third-party support in skewed elections. Additionally, ranked-choice voting was found to be the most popular form of voting among participants, indicating a general sense of dissatisfaction with the standard plurality system. These findings suggest that the implementation of non-plurality voting methods may be used to better represent voter preferences and decrease polarization in U.S. elections.
Keywords: Alternative voting · Plurality · Third party · Pennsylvania · Voting methods

Introduction

In recent years, American elections have consistently yielded extreme political outcomes. In 1971-72, Capitol Hill seated over 160 moderate Democrats and Republicans; however, in 2022, only about two dozen held moderate Democratic or Republican viewpoints (Desilver 2022). This is the mere consequence of a rapid surge in polarization among American voters. Scholars have found that increased levels of political polarization in election outcomes correspond with that of voters, pertaining both to their personal ideology (Dimock and Wike 2021) as well as their antipathy toward opposing party members (Nadeem 2022). Although the widening divide between liberal and conservative ideals is often attributed to voters' contemporary political environments, the source lies not within the people but rather in the rigid structure of the nation's electoral system.

In 1963, French sociologist Maurice Duverger formulated a law proposing that "the plurality rule for selecting the winner of elections favors the two-party system" (Riker 1982, 753). The lack of plausible candidate options is arguably the greatest flaw of the United States' standard plurality system. The "wasted vote" concept is commonly associated with this system: regardless if voters' political preferences are more closely aligned with a third-party candidate, by plurality rule, only two major-party candidates have the ability to gain enough electoral support to win an election (Riker 1982, 761; Rosenstone, Behr, and Lazarus 1984; Bassi 2008). Alternatives to the standard plurality system are increasing in popularity, with 261 nationwide jurisdictions, most on a local scale, having reportedly adopted some form of a non-plurality voting system

(Desilver et al. 2021). However, the impact these voting methods could have on the success of third-party candidates has, thus far, only been hypothesized.

Key Definitions

Some key terminology that will be heavily used throughout the paper include:

Two-party system - a political system in which two major parties consistently dominate votes given by the electorate.

Major party - party that holds enough electoral strength to win control of a large government body. In the United States, the Democratic Party and the Republican Party are major parties.

Third party - also known as a minor party, a party that rarely holds enough electoral strength to win control of a large government body. In the United States, some examples of third parties include the Green Party, the Libertarian Party, the Keystone Party of Pennsylvania, the Constitution Party, the Working-Class Party, and, in some cases, the Independent Party.

Literature Review

Third Parties

It is pertinent to mention the emphasis Duverger's Law places on partisan disparities within plurality elections. The "winner-takes-all" structure impedes minor party representation due to a predisposed deprivation of financial resources and a lack of recognition among voters. Minor party candidates have a disincentive to run in elections or carry out their platforms because of the inevitable dissipation of resources spent on a battle that can never be won (Verma 2021, 230). Plurality voting only prolongs this paradox and incites the deficiencies of the two-party system. However, it is not the inherent act of voting third party that leads to unfavorable election outcomes. Rather, minor party candidates simply cannot accumulate enough votes to win under a voting system structured around a two-party system (Collet 1996, 432-33). Research has shown that this is not a choice made by the people but rather an entrapment caused by the system. While 62% of American adults agree with the statement that "parties do such a poor job representing the American people that a third party is needed" (Jones 2021), third parties generally only capture around 5% of voter support (Atske 2020). This suggests that although there is a desire for a two-party system reform to gain traction, plurality defects will continue to limit political representation in government.

Polarization and the Plurality System

Literature has demonstrated a recognition of the mass partisan divides within the American electoral system. Studies have found that a majority of Americans feel pressured to uphold a particular political opinion in their daily lives (Carlson and Settle 2016) and vote for "extremist" candidates in both local and federal elections (Smidt 2017), despite such a large portion of the population reportedly holding moderate viewpoints. Election outcomes are, by standard, reflective of one's surrounding political climate. Thus, political polarization limits single-ballot plurality voting systems to the success of solely major-party candidates, a claim supported by political scientist Daniel Bochsler's (2017) study on the strategic effects of plurality voting (Bochsler 2017). Despite the lack of accommodation in plurality-structured elections, minor-party candidates have the capability to adversely influence their outcomes. Between 1992 and 2019, 49 Senate elections within 27 different states resulted in a winner with less than majority (50%) support (Harrow and Shi 2019). This results in extreme voter dissatisfaction from at least one side of the political coin, only widening the partisan divide.

Pennsylvania in particular is vastly divided due to political differences between rural and urban regions of the state. A poll conducted by the Rose Institute of State and Local Government Pennsylvania found that 4 out of 5 Pennsylvanian respondents planned on voting consistently within their party (Sinclair and Miller 2022). By the end of the race, the margin of victory between Democratic candidate John Fetterman and Republican candidate Dr. Mehmet Oz was a mere 4.92%; however, only 2.42% of voters chose to vote third party ("Pennsylvania Elections: Summary Results" 2022).

Alternative Voting Methods

The researcher believes that alternative voting methods should be taken into consideration as a potential solution for complications with the current two-party

system. Firstly, it is essential to note that votes from the same electorate can yield different results depending on the method used (Riker 1982). When there are only two viable candidates, a plurality-based election functions well. However, when three or more valid candidates run for a single position in office, there are a plethora of non-plurality voting methods that could be used to rationally determine a winner (Brams and Fishburn 1978, 831-32). A substantial number of experiments with alternative voting methods have resulted in outcomes contradictory to standard plurality results (Saari 1999, 313-55; Grofman and Feld 2004, 641-59; Igersheim et al. 2022), indicating that partisan votes may vary as a result of a reformed electoral structure.

Ranked-choice Voting

Ranked-choice voting (RCV), arguably the most popular form of alternative voting, has been put into practice in multiple municipalities throughout the United States. One must note that this particular method has proven to operate well on a local level within the nation. One coalition of researchers from Cornell Tech and MIT found that larger STV (single transferable voting) districts hold a more diverse set of winners from each major party and act similarly with minor-party candidates. When ranking based on partisan score, members of the same party across multiple single-member districts can easily collaborate to select and improve the winning chances of a particular candidate (Garg et al. 2022). Non-plurality voting structures, such as ranked-voting systems used in New York City, Maine, and California, tend to mediate vote distributions between candidates and ultimately equate interparty chances of success. Voters are not confined to two viable candidate selections; instead, they are given the freedom to arrange a ballot that ultimately epitomizes their political preferences. When examining ranked-choice voting in practice, the impacts on voter satisfaction and partisan tension are substantial. A study from the University of Pennsylvania on political attitudes found a decrease in the winner-loser gap in perceived fairness for ranked-choice systems in comparison to plurality (Fischer, Lee, and Lelkes 2021). This increased perception of fairness can be attributed to the more flexible electoral structure encompassed by RCV. Ranked-choice voting is designed to account for candidates' failure

to obtain a majority of single-selection votes, which, in contrast, the plurality system is unable to achieve (Steinberg 2022). This generally leads to increased voter satisfaction, as the outcomes of RCV elections rely not on the status or partisan identity of a given candidate but rather on the voter's individual preferences and willingness to vote for the candidates they most align with, regardless of predicted success.

