Elaborate: How Much Longer?

Purpose:

Use various technologies to generate and communicate an answer to a question. Compare strengths and weaknesses of different technologies when gathering, representing, and analyzing data. Generate a list of attributes to guide judicious use of technology.

Descriptor:

Participants will collect reaction time data. They will analyze their data using both hand-held technology and spreadsheet technology to determine generalizations about their data sets. Participants will identify the strengths and weaknesses of each technology. These tasks will take place within the structure of the problem-solving model: understand the problem; make a plan; carry out the plan; evaluate the plan and the solution; and extend the problem.

Duration:

2 hours

Mathematics TEKS Objectives:

6.10A	The student uses statistical representations to analyze data. The student is expected to select and use an appropriate representation for presenting and displaying different graphical representations of the same data including line plot, line graph, bar graph, and stem and leaf plot.
6.10B	The student uses statistical representations to analyze data. The student is expected to identify mean (using concrete objects and pictorial models), median, mode, and range of a set of data.
6.10D	The student uses statistical representations to analyze data. The student is expected to solve problems by collecting, organizing, displaying, and interpreting data.
7.11A	The student understands that the way a set of data is displayed influences its interpretation. The student is expected to select and use an appropriate representation for presenting and displaying relationships among collected data, including line plot, line graph, bar graph, stem and leaf plot, circle graph, and Venn diagrams, and justify the selection.
7.11B	The student understands that the way a set of data is displayed influences its interpretation. The student is expected to make inferences and convincing arguments based on analysis of given or collected data.
7.12A	The student uses measures of central tendency and range to describe a set of data. The student is expected to describe a set of data using mean, median, mode, and range.
7.12B	The student uses measures of central tendency and range to describe a set of data. The student is expected to choose among mean, median, mode, or range to describe a set of data and justify the choice for a particular situation.
8.12A	The student uses statistical procedures to describe data. The student is expected to select the appropriate measure of central tendency or range to describe a set of data and justify the choice for a particular situation.

8.12B Draw conclusion and make predictions by analyzing trends in scatterplots.

8.12C The student uses statistical procedures to describe data. The student is expected to select and use an appropriate representation for presenting and displaying relationships among collected data, including line plots, line graphs, stem and leaf plots, circle graphs, bar graphs, box and whisker plots, histograms, and Venn diagrams, with and without the use of technology.

6.11A, 7.13A, 8.14A The student applies Grade 6/7/8 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school. The student is expected to identify and apply mathematics to everyday experiences, to activities in and outside of school, with other disciplines, and with other mathematical topics.

6.11B, 7.13B, 8.14B The student applies Grade 6/7/8 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school. The student is expected to use a problem-solving model that incorporates understanding the problem, making a plan, carrying out the plan, and evaluating the solution for reasonableness.

6.11C, 7.13C, 8.14C The student applies Grade 6/7/8 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school. The student is expected to select or develop an appropriate problem-solving strategy from a variety of different types, including drawing a picture, looking for a pattern, systematic guessing and checking, acting it out, making a table, working a simpler problem, or working backwards to solve a problem.

6.11D, 7.13D, 8.14D The student applies Grade 6/7/8 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school. The student is expected to select tools such as real objects, manipulatives, paper/pencil, and technology or techniques such as mental math, estimation, and number sense to solve problems.

6.12A, 7.14A, 8.15A The student communicates about Grade 6/7/8 mathematics through informal and mathematical language, representations, and models. The student is expected to communicate mathematical ideas using language, efficient tools, appropriate units, and graphical, numerical, physical, or algebraic mathematical models.

6.12B, 7.14B, 8.15B The student communicates about Grade 6/7/8 mathematics through informal and mathematical language, representations, and models. The student is expected to evaluate the effectiveness of different representations to communicate ideas.

6.13A, 7.15A, 8.16A The student uses logical reasoning to make conjectures and verify conclusions. The student is expected to make conjectures from patterns or sets of examples and nonexamples.

6.13B, 7.15B, 8.16B The student uses logical reasoning to make conjectures and verify conclusions. The student is expected to validate his/her conclusions using mathematical properties and relationships.

Technology Applications TEKS Objectives:

(1)(B) The student demonstrates knowledge and appropriate use of hardware components, software programs, and their connections. The student is expected to compare, contrast, and appropriately use the various input, processing, output, and primary/secondary storage devices.

(1)(C) The student demonstrates knowledge and appropriate use of hardware components, software programs, and their connections. The student is expected to demonstrate the ability to select and use software for a defined task according to quality, appropriateness, effectiveness, and efficiency.

(1)(E) The student demonstrates knowledge and appropriate use of hardware components, software programs, and their connections. The student is expected to use technology terminology appropriate to the task.

(1)(F) The student demonstrates knowledge and appropriate use of hardware components, software programs, and their connections. The student is expected to perform basic software application functions including, but not limited to, opening an application program and creating, modifying, printing, and saving documents.

(3)(D) The student complies with the laws and examines the issues regarding the use of technology in society. The student is expected to identify the impact of technology applications on society through research, interviews, and personal association.

(3)(E) The student complies with the laws and examines the issues regarding the use of technology in society. The student is expected to demonstrate knowledge of the relevancy of technology to future careers, life-long learning, and daily living for individuals of all ages.

(5)(A) The student acquires electronic information in a variety of formats, with appropriate supervision. The student is expected to identify, create, and use files in various formats such as text, bitmapped/vector graphics, image, video, and audio files.

(7)(A) The student uses appropriate computer-based productivity tools to create and modify solutions to problems. The student is expected to plan, create, and edit documents created with a word processor using readable fonts, alignment, page setup, tabs, and ruler settings.

(7)(B) The student uses appropriate computer-based productivity tools to create and modify solutions to problems. The student is expected to create and edit spreadsheet documents using all data types, formulas and functions, and chart information.

