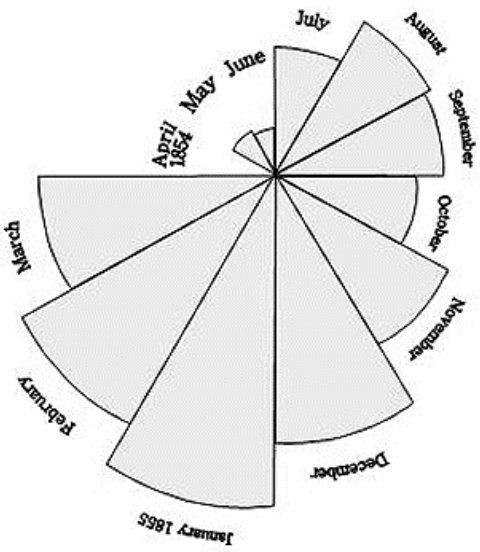
Activity Sheet: Florence Nightingale's Polar Area Diagrams

Florence Nightingale is known by legend as the "Lady with the Lamp," an innovator in the field of nursing. Born at a time when most colleges accepted only men, she insisted on learning mathematics from the time she was twelve years old, and then put those skills to good use analyzing data she collected herself in military hospitals. She wanted to clearly show that disease, not wounds, caused most of the British Army's deaths during the Crimean War (1854-1856). Most other statisticians at the time thought statistics should be very plain (and maybe even boring), but Florence decided to use interesting graphs to make her points stand out and to show people what was going on so that she could convince them to make changes in the way things were run.

Florence Nightingale was the first woman elected as a Fellow of the Royal Statistical Society, and she was also made an honorary member of the American Statistical Association. Her methods are widely used today, especially in health care and the census.

Portrait of Florence Nightingale, circa 1858, from the Library of Congress Prints and Photographs Division [#LC-USZ62-5877].



One of Florence's inventions was called a polar area chart, which is very similar to a pie chart. In a polar area chart, the circle is divided into angles or "wedges" of the same size for each category. The radius of each wedge is then equal to the square root of the count (or frequency) for that category. The square root is used for the radius because the area of a circle is πr^2, and using the square root of the frequency for radius means that the wedges in the polar area chart are still proportional to one another, like in the pie chart. An example is shown to the left.

Each wedge represents the number of deaths due to disease for the British Army in Crimea. There are no fatalities at the start of the war in April 1854, but as the months pass the numbers increase and the radii of the wedges get bigger until January 1855. She explained that this was due to the fact that, as fighting went on, the hospitals became more crowded and dirty, so there was more disease. The winter was also very cold – notice that January is the largest piece of the graph.

The data given below show the number of men and women athletes from all countries who have competed in each Summer Olympics since 1972. How many athletes participate? How has their participation changed over time? Are there more participants or fewer? Are the numbers of men and women similar? What are the causes of these trends or changes? These questions are similar to the kind Florence was trying to answer with her data.

Year	Host City	Host Country	Women		Men	
1972	Munich	West Germany	1058	15%	6065	85%
1976	Montreal	Canada	1247	21%	4781	79%
1980	Moscow	USSR	1124	22%	4093	78%
1984	Los Angeles	USA	1567	23%	5230	77%
1988	Seoul	South Korea	2186	26%	6279	74%
1992	Barcelona	Spain	2708	29%	6659	71%
1996	Atlanta	USA	3523	34%	6797	66%
2000	Sydney	Australia	4069	38%	6582	62%

(1) On a separate sheet of paper, make a pie chart for each year to show the percentage of women and men athletes.