Assumptions

This research operates under the assumption that voting data from the same electorate engenders different results as different methods are used (Riker 1982). Additionally, it can be assumed that the outcomes of non-plurality elections may contradict those yielded by plurality-based elections (Saari 1999, 313-55; Igersheim et al. 2022; Grofman and Feld 2004, 641-59). Finally, one must assume that a significant portion of the general public has some degree of an inclination to vote third-party, although the plurality system limits this (Jones 2021; Atske 2020).

Justification

Existing studies on alternative voting systems have analyzed the theoretical impact of non-plurality voting structures on election outcomes, many of which have discovered results contradictory to standard plurality (Saari 1999; Grofman and Feld 2004, 641-59; Igersheim et al. 2022). As noted by Brams and Fishburn (1978) as well as Riker (1982), various voting systems can be used to determine a winner from the same electorate, although results may vary. However, no detailed research has been done on how voter support may shift among candidates (primarily minor-party candidates) in multi-party elections through the use of alternative voting. Studying this concept may provide insight as to how different voting systems operate in practice and keep Americans in touch with the validity of varying political viewpoints.

Research Question

To address these factors, the research question is posed: To what extent would the implementation of

alternative voting methods impact partisan vote distribution in U.S. elections?

Methodology

Purpose

The purpose of this study was to observe the impact of alternative voting methods on partisan vote distribution in standard U.S. elections, particularly the highly polarized 2022 Pennsylvania Senate election. Preliminary research has demonstrated that modern U.S. elections inevitably skew in favor of the two primary political parties; thus, the researcher intended to determine if the structure of plurality voting is what may be partly responsible for a lack of third-party candidate support. The ultimate intent of the researcher in conducting this study was to establish the extent to which major and minor-party candidates would be impacted by alternative voting practices in U.S. elections.

The researcher chose to structure the study around the 2022 Pennsylvania Senate race due to its recency and relevance to the public. The vast majority of Pennsylvania residents in the chosen population were familiar with at least the primary two candidates. Having this prior knowledge would be greatly beneficial to the overall purpose of the survey, as the researcher intended to test participants' predisposed candidate preferences. Additionally, Pennsylvania is often regarded as a "purple" state, meaning that state-wide election results will sometimes swing toward the Republican "red", and sometimes toward the Democratic "blue". Due to this political divide, the real election results were nearly evenly split and arguably inconclusive up until the election. This prior knowledge was used to provide the researcher with a base statistic to refer to throughout the interpretation of the mock election results.

Procedure

Prior to data collection, two research methods were considered. The first was the construction of an in-person experimental study with separate groups and ballots for each electoral system. Experimental approaches are commonly used in political fields when observing voter behavior, such as in Bassi's (2008) experiment on strategic voting. An experimental study would allow the researcher to understand participants' perceptions of the varying voting methods to a greater degree, as political behavior can be recorded firsthand. Regardless, this method was rejected due to the anticipated apprehension voters may have about revealing their political views, as well as a relative lack of political diversity in the researcher's immediate geographical region.

The researcher ultimately selected the second method – a quantitative approach through the distribution of an online Google Forms survey. This method adopted a traditional ballot structure comparable to the first method but eliminated the need for participants to directly disclose their political identities. It also allowed the researcher to pool a considerably larger, slightly more representative sample. Despite the numerous advantages of conducting a survey, the researcher did discover some limitations. For instance, descriptions of the candidates' political platforms in addition to instructions on how to utilize each voting method were both elements included in the survey; however, the lack of accountability a survey provides could have very well hindered participants' likelihood of ensuring thorough understanding of their task and voting options. Additionally, although the demographic questions did require participants to verify demographic requisites, there was no way to confirm all responses were truthfully eligible.

Participants

The researcher chose to conduct the research with legal adults registered to vote in Pennsylvania. This group was the most appropriate and relevant to the study's purpose when considering levels of involvement in the most recent Senate election. To recruit participants for the survey, the researcher asked friends and family members aged 18 and older to participate and send the link to the survey to any eligible individuals they knew. The researcher also focused on the recruitment of members of the 12th grade class, as many of them are 18. Additionally, the link to the survey was posted on social media accounts, Reddit, and SurveyCircle, as well as distributed by flyers throughout the researcher's high school.

Survey Design

The survey was on Google Forms, with all personal-information collection features turned off to ensure anonymity. Participants were required to be aged 18 or older and give their informed consent before participating. If a participant marked that they were under the age of 18, the site would not allow them to proceed with the survey. After debriefing, they were required to consent once again to having their responses used for the purpose of the study (see Appendix B for complete informed consent and debriefing language). Participants were also asked if they were registered to vote in Pennsylvania. If an individual selected that they were not registered to vote, any following responses would not be considered. The researcher asked only for necessary political background and did not collect any identifiable information. Participants could answer as few or as many questions as they desired and could opt out at any point during the survey. Additionally, all responses were anonymous and kept in a secure Google Drive folder that only the researcher and project director had access to. The research study design was approved by an IRB.

In the first section of the survey, participants were asked three demographic questions regarding their political identity and level of involvement in the past PA Senate election. Participants were first asked to record if they voted in the 2022 Pennsylvania Senate election. If the participant chose "yes", the survey followed up by inquiring about the candidate they voted for. Participants were also asked to select the political party they most identify with from a list of seven options plus an "other," write-in permissible category.

In the following section, participants were asked to cast mock votes for the five most popular candidates in the 2022 Pennsylvania Senate election. They did so by using a variety of different voting methods, including plurality voting, ranking, cumulative voting, negative voting, and approval voting. The researcher primarily used the Stanford Encyclopedia of Philosophy's guide to voting methods to translate instructions on how to cast votes in the mock elections. Additionally, participants were provided with a chart featuring descriptions of the political platforms of each candidate. This feature was included so as to familiarize participants with lesser-known candidates. The researcher pulled unbiased information from candidates' respective campaign websites if available, and Wikipedia as a last resort.

For the third section, participants were presented with a mixture of multiple-choice and multiple-selection questions. Here, they were asked to provide further information on their political background and their thoughts on the voting procedures. Participants were also asked to report their likelihood of voting for a third-party candidate in a real U.S. election.

Finally, participants were debriefed and then given the option to enter a raffle for a $50 gift card of their choice. All contact information was kept confidential. Upon completion, participants were offered a link to share the survey with other people.

Data collection took place from January 5, 2023, to February 6, 2023.

Findings and Analysis

Demographics and Plurality

In total, the Google Form survey received 449 responses. Of the 449 responses, 206 were removed due to a Reddit bot infiltration. These were identified through the recognition of fake email addresses entered into the raffle (consisting of random strands of letters and numbers). Time stamps also revealed that the majority of those with suspicious email addresses were duplicate responses that had come in within seconds or milliseconds of one another. After removing the bot responses, 243 real responses remained. Of those 243 responses, 9 were removed due to the participant marking that they were not registered to vote in Pennsylvania. Another response was removed because the participant did not select "yes" or "no" when asked if they consented to their response data being used. This left 233 responses eligible for use. (Refer to Appendix A for definitions of each voting method.)