(7)(G) The student uses appropriate computer-based productivity tools to create and modify solutions to problems. The student is expected to integrate two or more productivity tools into a document including, but not limited to, tables, charts and graphs, graphics from paint or draw programs, and mail merge.

(7)(H) The student uses appropriate computer-based productivity tools to create and modify solutions to problems. The student is expected to use interactive virtual environments, appropriate to level, such as virtual reality or simulations.

(8)(E) The student uses research skills and electronic communication, with appropriate supervision, to create new knowledge. The student is expected to integrate

acquired technology applications skills, strategies, and use of the word processor, database, spreadsheet, telecommunications, draw, paint, and utility programs into the foundation and enrichment curricula.

(10)(E) The student formats digital information for appropriate and effective communication. The student is expected to match the chart style to data when creating and labeling charts.

TAKS Objectives:

- Objective 5: Probability and Statistics
- Objective 6: Underlying Processes and Mathematical Tools

Technology:

- Internet
- Spreadsheet technology
- Hand-held graphing technology
- Word-processing technology

Materials:

Advanced Preparation: **Transparency: How's Your Timing?**, **Transparency: Data Collection**, **Transparency: Teaching Strategies**, **Transparency 1: Looks Like – Sounds Like**, **Transparency 2: Looks Like – Sounds Like**, **Transparency: Research**

Presenter Materials: Computer with internet access and data projection device or access to a computer lab, graphing calculator with presentation capabilities.

Per group: Computer, masking tape

Per participant: graphing calculator, sentence strips in three different colors, **Rubric for Answering the Question**, **Understanding the Question** activity page, **Making a Plan** activity page, **Carrying Out the Plan and Answering the Question** activity page, **Evaluating the Answer and the Plan** activity plan, **Extending the Question** activity page

Leader Notes:

This activity prompts the participants to use a problem-solving model to generate a plan for collecting data, to collect data, and to determine what statistical measures and what statistical representations may be generated from this data. The participants will represent the data using spreadsheet and hand-held graphing technology. The participants will evaluate each technology tool in light of the solution process used to answer the questions posed at the beginning of the activity.

The leader should attend to the understanding that participants' exhibit with respect to the mathematical and technological goals of the previous phases. The facilitation questions are offered as a means for helping participants articulate their learning and as a means for enhancing

participants' learning. Some facilitation questions may be beneficial in a whole group setting. Use those questions that "fill in the blanks" that may be remaining after the Engage, Explore, and Explain phases.

Posing the Problem:

1. **What is elapsed time?**
   Answers may vary. The amount of time that passes between a beginning time and an ending time.

2. **What are real-life applications of elapsed time?**
   Answers may vary. Estimating one minute to get to class when the "run bell" rings, race times, surgical times for scheduling surgeries, instructional time, etc.

3. **What is feedback?**
   Answers may vary. Information returned from the output of effort or a process. This information guides the evaluation and revision of the effectiveness or efficiency of the effort or process.

4. **What are ways that people provide feedback?**
   Answers may vary. The ways by which people provide feedback vary according to the role of the feedback provider. The feedback may be in the form of qualitative statements such as "You seemed at ease when presenting." The feedback may be in the form of quantitative statements such as "You spent 37 minutes on an activity designed to take 15 minutes."

5. **What are ways that coaches provide feedback?**
   Answers may vary. Coaches make use of qualitative and quantitative data.

6. *Use the **Transparency: How's Your Timing?** to pose the problem for the elaborate phase of this professional development session.*

Part 1: Understanding the Problem (5-10 min)

This part of the Elaborate phase is designed for paired and whole-group discussion. Listen to the participants' responses to assess the learning that is taking place as a result of the Explore/Explain phases.

1. *Distribute the **Understanding the Question** activity page to each participant.*

2. *Prompt participants to brainstorm responses to the questions and then share responses with another participant.*

3. *Debrief questions 4 and 5 on the **Understanding the Question** activity page as a whole group. If the presenter assesses the participants' understandings as lacking, the presenter may choose to review each of the questions posed on the **Understanding the Question** activity page.*

Understanding the Question Activity Page

1. Have you answered a question or conducted an investigation similar to this one before? If yes, what was the problem or investigation? How did you answer the question?
   Answers may vary. A sample response: We have done estimating activities in class that require us to estimate the length of a piece of string. We were asked to determine which pieces of string were longer than 0.5 meter. We answered the question by predicting a length and then measuring the piece of string to determine the actual length. Knowing the actual measurement was similar to feedback. I became a better estimator after predicting and measuring.

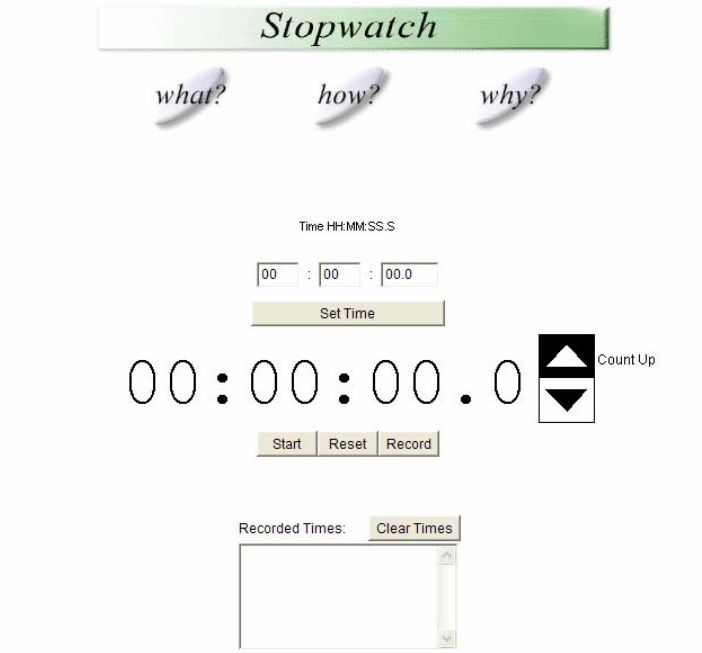
2. How might you restate the question?
   Answers may vary. A sample response: Does feedback improve my ability to estimate lengths of time?