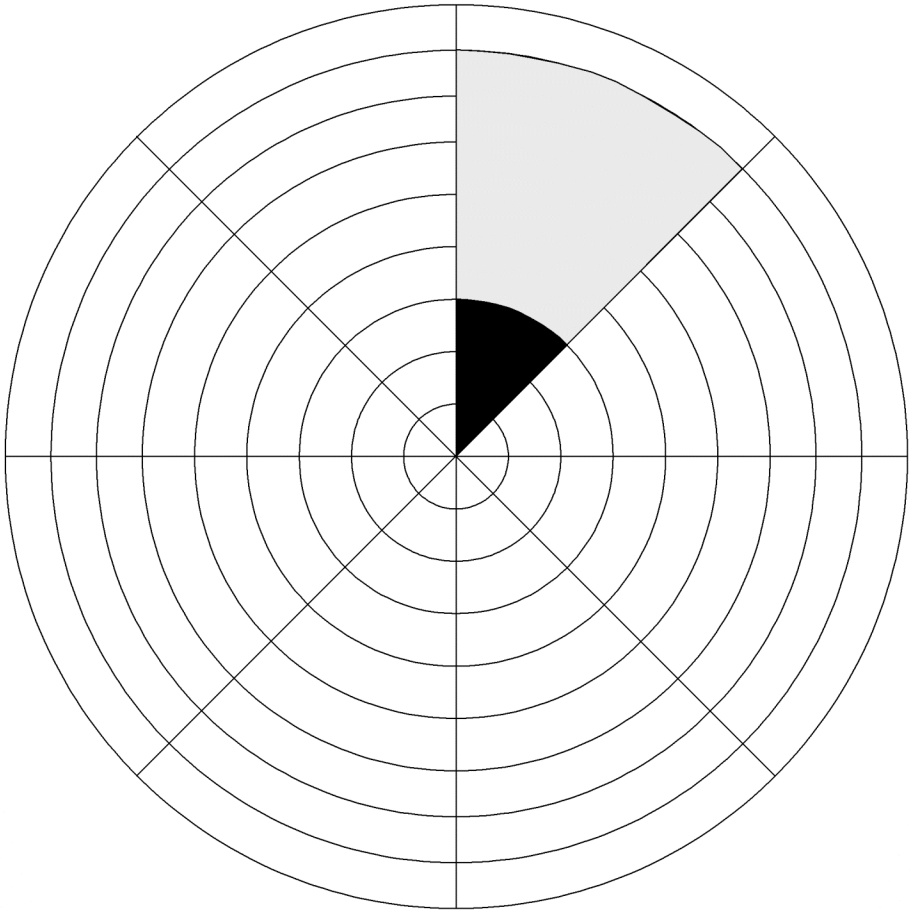
(2) On a separate sheet of graph paper or using a computer program, make a comparative bar chart showing the number of women and men athletes for each year.

(3) Create a polar area chart for the data using the table and the grid on the following page.

		1972	1976	1980	1984	1988	1992	1996	2000
Women	Count	1058	1247	1124	1567	2186	2708	3523	4069
	Square Root	33							
Men	Count	6065	4781	4093	5230	6279	6659	6797	6582
	Square Root	78							

- Find the square roots for all the counts in the table.
- For each year, draw the radius for the women's count and shade in the wedge.
- For each year, find the radius for the men's count (which is larger). Shade in the extra area covered by the men's wedge with a different color. When you are done it should look like the women's wedge is on top of the men's wedge for each year. The year 1972 has already been done for you. Label each section with the appropriate year.

There are eight equal sections on the grid, one for each year. The circles on the grid represent the tens digit (e.g., 10, 20, 30). For convenience, round all your square roots to the nearest tens place when drawing the graph.



(4) Answer the questions below using the tables and your graphs.

a) Describe participation by men athletes over time. Are there more men participating now than in the past, fewer men participating now, or are the numbers staying the about same? Explain your answer.
b) What year had the lowest participation by men? Can you find a historical reason why this is true?
c) Describe participation by women athletes over time. Are there more women participating now than in the past, fewer women participating now, or are the numbers staying the about same? Explain your answer.
d) In 1972, the United States Congress passed a law called Title IX. One of things it did was to create more opportunities for women athletes in high school and college. Can you use this to help explain the reason for your answer to part (c)?
e) What can you say about the total number of participating athletes for each year?

To quote Florence Nightingale, she believed that statistics is "...the most important science in the whole world; for upon it depends the practical application of every other science and of every art; the one science essential to all political and social administration, all education, all organization based on experience, for it only gives results of our experience."