Of the 233 eligible participants, 232 reported their political affiliation, with an overwhelming majority indicating that they most identify with the Democratic Party (see Table 1a). Nine participants indicated support for a party other than what was provided and gave a brief description of their political identity (see Table 1b).

As shown in Table 1a, a total of 156 of the 232 participants, or about 67.2%, reported identifying most

Table 1a

Which party holds the viewpoints you most identify with?

Party	Number of Participants
Democratic	135
Independent	25
Republican	21
Green Party	18
Libertarian	15
None/non-partisan	4
Constitution Party	3
Keystone Party of Pennsylvania	2
Other*	9

Note. n=232

Table 1b

Cont.

"Other" Write-In Responses
Progressive/very leftist
Communist
Working families
Socialist
Democratic Socialist
Social Democrats
Each has its advantages and disadvantages, and complementation is better
Fiscally Republican, but much less homophobic
I always vote Democrat, but my views tend to be more left than the party espouses.

Note. n=9

Table 2

Participants' Real 2022 PA Senate Election Votes

Fetterman (D)	Oz (R)	Gerhardt (L)	Weiss (G)	Other	TOTAL
189 (85.14%)	25 (11.26%)	3 (1.35%)	4 (1.80%)	1 (0.45%)	222 (100%)
Total: 214 (96.40%)			Total: 8 (3.60%)		222 (100%)

Note. n = 222; D=Democrat, R=Republican, L=Libertarian, G=Green Party

Table 3

Participants' Mock Plurality Votes

Fetterman (D)	Oz (R)	Gerhardt (L)	Weiss (G)	Wassmer (K)	TOTAL
160 (68.67%)	26 (11.16%)	9 (3.86%)	30 (12.88%)	8 (3.43%)	233 (100%)
Total: 186 (79.83%)			Total: 47 (20.17%)		233 (100%)

Note. n = 233; K=Keystone Party of PA

Table 4: 2-Proportion Z-Test

Real Election Votes vs. Mock Election Votes

H0: p1=p2 HA: p1>p2						
Real Election (p**1**)	Mock Election (p**2**)	**n1**	**n2**	Significance Level	Z-score	p-value
214 (96.40%)	186 (79.83%)	222	233	0.05	5.419	3.003 x 10^-8

with the viewpoints of one of the two major parties in the United States. This statistic aligns with researcher Jones's (2021) poll, which found that ~62% of Americans feel as though the two major parties are not representative of the political beliefs of the general public (Jones 2021). Although roughly 1 in every 3 participants reported identifying most with something other than the Democratic or Republican parties, as is known, the victory of a major-party candidate is a near-inevitable outcome.

In Table 3, Fetterman won the mock plurality election, followed by Weiss, Oz, Gerhardt, and finally Wassmer.

The researcher noted that of the 222 participants who did vote in the most recent Pennsylvania Senate election, approximately 96.40% reported having voted for a two-party candidate (Fetterman or Oz). Pew Research's Sara Atske gave credence to the notion of par-

tisan disparity after reporting that only 5% of registered voters tend to vote third party in plurality-based elections (Atske 2020). The researcher's findings in Table 2 support Atske's claim, seeing as less than 4% of participants who voted in the 2022 PA senate election reported having voted for a third-party candidate.

However, when the participants were asked again to cast a single-ballot plurality vote for the candidate of their choice, only 79.83% decided to vote for a two-party candidate. In Table 3, it must be noted that the number of votes for Fetterman vastly exceeded that of any other candidate. However, the 31.33% of plurality votes that were not placed for Fetterman were distributed with moderate proportionality between the remaining four candidates. For instance, Green Party candidate Richard Weiss received four more votes than Republican candidate Dr. Oz, despite Oz belonging to one of the major parties. This result contradicts

Table 5

Candidate Ranking	Fetterman (Democrat)	Oz (Republican)	Gerhardt (Libertarian)	Weiss (Green Party)	Wassmer (Keystone)
1	123	15	8	30	16
2	28	8	30	87	39
3	23	12	37	33	87
4	9	18	103	24	38
5	9	139	14	18	12

Table 6

Anti-Plurality

Candidate	Points
John Fetterman (Democrat)	183
Dr. Mehmet Oz (Republican)	53
Erik Gerhardt (Libertarian)	178
Richard L. Weiss (Green Party)	174
Daniel Wassmer (Keystone Party of PA)	180

Note. 0 points are given to each last-place candidate, and 1 point is given to the rest.

Bassi and Bochsler's respective studies, which determined that only two candidates (Bassi 2008) from the two major parties (Bochsler 2017) would dominate voter support in multi-party elections.

The researcher chose to conduct a 2-proportion z-test on the two percentages, as seen in Table 4. The purpose of conducting this statistical test was to determine whether or not there could be an outside factor contributing to the significant drop in major-party candidate votes. The p-value is less than the alpha level of 0.05; therefore, the null hypothesis can be rejected. There is enough convincing evidence to make the assumption that it was not by random occurrence that there was a nearly 17% drop in major-party votes for the plurality method.

Ranked-Choice Methods

For this section of the survey, participants were asked to use ranked-choice voting to number each of the five candidates from 1 (candidate I [the voter] would most like to win) to 5 (candidate I would least like to win). The researcher referred to the following data for all voting methods that involved the ranking of the five candidates (see Table 5). Forty-one responses were removed due to participants not ranking all five candidates. This left 192 eligible responses for any voting method that involved ranking.

The average ranking scores for each candidate are as follows: John Fetterman (1.7135), Dr. Mehmet Oz (4.3438), Erik Gerhardt (3.4427), Richard L. Weiss (2.5469), Daniel Wassmer (2.9531). It is worthy to note that a lower average score indicates a more favorable candidate ranking.

The following alternative voting methods will refer to the ranking displayed in Table 5. All of the following mock election results in this section have been calculated using variances of ranked-choice voting.

In Table 6, Fetterman won the anti-plurality election, followed by Wassmer, Gerhardt, Weiss, and finally Oz.

Figure 1
Borda Count

$$BS(Fetterman) = 123*4 + 28*3 + 23*2 + 9*1 + 9*0 = 631$$

$$BS(Oz) = 15*4 + 8*3 + 12*2 + 18*1 + 139*0 = 126$$

$$BS(Gerhardt) = 8*4 + 30*3 + 37*2 + 103*1 + 14*0 = 299$$

$$BS(Weiss) = 30*4 + 87*3 + 33*2 + 24*1 + 18*0 = 471$$

$$BS(Wassmer) = 16*4 + 39*3 + 87*2 + 38*1 + 12*0 = 393$$

Note. 5 candidates: first gets 4 points - second gets 3 - third gets 2 - fourth gets 1 - last gets 0

In Figure 1, Fetterman won the Borda Count election, followed by Weiss, Wassmer, Gerhardt, and finally Oz.