3. What is the unknown you are investigating?
   Answers may vary. A sample response: We are investigating the unknown effect of feedback.

4. What data might you gather to answer the question: When estimating elapsed time, does feedback help you become a better estimator? Why might this data be appropriate?
   Answers may vary. A sample response: The participant's estimated times with and without feedback.

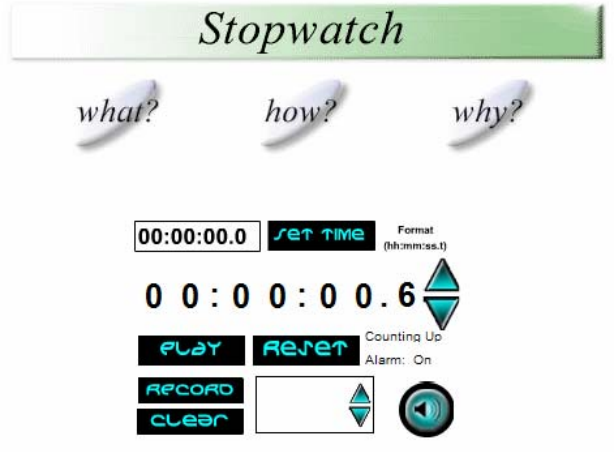
5. What data collection tools are available to help answer this question?
   Answers may vary. Sample responses include stopwatches and on-line stopwatch tools.

4. *Use a projection system to demonstrate the on-line stopwatches for the participants. Use the Word document containing links for the elaborate phase. Click on the link for Stopwatch 1. This stopwatch is a java applet.*
http://www.shodor.org/interactivate/activities/stopwatch/index.html.



Stopwatch retrieved November 27, 2005 from
http://www.shodor.org/interactivate/activities/stopwatch/index.html
Click on the start and stop buttons to illustrate how the timer counts up. Click on the record button to show the times recorded in a list.

Click on the link for Stopwatch 2. This stopwatch uses Macromedia Flash technology.
http://www.shodor.org/interactivate/activities/stopwatch/indexflash.html



Stopwatch retrieved November 27, 2005 from
http://www.shodor.org/interactivate/activities/stopwatch/indexflash.html
Click on the Play and Pause buttons to illustrate how the timer counts up. Click on the record button to show the times recorded in a list.

Part 2: Making a Plan (15-20 min)

This part of the Elaborate phase is designed for paired and whole-group discussion. Listen to the participants' responses to assess the learning that is taking place as a result of the Explore/Explain phases.

1. *Distribute the **Rubric for Answering the Question** activity page and the **Making a Plan** activity page to each participant.*

2. *Display the **Transparency: Data Collection** so that it is visible to all participants.*

3. *Prompt the participants to brainstorm responses to the questions posed on the **Making a Plan** activity page while considering the information found on the **Rubric for Answering the Question** and the **Transparency: Data Collection**. Remind the participants that they will use the spreadsheet and a graphing calculator to organize, represent, and analyze data.*

4. *Prompt participants to share responses with another participant.*

Facilitation Questions

- Have you made a prediction or formulated a testable hypothesis? What is your prediction or hypothesis?
  Answers may vary. A sample response: Feedback will impact one's ability to estimate times greater than 5 seconds.
- What process will lead to reliable data?
  Answers may vary. A sample response: One group member will be the one to push the start and stop buttons on the stopwatch for each data collection process. One group member will ensure that we are consistent in our steps as we gather data. A larger data sample will provide better results.
- What materials might help you answer this question?
  Answers may vary. A sample response: An accurate stopwatch, a spreadsheet to organize and represent data, a word-processing document to summarize findings and to justify the answer.
- How might you organize your data?
  Answers may vary. A sample response: A table with two columns: The data without feedback next to the column containing data with feedback.
- How might measures of central tendency answer this question?
  Answers may vary. The effect of feedback may be evaluated based on averages of each data sample.
- How might a bar graph answer this question?
  Answers may vary. For each attempt, one may compare the time with feedback and without feedback with side-by-side bars. One may look for trends in the bars according to order of attempts.

Facilitation Questions

- How might a scatterplot answer this question?
  Answers may vary. One may plot attempts (first, second, third, etc. attempts) without feedback against attempts (first, second, third, etc. attempts) with feedback. One may graph the lines showing $x = 1$ *and* $y = 1$ *to represent exact estimates of one second.*
- How might a circle graph be answer this question?
  Answers may vary. One may graph comparisons between the number of estimates that are less than the given time, equal to the given time, and greater than the given time. One may create two graphs: one to represent the data without feedback and one to represent the data with feedback.

5. *Prompt participants to open the* ***Making a Plan*** *document to record answers that describe the plan resulting from their collaborative conversations.*

Making a Plan Activity Page

1. How might you gather data?
   Answers may vary. A sample response: A participant will say "start" and then "stop" when estimating one second. Repeat this process 15 times. The participant will then repeat this process again; however, this time the data recorder will say "over one second," "exactly one second," or "less than one second." The participant will repeat this process again with the data recorder stating the measured elapsed time. Repeat these three steps for estimating five seconds and then ten seconds.

2. What statistical concepts might you address after collecting data related to estimating elapsed time?
   Answers may vary. If we gather more than one data point, we can determine measures of central tendency as well as the range of the data. We can examine our data in tabular and graphical form to determine trends in the data.

3. How might you use spreadsheet software to organize, represent, and analyze this data?
   Answers may vary. A sample response: Create a table to record the data as the estimates are measured by the stopwatch. Use these data to create bar graphs, circle graphs, and scatterplots. Use the range, median, and mean functions to calculate these values for the data set.

