DATA COLLECTION AND CHARTING TECHNIQUES

❑ **Grade Level:** Middle School	❑ **Subject Areas:** Mathematics	❑ **Setting:** Classroom/Computer Lab
❑ **Duration:** 40 minutes	❑ **PA Academic Standards:** 2.2.11G; 2.6.5A,E; 2.6.8B,F; 2.6.11B; 3.7.7D; 3.7.10B,D;	❑ **Keywords:** graphing, run chart, variable, average, trend, variation, shift, statistics

SUMMARY

Run charts will be completed using the Monastery Run Improvement Project Data to show trends and shifts over time. These charts will be used evaluate the success or failure of the treatment system over the past 5 years.

OBJECTIVES

- Given a set of data from the Monastery Run Improvement Project Site, the student will evaluate the trends without the use of a run chart.
- Using the data provided, the student will construct a run chart of the data including appropriately labeled axis, units, title, etc…
- After completing the run chart, the student will examine the charted data and re-evaluate their original trends prior to the charting.

MATERIALS

A. Data
B. Stream data – Iron
C. Flip chart paper
D. Color markers
E. Tape

BACKGROUND

Run charts (often known as line graphs outside the quality management field) display process performance over time. Upward and downward trends, cycles, and large aberrations may be spotted and investigated further. In a run chart, events, shown on the *y-axis*, are graphed against a time period on the *x-axis*. Run charts can also be used to track improvements that have been put into place, checking to determine their success. Also, an average line can be added to a run chart to clarify movement of the data away from the average.

Alternatives with run charts:

1. An average line, representing the average of all the y values recorded, can easily be added to a run chart to clarify movement of the data away from the average. An average line runs parallel to the x-axis.

2. Several variables may be tracked on a single chart, with each variable having its own line. The chart is then called a multiple run chart.

3. Run charts can also be used to track improvements that have been put into place, checking their success.

Questions to ask about a run chart:

1. Is the average line where it should be to meet customer requirements?

2. Is there a significant trend or pattern that should be investigated?

Two ways to <u>mis</u>interpret run charts:

1. You conclude that some trend or cycle exists, when in fact you are just seeing normal process variation (and **every** process will show some variation).

2. You do not recognize a trend or cycle when it **does** exist.

Both of these mistakes are common, but people are generally less aware that they are making the first type, and are tampering with a process that is really behaving normally. To avoid mistakes, use the following rules of thumb for run chart interpretation:

1. Look at data for a long enough period of time, so that a "usual" range of variation is evident.
2. Is the recent data within the usual range of variation?
3. Is there a daily pattern? Weekly? Monthly? Yearly?

Using run charts to detect "special causes" of variation:

If you have 25 points or more in your data series, you can use run charts to detect special causes - something beyond the usual variability of the process -acting on the process.

1. Shifts: If you see eight or more consecutive points on one side of the center line, that indicates that a special cause has influenced the process. Points on the centerline don't count; they neither break the string, nor add to it.
2. Trends: Six consecutive jumps in the same direction indicate that a special cause is acting on the process to cause a trend. Flat line segments don't count, either to break a trend, or to count towards it.
3. Pattern: If you see a pattern that recurs eight or more times in a row, it is a good idea to look for a special cause.

For more robust monitoring of a process, and better information about when your process is showing variation beyond what is expected, try using a control chart. It will detect special causes more quickly, and with more accuracy.

Run chart statistics:

For each line in the run chart, the following statistics are calculated:

Mean	average of all the data points in the series.
Maximum	maximum value in the series.
Minimum	minimum value in the series.
Sample Size	number of values in the series.
Range	maximum value minus the minimum value.
Standard Deviation	Indicates how widely data is spread around the mean

PROCEDURE

WARM UP

ONE DAY BEFORE THIS LESSON: Assign/Inform the students that they will need to bring in a newspaper or magazine for the next day. If they do not have access to one, they should speak to you and you should also bring some extras in that event.