In Figure 2, Fetterman won the Condorcet election. Runner-ups were not calculated.

Figure 2
Condorcet's Method

51:A>D>E>C>B	3:E>A>D>C>B	1:D>A>E>B>C	1:D>C>E>B>A
18:A>E>D>C>B	3:A>E>D>B>C	1:C>E>A>D>B	1:B>C>A>E>D
15:D>A>E>C>B	2:E>B>A>C>D	1:B>A>C>D>E	1:B>D>E>A>C
15:A>D>C>E>B	2:B>D>A>C>E	1:E>B>C>D>A	1:A>D>B>C>E
8:D>E>A>C>B	2:E>C>A>D>B	1:B>D>C>A>E	1:B>C>D>A>E
7:A>D>E>B>C	2:E>D>A>C>B	1:D>C>E>A>B	1:C>A>B>D>E
6:A>C>D>E>B	2:C>B>E>D>A	1:D>C>A>E>B	1:A>C>D>B>E
6:A>E>C>D>B	2:B>C>E>D>A	1:A>E>B>C>D	1:A>C>E>D>B
5:A>C>B>E>D	2:C>D>A>E>B	1:C>E>B>D>A	1:E>C>B>D>A
4:B>C>E>A>D	2:A>D>B>E>C	1:E>A>C>B>D	1:A>C>E>B>D
3:E>A>C>D>B	2:A>D>C>B>E	1:A>E>C>B>D	1:C>B>A>D>E
3:D>A>C>E>B	2:A>B>C>E>D	1:E>D>C>A>B	1:B>C>D>E>A
			1:B>C>A>D>E

Note. A = Fetterman, B = Oz, C = Gerhardt, D = Weiss, E = Wassmer

Figure 3
Hare Method

Gerhardt Eliminated First (8 first-place votes)
Fetterman: 124
Oz: 18
Weiss: 32
Wassmer: 18
Oz and Wassmer Eliminated (18 first-place votes)
Fetterman: 144
Weiss: 48
Weiss Eliminated (48 first-place votes)
Fetterman Wins

Traditionally, for both the Hare method and Coombs' method, a candidate is declared the winner as long as they obtain over 50% of the first-place votes (Pacuit 2019). However, the researcher chose to proceed with both methods in order to find the theoretical order of elimination.
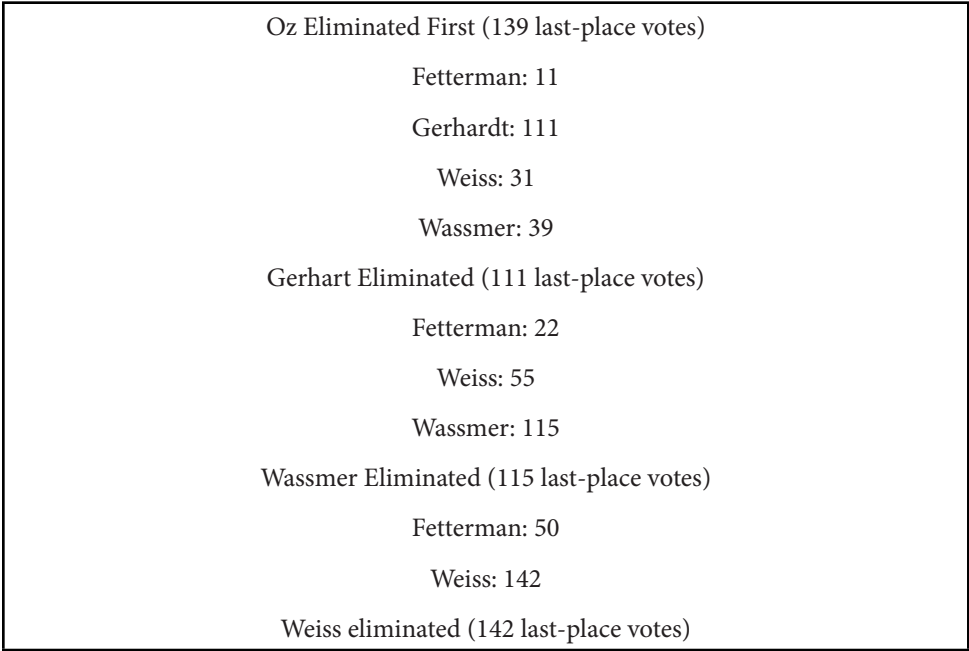
In Figure 3, Fetterman won the Hare election, followed by Weiss, Oz, and Wassmer, and finally Gerhardt.

In Figure 4, Fetterman won the Coombs election, followed by Weiss, Wassmer, Gerhardt, and finally Oz.

Overall, all five methods that operated under RCV resulted in a Fetterman (Democratic Party) victory. One must note that despite the skewed political preferences, Republican candidate Dr. Oz placed third in the mock plurality election. However, Oz was surpassed by third-party candidates in every mock election under the ranking system (excluding the unknown elements of Condorcet's method). Both the Borda Count method and Coombs' method resulted in the same outcome in terms of the arrangement of runners-up (see Figure 1 and Figure 4), further presenting a contradiction to the mock plurality results. Literature supports these findings: both Borda Count and Coombs' method are known to have a mediating effect on electoral outcomes due to their structures, which favor equitability and compromise regarding voter preferences (Alos-Ferrer and Buckenmaier 2021; Grofman and Feld 2004). Additionally, the anti-plurality method displayed an unexpected distribution of points, as the three runners-up (Wassmer, Gerhardt, and Weiss) were in close proximity both to one another and to Fetterman (see Table 6). This indicates that the event of a third-party candidate winning under the anti-plurality method is highly likely, assuming data is polled from a similar electoral body. Contrary to the prior methods, the partisan vote distribution in the Hare method was most comparable to plurality, with Oz tying for third place. These findings suggest that it is less likely for a third-party candidate to succeed under the Hare method, once again assuming the makeup of a similar electorate.

Figure 4
Coombs' Method

Oz Eliminated First (139 last-place votes)
Fetterman: 11
Gerhardt: 111
Weiss: 31
Wassmer: 39
Gerhart Eliminated (111 last-place votes)
Fetterman: 22
Weiss: 55
Wassmer: 115
Wassmer Eliminated (115 last-place votes)
Fetterman: 50
Weiss: 142
Weiss eliminated (142 last-place votes)

Non-Ranking Methods

The following alternative voting methods do NOT refer to the ranking in Table 5.