4. How might you use a graphing calculator to organize, represent, and analyze this data?
   Answers may vary: A sample response: Record the estimates measured by the stopwatch in lists. Use these data to create bar graphs, circle graphs, and scatterplots. Use the range, median, and mean functions to calculate these values for the data set.

5. How might you create a summary document that explains and justifies our answer to the question?
   Answers may vary. Sample responses: Enter text boxes onto the spreadsheet document where the data are stored to describe how the tables of data and graphical representations help to answer the question. Cut and paste the data and graphs into a word-processing document. Make screen shots of the graphing calculator screens and import these into a word-processing document.

6. After discussing your plan with another participant, use a word processor to open the **Making a Plan** document. Record your plan on this document. As you work, save this file.

Part 3: Carrying Out the Plan (40 min)

This part of the Elaborate phase is designed for paired and whole-group discussion. Listen to the participants' responses to assess the learning that is taking place as a result of the Explore/Explain phases.

1. *Distribute the **Carrying Out the Plan** activity page to each participant.*

2. *Prompt the participants to gather the data described on the **Transparency: Data Collection** according to the plan that they developed.*

Facilitation Questions

- What activity might we see as we collect this data?
  Answers may vary. One person is estimating the time. One person is operating the stopwatch. One person is entering the data into the graphing calculator.
- What might we hear as we collect this data?
  Answers may vary. We will hear people saying "Start." And "Stop." We will hear people announcing elapsed time.

3. *Prompt the participants to create summary document **Answering the Question** as described on the **Carrying Out the Plan** activity page. Techniques for importing information from the spreadsheet and the graphing calculator are included in the technology tutorial.*

Facilitation Questions

- How might knowing the mode of the data assist you in answering the question? Why?
  Answers may vary. If a mode is present, the participant may have prior experience that leads to a consistent estimate of elapsed time.
- How might knowing the median of the data assist you in answering the question? Why?
  Answers may vary. If the median of the data is greater for the data with feedback than for the data without feedback, one might make a statement about the upper half of the collected data being improved by feedback.
- How might knowing the mean of the data assist you in answering the question? Why?
  Answers may vary. If the mean of the data is greater for the data with feedback than for the data without feedback, one might make a statement that feedback improves one's ability to estimate time.
- How might knowing the range of the data assist you in answering the question? Why?
  Answers may vary.
- How might a line plot assist you in answering the question? Why?
  Answers may vary. The line plot provides a sketch of the shape and the spread of the data. Comparing the line plots of data with and without feedback would let one evaluate the impact of feedback on the shape and the spread of data, provided that the participants used the same scales for both plots.
- How might a line graph assist you in answering the question? Why?
  Answers may vary. The line graph does not reveal much as the data are not continuous.
- How might a bar graph assist you in answering the question? Why?
  Answers may vary. One might graph each estimate separately by placing the first estimate without feedback next to the first estimate with feedback. This would allow one to explore if the "position" of the estimate impacts the estimate.
- How might a stem and leaf plot assist you in answering the question? Why?
  Answers may vary. The stem and leaf plot may be used to quickly organize the data.

Facilitation Questions

- How might a box and whisker plot assist you in answering the question? Why?
  Answers may vary. A box and whisker plot provides a pictorial representation of the spread of the data and the ranges of the data above and below the median.
- How might a circle graph assist you in answering the question? Why?
  Answers may vary. A circle graph might allow one to explore the relationships within the set of estimates. For example, graph three sections: times less than one second, times equal to one seconds, and times greater than one second.
- How might a scatterplot assist you in answering the question?
  Answers may vary.
- How does your graphical representation show the shape and the spread of the data?
  Answers may vary.
- What is the meaning of point (*x*, *y*) on your scatterplot?
  Answers may vary.
- How might drawing $x = 1$ and $y = 1$ on your scatterplot assist you in answering the question?
  Answers may vary. If one creates a scatterplot where the estimated times without feedback are represented by the x-axis and the estimated times with feedback are represented by the y-axis, one might gauge whether one is overestimating or underestimating following feedback based on how the data cluster about the lines.
- How might drawing $x = 5$ and $y = 5$ on your scatterplot assist you in answering the question?
  Answers may vary. If one creates a scatterplot where the estimated times without feedback are represented by the x-axis and the estimated times with feedback are represented by the y-axis, one might gauge whether one is overestimating or underestimating five seconds of elapsed time following feedback based on how the data cluster about the lines.
- How might drawing $x = 10$ and $y = 10$ on your scatterplot assist you in answering the question?
  Answers may vary. If one creates a scatterplot where the estimated times without feedback are represented by the x-axis and the estimated times with feedback are represented by the y-axis, one might gauge whether one is overestimating or underestimating five seconds of elapsed time following feedback based on how the data cluster about the lines.
- How might graphing all of your data in one chart assist you in answering the question?
  Answers may vary. It allows one to see all the data at one time to see if the effect of feedback is consistent for all the estimated times.

*Sample **Answering the Question** document:*

We are to address two questions:
Does feedback on estimating elapsed time help you become a better estimator of elapsed time?
How does technology assist you in answering this question?

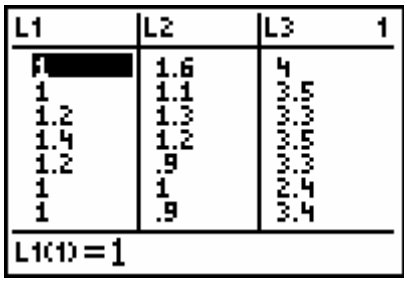
As times were recorded by the stopwatch, a group member entered the time into the spreadsheet. Another group member entered the data into lists on the graphing calculator. We chose to use both tools so as to compare their use in answering the questions.