1. Remind the students that data is around us every day. Have the students examine the newspapers and magazines for graphs and charts displaying data.
2. Make a list of the types of graphs and charts that were found on the board.
3. Ask the students what types of charts they worked with or completed in the past. Have them describe the difference between the charts and what they are often times used for.
4. Ask the students if they know what AMD wetlands are. Expand upon their answer or describe to them what is involved using the AMD Background.
5. Ask the students what types of data they think could be collected from AMD Wetlands.
   - Iron, sulfate, pH, flow rates, iron loading (amount of iron deposited every day, month or year), pounds of iron retained per day.
6. Announce that more data will be examined by using actual wetland data collected from the Monastery Run Improvement Project in Latrobe, Pennsylvania.

- Half of the students will have iron input and output data from Wetland #3.
- Half will have the iron data from the surrounding streams.

7. Distribute the data.
8. After a few minutes, ask the students,
   What does the data tell you about iron out contents?
   What does the data tell you stream contents?
   - When applicable, prompt for responses such as: greater than, less than, more, less, increasing, decreasing, staying the same, and etcetera.
   - The students may state the difficulty in responding to the questions. Prompt for this response.
9. Remind the students of charts that they gathered from newspapers and magazines.
10. Ask the students if it would be easier to answer the same questions by looking at a chart?
11. What is it about charts that make analyzing data easier?
    Prompt for answers like being able to see a trend, being able to see the relationship of the data over time.

THE ACTIVITY – MAKING A RUN CHART

1. Ask the students what elements they would need to make a chart.
   - Prompt for such elements as a title, a scale (range of data on the x and y axes), the units (of the x and y axes), and the x and y-labels.
   - Write each of these on the board by demonstrating where each of these items is on a chart.
   - Emphasize that the scale should be large enough to include all the data.
   - The units should be of equal lengths that make sense, that is, not too small and not too large.
   - Scales should be even, do not have a block that is 2.3333333 or 1.67
   - State that these elements are necessary to help the reader understand the chart.
   - Also necessary for the Run Chart is the addition of an average line, this is completed by finding the average of all the y values and making 1 straight line at that value.
2. Divide the class into groups (to assist each other with questions). **EACH student should complete his or her own chart to ensure understanding.**
3. Distribute the paper and markers.
   - Ask the students to construct a chart using the wetland data and the elements written on the board.
   - Remind the class that missing data should not be plotted.
   - The line would not be connected to a marker during any period where data was not collected.
4. Announce that they have twenty minutes to chart their data and display the results. Then the students would be asked to respond to questions.

WRAP UP

1. Review the results. Compare to teacher version. Correct any omissions of any chart labeling.
2. Ask the students:
   - What do you know notice about the iron values, is there any trend?
   - Do the iron levels increase at a certain time of the year?
   - Prompt for responses such as: greater than, less than, more, less, increasing, decreasing, staying the same, higher or lower results in winter and summer, etcetera". Answer any questions regarding wrong answers.
3. Erase the board showing the elements of the chart.

ASSESSMENT

- Teacher will verbally check the student's opinions of the trends in the data without the use of a chart. **(Objective 1)**
- Teacher will check the students run chart for accuracy, labels, units, titles, etc. **(Objective 2)**
- Teacher will verbally question the student's about the new trend conclusions. **(Objective 3)**
- Provide the students with the following Quiz to ensure their understanding.

EXTENSIONS

RESOURCES

Data Collection and Charting Techniques

NAME_____

Using the data below, complete the Run Chart for the Average Math Entrance Exam Scores are listed by year. Include an average line.

Year	Avg Math Score
1975	139
1976	130
1977	61
1978	164
1979	129
1980	100
1981	108
1982	110
1983	68
1984	78
1985	57
1986	77
1987	38
1988	53
1989	50
1990	81
1991	105
1992	65
1993	97
1994	62
1995	96
1996	93

Interpret the chart, Are there any trends present, if so, what are they?

Would the chart look different if everything were perfect, How?

COPY ME

One Per Student