Figure 5
Cumulative Voting
Note. n=224
9 responses were removed for participants incor-
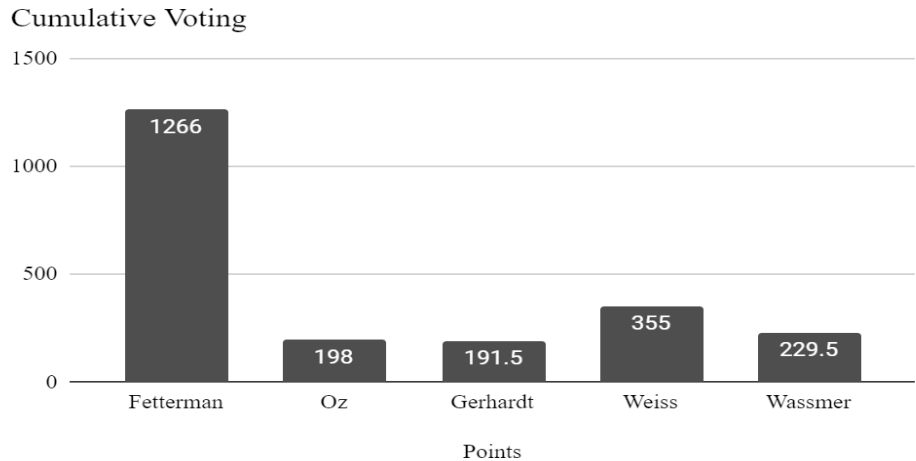
Cumulative Voting

Table 7
Negative Voting

Candidate	+1 Point	-1 Point	Total Points
Fetterman (Democrat)	95	14	**81**
Oz (Republican)	11	87	**-76**
Gerhardt (Libertarian)	6	4	**2**
Weiss (Green Party)	9	2	**7**
Wassmer (Keystone Party of PA)	3	1	**2**

Note. n=232

rectly adding points, leaving 224 responses to be considered for the cumulative voting method. Participants were asked to distribute ten points among the five candidates, resulting in yet another Fetterman victory.

In Figure 5, Fetterman won the cumulative voting election, followed by Weiss, Wassmer, Oz, and finally Gerhardt.

In Table 7, Fetterman won the negative voting election, followed by Weiss, Gerhardt and Wassmer, and finally Oz.

In Table 8, Fetterman won the approval voting election, followed by Weiss, Wassmer, Gerhardt, and finally Oz.

Overall, Republican candidate Dr. Oz was sur-

passed by third-party candidates in every non-RCV, non-plurality mock election. In the approval voting election, candidates were within the general margin of 30–60 points away from one another, indicating that although there was a clear winner, the margin of approval between candidates of comparable ranking was not exceedingly large. Additionally, all three third-party candidates received more approval votes than Oz, suggesting that voters would rather vote for candidates with more moderate viewpoints than the less favorable major-party alternative. This finding is supported by a study modeled after the 2016 presidential election, which found third-party candidates to perform significantly better in approval voting as compared to plurality (Igersheim et al. 2022). The re-

Table 8

Approval Voting

Candidate	Votes
John Fetterman (Democrat)	198
Dr. Mehmet Oz (Republican)	34
Erik Gerhardt (Libertarian)	63
Richard L. Weiss (Green Party)	143
Daniel Wassmer (Keystone Party of PA)	100

Note. n=233. Voters were to select any candidates they would approve of winning.

Figure 6

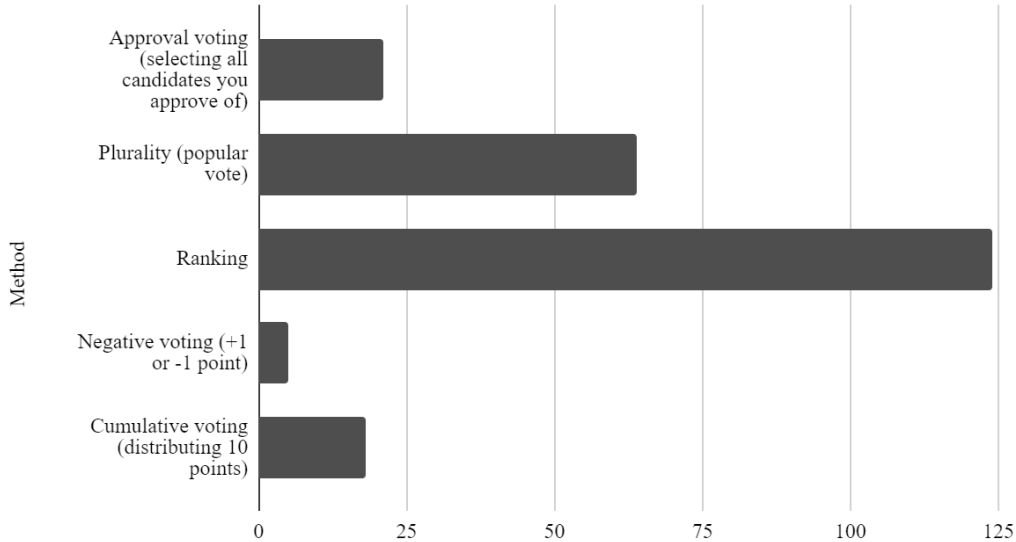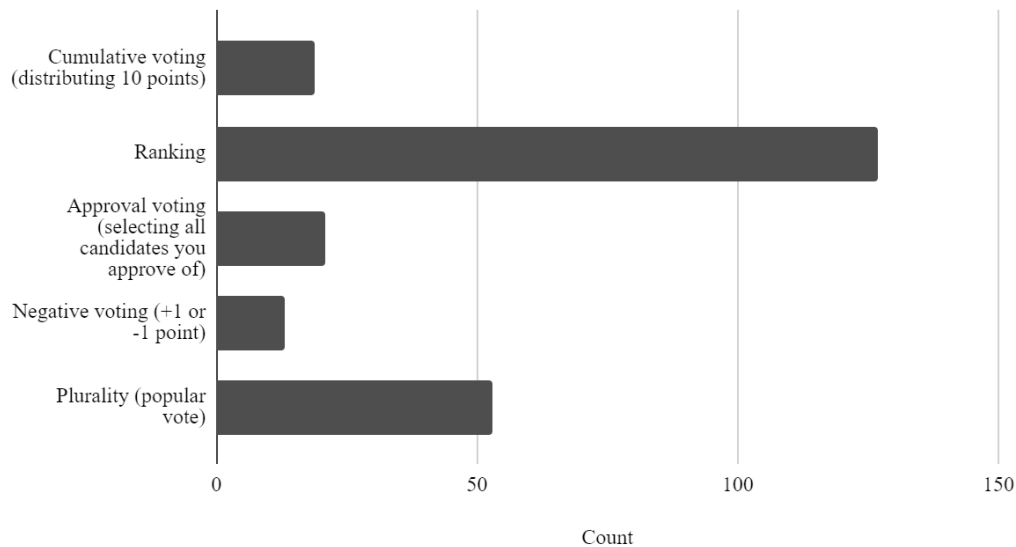Which voting method did you find to be the most fair?

Figure 7

Which voting method did you like best?

sults of the cumulative voting election displayed the closest alignment to the results of the mock plurality election: Fetterman's overall score vastly exceeded that of every other candidate, and Oz received fourth place rather than last. Similarly, under the negative voting election, Fetterman had an extremely high number of points compared to the other candidates, whereas Oz's was extremely low. Moreover, the point values of all three third-party candidates fell close to 0, suggesting that the electorate had strong opinions regarding the major-party candidates and was less likely to "waste" votes on a third-party candidate. This concept is heavily connected to the wasted vote paradox seen in plurality voting (Riker 1982; Rosenstone, Behr, and Lazarus 1984).