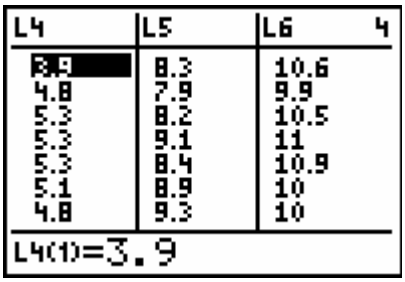
We organized our data in the spreadsheet as shown below.

1 second without	*1 second with*	*5 seconds without*	*5 seconds with*	*10 seconds without*	*10 seconds with*
1.0	*1.6*	*4.0*	*3.9*	*8.3*	*10.6*
1.0	*1.1*	*3.5*	*4.8*	*7.9*	*9.9*
1.2	*1.3*	*3.3*	*5.3*	*8.2*	*10.5*
1.4	*1.2*	*3.5*	*5.3*	*9.1*	*11.0*
1.2	*0.9*	*3.3*	*5.3*	*8.4*	*10.9*
1.0	*1.0*	*2.4*	*5.1*	*8.9*	*10.0*
1.0	*0.9*	*3.4*	*4.8*	*9.3*	*10.0*
0.9	*0.9*	*3.7*	*5.2*	*9.4*	*10.0*

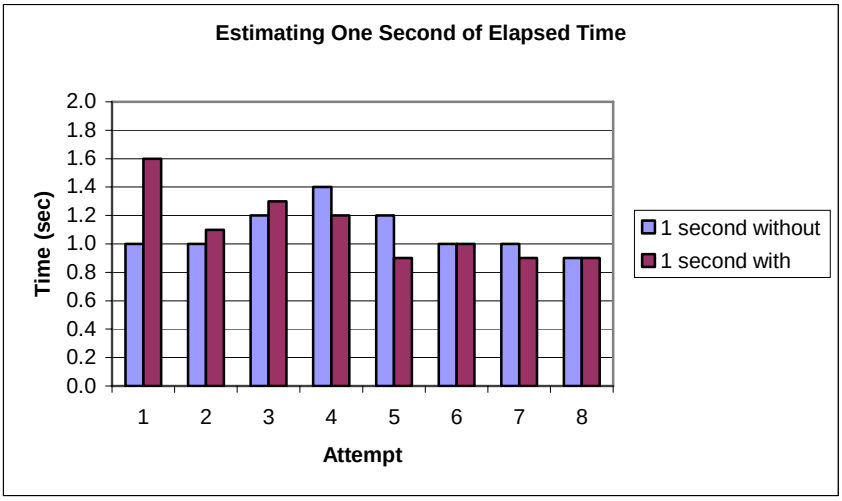
We organized our data in the graphing calculator as shown below.

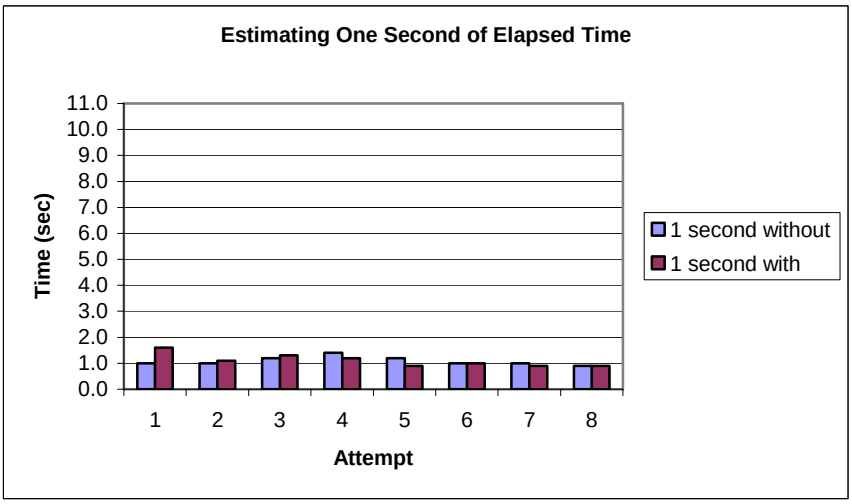
L_1 contains the estimations for 1 second without feedback.
L_2 contains the estimations for 1 second with feedback.
L_3 contains the estimations for 5 seconds without feedback.
L_4 contains the estimations for 5 seconds with feedback.
L_5 contains the estimations for 10 seconds without feedback.
L_6 contains the estimations for 10 seconds with feedback.

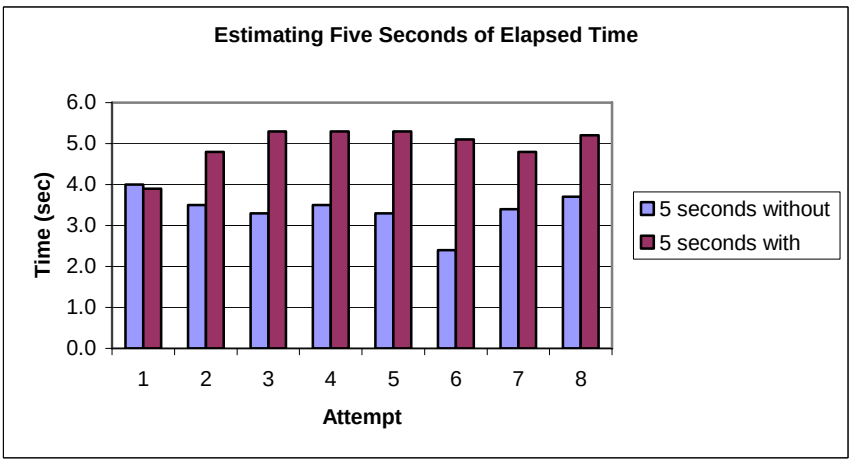


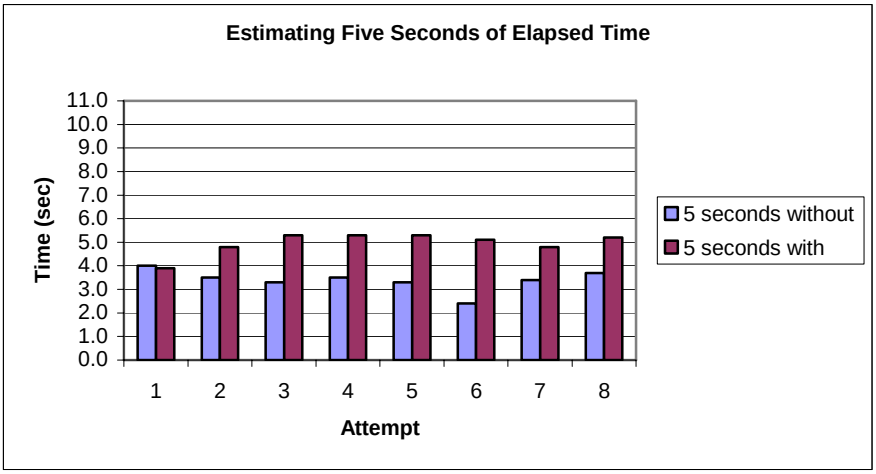


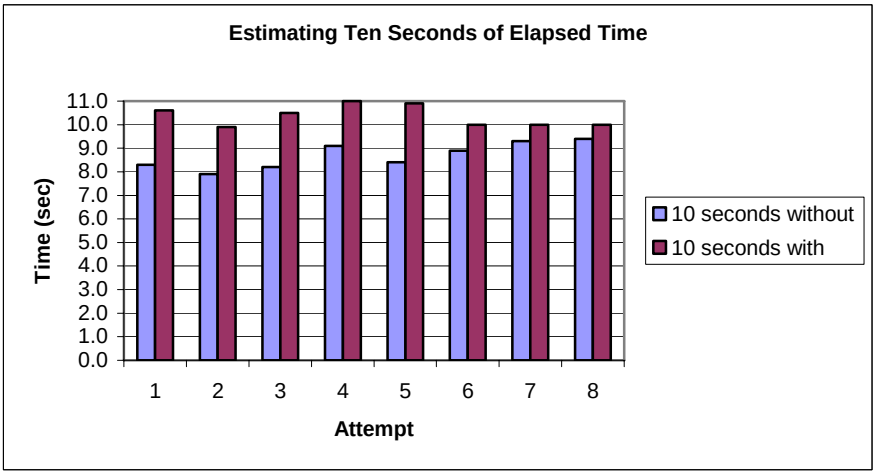
We created several representations using the spreadsheet.
We created bar graphs to compare estimates in the order in which we made the estimates. For example, the first estimate of time without feedback is next to the first estimate of time with feedback. We graphed the data twice: using a scale that is "friendly" to the data being recorded and using 10 seconds so that we can visually compare the data with the other two trials.


Estimating One Second of Elapsed Time
Time (sec)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8
Attempt
1 second without
1 second with

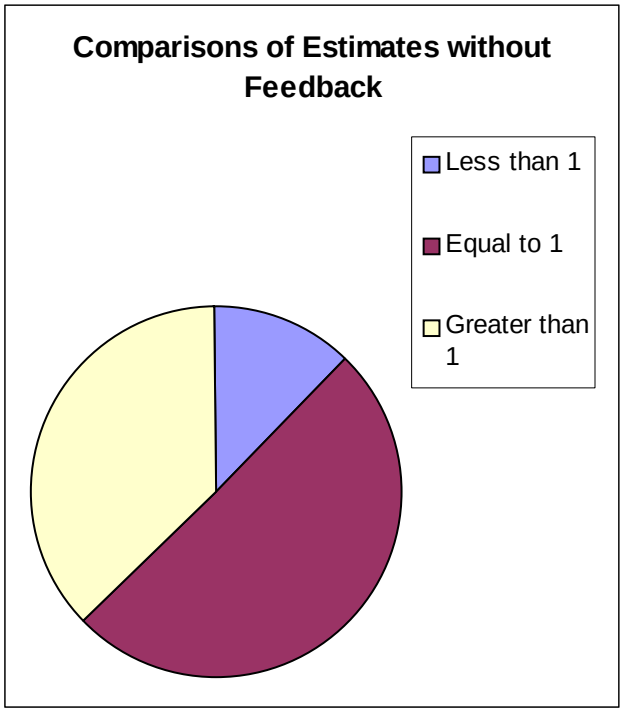

Estimating One Second of Elapsed Time
Time (sec)
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1 2 3 4 5 6 7 8
Attempt
1 second without
1 second with

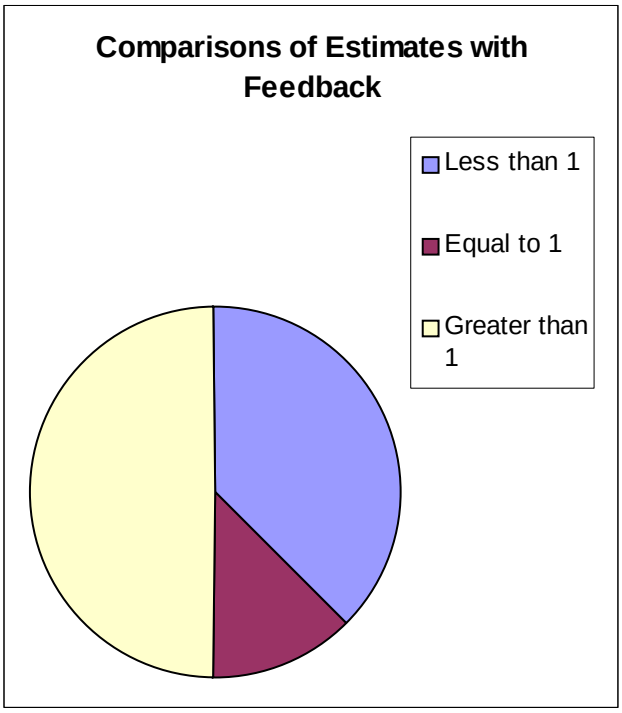

Estimating Five Seconds of Elapsed Time
Time (sec)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1 2 3 4 5 6 7 8
Attempt
5 seconds without
5 seconds with