Participant Feedback

Figures 6 and 7 demonstrate the participants' opinions on each distinct voting method. As shown,

ranked-choice voting was deemed to be both the most favorable and the fairest method. These findings are supported by the results of Fischer, Lee, and Lelkes's (2021) study on perceived fairness, which was higher in ranked-choice voting than plurality systems (Fischer, Lee, and Lelkes 2021).

Figure 8 displays the likelihood of participants voting for a third-party candidate in any given election. Participants were asked to report their response on a scale from 1-5: never (1), likely not (2), maybe (3), likely would (4), and definitely would (5). The average for this question was ~2.9571, falling extremely close to the "maybe" value. These rather neutral responses were not expected by the researcher. It had been assumed that, despite the findings of Jones's (2021) poll, most participants would report low levels of interest in voting third-party, considering the miniscule chances of a third-party victory under plurality.

Figure 8

Note. n=233. The values shown are based on a Likert scale of 1-5, ranging from Never (1), Maybe (3) and Definitely Would (5).

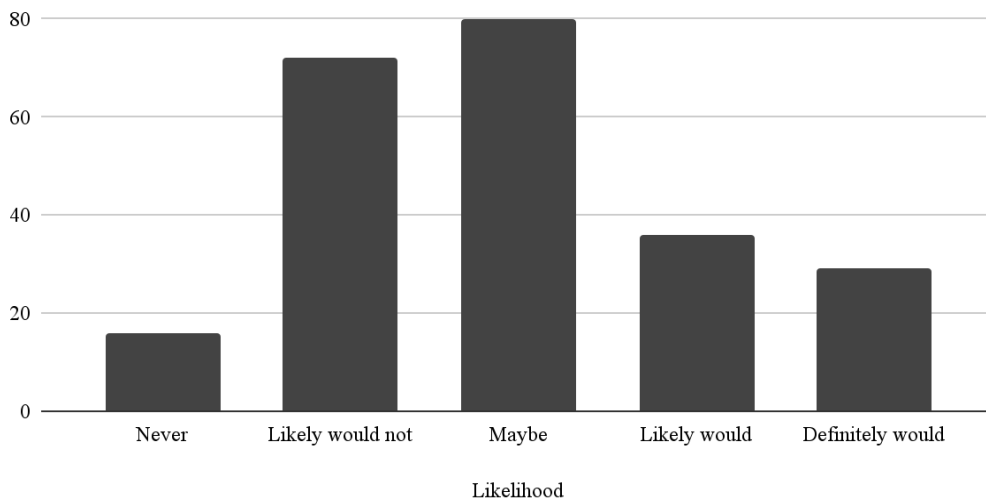**On a scale from 1 (never) to 5 (definitely would), how likely would you to be to vote third party in any given election?**

Likelihood

Table 9

Which candidates did you recognize prior to participating in the survey?

Candidate	Count
John Fetterman (Democrat)	225
Dr. Mehmet Oz (Republican)	213
Erik Gerhardt (Libertarian)	77
Richard L. Weiss (Green Party)	47
Daniel Wassmer (Keystone Party of PA)	30

Note. n=233

In Table 9, very few participants recognized the names of the third-party candidates. This finding suggests that despite being provided with multiple options, Americans generally focus on the platforms of major-party candidates. This once again highlights the "wasted vote" paradox, as explained by Riker (1982) as well as Rosenstone, Behr, and Lazarus (1984).

As seen in Table 10, a vast majority indicated that they would or currently do vote Democrat on a typical basis. However, a minor-party option was selected 124 times (excluding the "other/none" selections).

This finding aligns with Jones's (2021) poll, suggesting that a significant portion of the population is not fully satisfied with major-party options.

Limitations

The researcher identified multiple limitations that acted as potential barriers to the conclusions of the study. For one, the vast majority of responses (estimated ~300+) came from posting the survey on

Table 10

What party do you typically vote for/would you typically vote for in elections? (Select all that apply)

Party	Count
Democratic	188
Republican	42
Green Party	35
Libertarian	30
Keystone Party of PA	7
Independent	46
Constitution Party	6
Other/None	11

Reddit. Although this may not inherently limit the findings of the study, the researcher came across a problem with bot responses, presumably from Reddit, on the Google form. The data was tainted with multiple identical responses that would come in within milliseconds of one another and enter fake email addresses for the raffle incentive. The researcher individually examined each response and removed those with evidently non-human responses (e.g., a series of arbitrary digits and characters in place of written responses); however, the process may have limited the overall legitimacy of the study.

Additionally, although the sample size of usable responses (233) was sufficient, the political backgrounds of those who participated were not nearly as diverse or varied as the researcher intended. The data was skewed tremendously toward left-leaning individuals, particularly Fetterman voters. This made the sample far less representative of the more politically polarized population of Pennsylvania and likely contributed to the disproportional support for left-leaning candidates in the mock election. The researcher made attempts to collect a politically diverse sample by posting the survey in Reddit groups belonging to a variety of Pennsylvania cities and counties (ex: r/Butler, r/Pittsburgh, r/Harrisburg, r/LancasterPA, etc.) and through unbiased advertisement. However, due to the left-leaning political nature of Reddit and the researcher's city of residence, some degree of skew was expected. In order to compensate for this in future studies, it may be beneficial to distribute the survey on more neutral platforms or, potentially, conduct an in-person poll throughout Pennsylvania.

Conclusion and Future Directions

Although every voting method had the same overall outcome (John Fetterman winning) Republican candidate Dr. Oz was surpassed by one or more third-party candidates in every mock election. In five of the seven non-plurality voting systems that included runner-up calculations – anti-plurality, Borda Count, Coombs' method, negative voting, and approval voting – all three third-party candidates received more votes than major-party candidate Oz. Anti-plurality was by far the most promising method, as a third-party victory was only 4 votes away. Overall, the findings of this study suggest that, although subjective to each method, alternative voting methods on a general scale do increase the chances of third-party candidate victories in comparison to standard plurality voting. It can also be determined that alternative voting tends to mediate vote distribution in skewed elections where one candidate appears to be widely disliked by the population.

Additionally, the fact that the majority of participants preferred ranked-choice voting demonstrates some degree of dissatisfaction with the plurality system. Although the implementation of alternative voting methods on a national scale may not be entirely feasible, the adoption of ranked-choice voting systems in local elections is already a reality. It is likely that as Americans become aware of potential alternatives in voting, an increased number of regional governments may consider non-plurality electoral systems. As a nation so heavily influenced by politics, it is imperative to recognize potential flaws in plurality and consider alternatives in order to better represent the true preferences of the electorate.