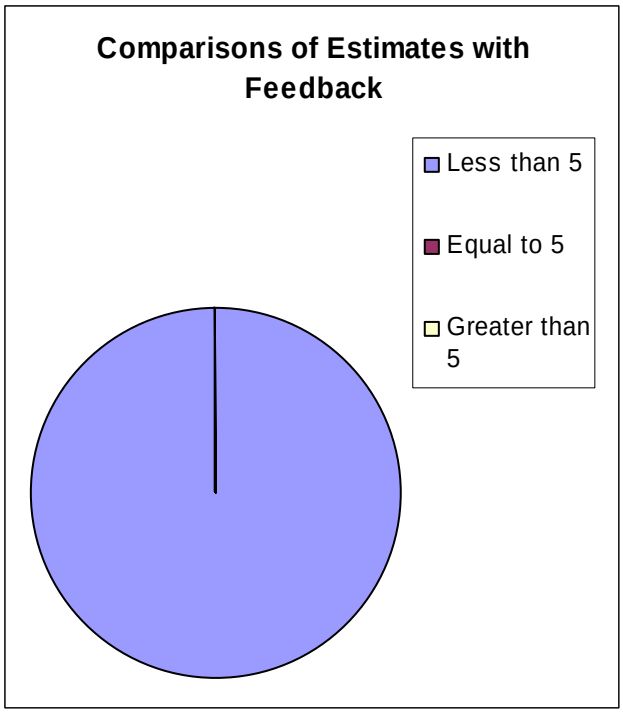


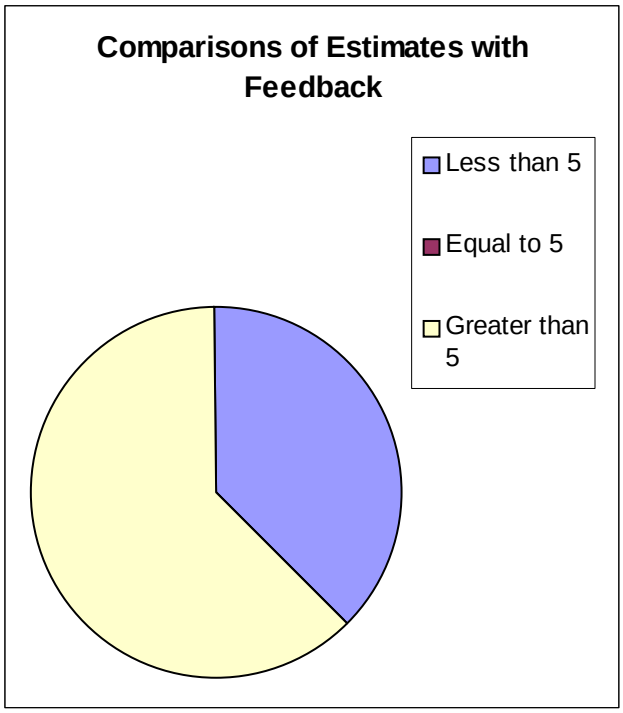


We created circle graphs to make comparisons between those estimated times that were less than, equal to, or greater than one second.