Considering that the researcher's sample was not proportional to the distribution of votes in the real PA 2022 Senate election, it may not reflect the actual results of shifting to a non-plurality method. However, it is a strong starting point for future research. In order to further generalize these findings and apply them to a broader context, it is recommended that future researchers consider polling data from various regions across the United States and examine other types of elections besides solely Senate races. Additionally, researchers should consider recreating the study on more politically polarized samples in order to reflect the nature of the two-party system and enhance the mediating impact of alternative voting. Doing so may help determine the relative consistency of results on both a national and localized scale. Overall, as explained by Duverger's law, partisan disparities in voting are unavoidable. However, regional applications of alternative voting methods may address these limitations and challenge standard electoral outcomes.

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Appendix A: Voting Methods

These are the various voting methods that will be explored throughout the study. Please note that these methods will appear in the findings section and may be referred to at any time.

1. *Plurality voting* - an electoral system in which each voter is to select one candidate, and the candidate with the most votes wins (Pacuit 2019).

2. *Ranked-choice voting* - an electoral system in which voters rank candidates by personal preference.
   a. *Anti-plurality* - voters choose one candidate to vote against, rather than choosing one to vote for (Pacuit 2019).
   b. *Borda Count* - a (Borda) score is assigned to each candidate based on their ranking among other candidates. Out of n candidates, n-1 points are given to the first-place rankings, n-2 to the second-place rankings, etc. 1 point is given to any candidate with a second-to-last ranking, and 0 points are assigned to the last-place ranking (Pacuit 2019).
   c. *Condorcet's method* - each calculation is based on the premise that "A is ranked higher than B". The Condorcet winner is the candidate that dominates the greatest number of candidates when placed in an immediate comparison (Young 1988, 1231).
   d. *Hare method* - the candidate with the fewest first-place votes is continuously deleted from the running until one remains with a majority of votes (Pacuit 2019).
   e. *Coombs' method* - the candidate with the most last-place votes is continuously deleted from the running until one remains with a majority of votes (Pacuit 2019).

3. *Cumulative voting* - each voter must distribute a fixed number of points among the candidates in any way they choose. The candidate with the most points wins (Pacuit 2019).

4. *Negative voting* - each voter may choose one candidate to either vote for (giving the candidate 1 point) or to vote against (giving the candidate –1 points). The positive points and negative points are then added together. The winner is the candidate with the greatest number of votes after the summation (Pacuit 2019).

5. *Approval voting* - voters are to select a subset of candidates (any candidate that they would approve of winning), and the candidate selected by the most voters wins (Pacuit 2019).

Appendix B: Complete Survey

Voting Theory in the Pennsylvania 2022 Senate Election Survey

Voting Theory in the Pennsylvania 2022 Senate Election Consent Form

You are being asked to take part in a research study on the potential influence of alternative voting methods on the results of the Pennsylvania 2022 senate election. We are asking you to take part because you have expressed interest in acting as a voter in this mock election. Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

What the study is about: The purpose of this study is to analyze how the real results of the Pennsylvania 2022 senate election compare to the results of a series of mock elections, which will be conducted through experimentation with non-traditional voting methods. You must be 18 years or older and eligible to vote in Pennsylvania in order to take part in this study.

What we will ask you to do: If you agree to be in this study, we will have you fill out a survey. The survey will ask you to cast fake votes for candidates who ran in the 2022 Pennsylvania senate race through a

variety of voting methods such as rankings, point distributions, approval scales, and more. Additionally, it will include questions about your political affiliation and feelings toward each candidate. The survey will take about 10 minutes to complete.

Risks and benefits:

There is the risk that you may find this survey to be violative of your political opinions.

There are no direct benefits to you. However, this study can provide insight about how election results may vary if an alternative voting method is used as opposed to the United States' traditional voting system.

Compensation: You may be entered into a raffle for a $50 gift card at the conclusion of the survey. You will have to provide a preferred form of contact information (phone number, email address, etc.) in order to be entered into the raffle.

Your answers will be confidential. The records of this study will be kept private. In any sort of report that we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked file; only the researchers will have access to the records.

Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide to take part, you are free to withdraw at any time.

If you have questions: The researcher conducting this study is [redacted]. Please ask any questions you have now. If you have questions later, you may contact [redacted] at [redacted]. You can reach [redacted] at [redacted]. If you have any questions or concerns regarding your rights as a subject in this study, you may contact the Institutional Review Board (IRB) at [redacted].

If you are 18 years of age or older, have you read/understood the above information and consent to participate in this study?

Yes, I am 18 years old or older and I consent to participate in this study. [continue to next section]

No, I am under the age of 18. [submit form]

No, I do not consent to participate in this study. [submit form]

Political History

Are you eligible to vote in Pennsylvania?

Daniel Wassmer

Adapted from: https://wassmer4pa.com

-Keystone Party of Pennsylvania
-Pro-choice
-Pro-second amendment
-Pro-immigration
-Union member
-Anti-over policing; pro "peace officers"
-Supports social security protections
-Wants greater anti-corruption enforcement
-Supports affordable healthcare

*not much information on candidate, so more information on party adapted from https://www.keystone.party/
-Believe legislators should spend half of their time among constituents so they can understand those they represent
-Believe state should not spend more than it receives in revenue, and that the annual budget must be balanced
-Support pardoning of convictions for victimless crimes
-Believe individuals should be allowed to exchange goods/services as currency; no flat currency
-Support free trade

Yes [continue to next section]

No [submit form]

Did you vote in the 2022 Pennsylvania senate election?

Yes

No

If yes, which candidate did you vote for?

    John Fetterman

    Dr. Mehmet Oz

    Erik Gerhardt

    Richard L. Weiss

    Daniel Wassmer

    I did not vote in the 2022 Pennsylvania senate election.

    Other

Which political party holds the views you most identify with?

    Democrat

    Republican

    Libertarian

    Independent

    Green Party

    Constitution Party

    Keystone Party of Pennsylvania

    Other

Erik Gerhardt

Adapted from: https://erik4pa.com/

-Libertarian
-Wants to "decrease taxes to their absolute minimum"
-Supports applying flat tax on sales and getting rid of property tax
-Against extra credit for unemployment benefits
-Against defunding police, but for police reform such as more/better training
-Supports the legalization and decriminalization of marijuana
-Believes abortion should not be dependent on the senate as it is the personal choice of the woman
-Supports court's decision for overturning Roe v. Wade, and believes that "the states and their people should have a constitutional question added to the ballot to have the people decide on the issue"

Richard L. Weiss

Adapted from: https://www.greenslate2022.com/us_senator

-Green Party
-Supports Medicare for All
-Advocates for securing reproductive rights
-Believes in gun regulation
-Advocates for peace in Ukraine
-Supports restorative justice reforms, believing they would reduce crime and save money
-Strongly opposes fracking; advocate for a ban on fracking
-Supports a rapid transition to renewable energy
-Platform based on using green alternatives for state grants and tax breaks given to energy/natural resource industries
-Supports transition to 100% clean energy and the creation of an environmentally sustainable economy

Dr. Mehmet Oz

Adapted from:
https://en.wikipedia.org/wiki/Mehmet_Oz#Political_positions

-Republican
-Against abortion except for rape, incest, or if mother's life is in danger
-States he would "potentially" support the death penalty for fentanyl dealers
-Pro-school choice + charter schools
-Supports same-sex marriage
-Supports fracking and the reduction of strict environmental regulations
-Supporter of Israel-United States relations
-Gun owner and supporter of 2nd amendment
-Said he would vote against Affordable Care Act
-Supports medical use of marijuana, not recreational + supports pardoning of marijuana possession sentences
-Offered support to transgender youth in 2010
-Supports prohibiting transgender people from sports that are divided by gender-based categories

John Fetterman

Adapted from:
https://en.wikipedia.org/wiki/John_Fetterman#Political_positions

-Democrat
-Stated that abortion is "between a woman and her physician"
-Against death penalty; advocate for more rehibilitation action for model prisoners
-Described as "skeptic of free trade"
-Previously opposed fracking, now supports it along with stricter environmental regulations
-Supporter of Israel-United States relations
-Supports restrictions on gun purchases
-Supporter of Medicare for All
-Supports legalization of marijuana and expunging criminal convictions related to marijuana
-Supports raising minimum wage to $15 + unions
-Supports imposing a wealth tax
-Pro-policing and anti-defund the police

Voting Methods

The following questions will ask you to vote for candidates using a variety of methods. Some may require you to select multiple candidates, distribute points, or construct a ranking. For each method, you will be given instructions on how to properly cast your vote. Please be sure to read the instructions before proceeding with your votes. Your identity is anonymous, and your answers will be kept confidential.

Provided are brief descriptions on five candidates who ran in the 2022 Pennsylvania senate race. You may refer to these descriptions throughout the study to understand the positions held by each candidate.

Plurality

This is the traditional voting system used for senate elections (and most other elections) in the United States. Plurality voting is equivalent to election by popular vote -- whichever candidate gets the highest number of votes will win.

Please select your one top candidate.

John Fetterman (Democrat)
Dr. Mehmet Oz (Republican)
Erik Gerhardt (Libertarian)
Richard L. Weiss (Green Party)
Daniel Wassmer (Keystone Party of Pennsylvania)

Ranking Methods

Rank the candidates from 1-5. 1 represents the candidate you would most like to win, 2 the second most, etc. 5 represents the candidate you would least like to win. Your ranking will be used to calculate the winner for multiple types of methods such as the Condorcet Method, Borda Count, anti-plurality, the Hare rule, Coombs rule, etc.

[multiple choice grid with choices 1-5 for each candidate]

Cumulative Voting

For this method, you will be given 10 points to distribute among the five candidates in any way you please. Please type the number of points you would like to allot to each candidate into the corresponding boxes below. The more points a candidate is given, the higher their chances of winning are. For instance, if you really like candidate A, but hate candidate C, you may want to give some points to candidate B (even though you are impartial to them) because you don't want candidate C to win. Please ensure your point distributions add up to 10 in the end.

[candidates' names with an open textbox]

Negative Voting

For this method, the voter is able to select one candidate to either vote for, or one candidate to vote against. You may select your favorite candidate to give +1 point to, or select your least favorite candidate to give -1 point to (take 1 point away from). This method is more indicative of which candidates are more positively perceived by voters and which are perceived more negatively.

+1 point to John Fetterman (Democrat)
+1 point to Dr. Mehmet Oz (Republican)
+1 point to Erik Gerhardt (Libertarian)
+1 point to Richard L. Weiss (Green Party)
+1 point to Daniel Wassmer (Keystone Party of Pennsylvania)
-1 point from John Fetterman (Democrat)
-1 point from Dr. Mehmet Oz (Republican)
-1 point from Erik Gerhardt (Libertarian)
-1 point from Richard L. Weiss (Green Party)
-1 point from Daniel Wassmer (Keystone Party of Pennsylvania)

Approval Voting

For this method, select all the candidates that are above your "threshold of acceptance", or the point a candidate would have to pass for you to be at least moderately satisfied with them winning. Mark the boxes of any candidate (even if they are not your first pick) that you would approve of winning. For instance, if you love candidate A, don't mind candidate B, but strongly dislike C and D, you may want to select both candidates A and B in order to lower the chances of having your least favorite candidates win.

Select all candidates that you would approve of winning:

[checkboxes with candidates' names]

Political Background Cont.

Prior to taking this survey, which candidates did you know/recognize? (Select all that apply)

[checkboxes with candidates' names]

What party do you typically vote for/would you typically vote for in elections? (Select all that apply)

[checkboxes with party options]

On a scale from 1 (never) to 5 (definitely would), how likely would you be to vote third party (non-Democrat or Republican) in any given election?

[Likert scale]

Which voting method(s) did you like? (Select all that apply)

[checkboxes with each voting method]

Which voting method did you like best?

Plurality (popular vote)

Ranking

Cumulative voting (distributing 10 points)

Negative voting (+1 or -1 point)

Approval voting (selecting all candidates you approve of)

Which voting method(s) would you consider to be fair? (Select all that apply)

Plurality (popular vote)

Ranking

Cumulative voting (distributing 10 points)

Negative voting (+1 or -1 point)

Approval voting (selecting all candidates you approve of)

Which voting method did you find to be the most fair?

Plurality (popular vote)

Ranking

Cumulative voting (distributing 10 points)

Negative voting (+1 or -1 point)

Approval voting (selecting all candidates you approve of)

In your opinion, which voting method would yield a candidate that would satisfy the greatest number of people?

Plurality (popular vote)

Ranking

Cumulative voting (distributing 10 points)

Negative voting (+1 or -1 point)

Approval voting (selecting all candidates you approve of)

Thank you for completing this survey.

Project Title: Voting Theory in the Pennsylvania 2022 Senate Election

Principal Investigator: [redacted]

Department/Course: AP Research

Contact Information: [redacted]

Taking part is voluntary

Although you have already completed the survey, your involvement is still voluntary, and you may choose to withdraw the data you provided prior to debriefing, without penalty or loss of compensation offered to you. Withdrawing your submission will not adversely affect your relationship with Hampton High School, the researchers, or any of our affiliates.

Privacy/Confidentiality

If you agree to allow us to use your data, here is how we will maintain confidentiality of the information. No personal information will be collected from your response, meaning that it is impossible to retrace your responses back to you.

The main researcher conducting this study is [redacted], a student at [redacted].

If you have questions later, or would like to know about the results of the study, you may contact [redacted] at [redacted].

If you have any questions or concerns regarding your rights as a subject in this study, you may contact the Institutional Review Board (IRB) for Human Participants at [redacted]. Please mark below if you do, or do not, give permission to have your data included in the study:

Do you understand the intent and purpose of your participation in the Voting Theory in the Pennsylvania 2022 Senate Election Study and give permission for your responses to be included in the study?

Yes, I agree that the data collected during the study may be included for the purpose of the study. [continue to next section]

No, I DO NOT give permission to have my data used. [submit form]

Gift Card Raffle

If you wish to participate in the raffle to receive a $50 gift card (of your choice), please provide your cell phone number or email address below to be entered into the raffle. Whether or not you wish to participate in the raffle, please remember to submit your responses.

[short answer text box]