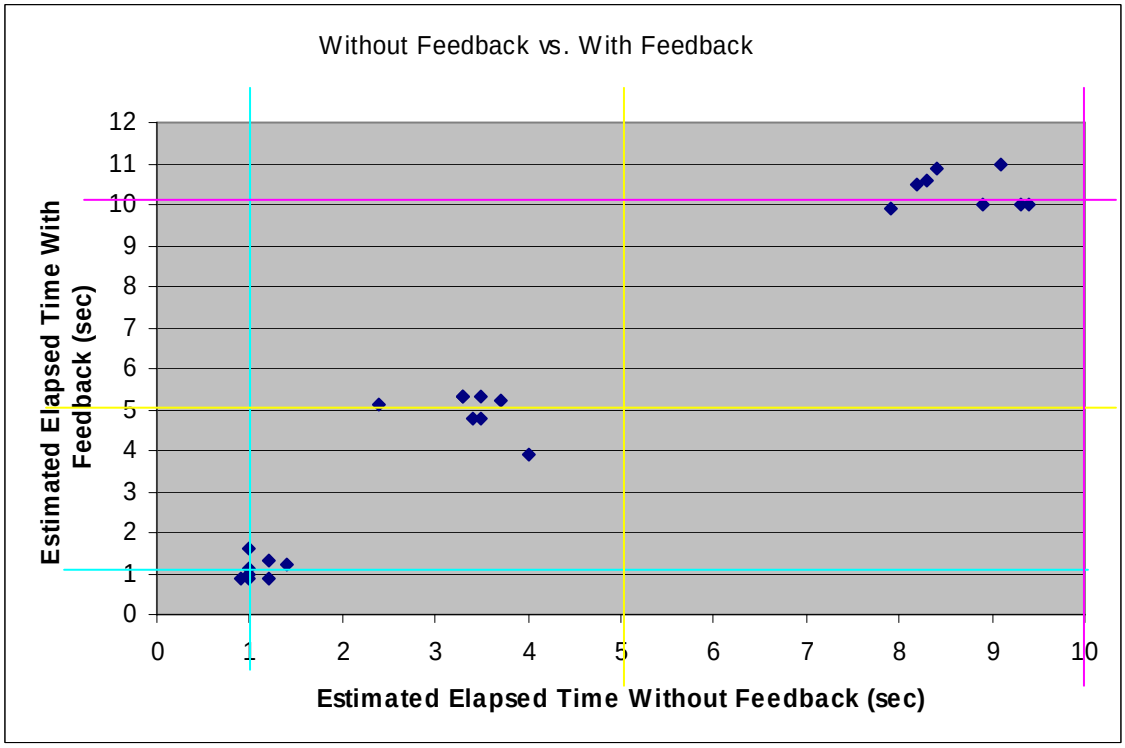




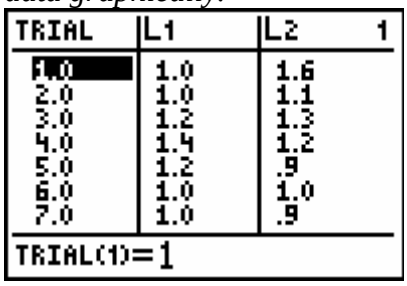


At this point, we decided not to continue with the circle graphs. It was interesting to see how the frequencies within ranges changed, but we did not feel we were gaining representations relevant to answering the questions.

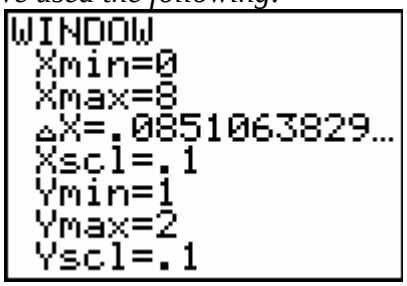
We created a scatterplot including all three sets of data. We used the draw function to draw lines to represent estimates equal to the goal time.



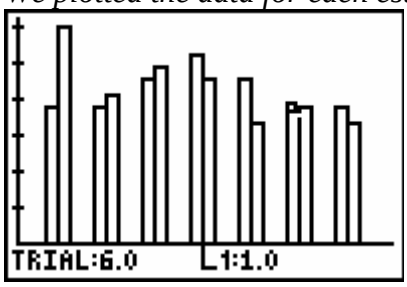
We did all of our representations on the spreadsheet first because they were easily visible to the entire group. Based on this experience, we decided to create bar graphs and scatterplots using the graphing calculator to compare the use of the technologies.
To do this, we had to insert a category list before L1 as shown below as the bar graph plotter requires a list that contains the categories of the data. We also learned that we can only enter up to seven data points in this plotter, so we had to delete our eighth data point to represent the data graphically.

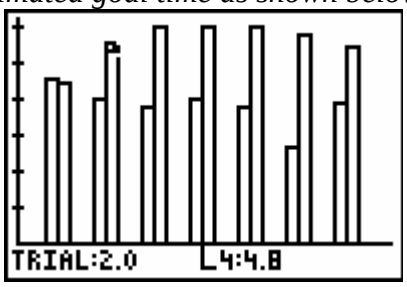


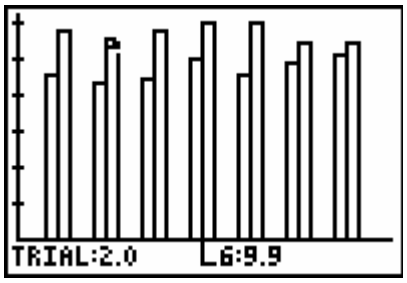
To set up the bar graph plotter, we used the following:



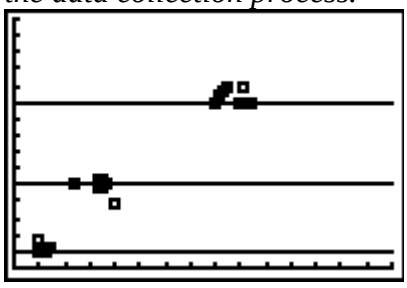
We plotted the data for each estimated goal time as shown below.







We plotted the data of attempts without feedback against with feedback in order of occurrence in the data collection process.



To analyze the data, we determined the mean, the median, and the range of each set of data using the spreadsheet and the graphing calculator. Effective feedback resulted in a smaller range of data. Effective feedback resulted in a mean value and a median value closer to the goal time.

One second:

	Without Feedback (sec)	With Feedback (sec)
Range	0.5	0.7
Median	1.0	1.1
Mean	1.1	1.1

Five seconds:

	Without Feedback (sec)	With Feedback (sec)
Range	1.6	1.4
Median	3.5	5.2
Mean	3.4	5.0

Ten seconds:

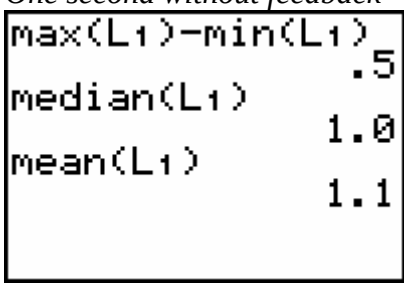
	Without Feedback (sec)	With Feedback (sec)
Range	1.5	1.1
Median	8.7	10.3
Mean	8.7	10.4

We cut and pasted the view with formulas to show we used the spreadsheet:

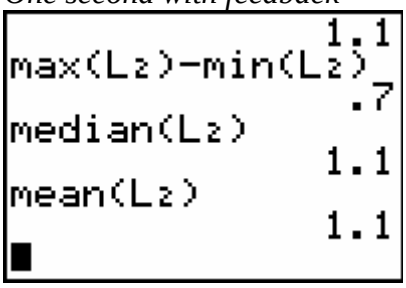
	Without Feedback (sec)	With Feedback (sec)
Range	=MAX(D25:D32)-MINA(D25:D32)	=MAX(E25:E32)-MINA(E25:E32)
Median	=MEDIAN(D25:D32)	=MEDIAN(E25:E32)
Mean	=AVERAGE(D25:D32)	=AVERAGE(E25:E32)

With the graphing calculator:

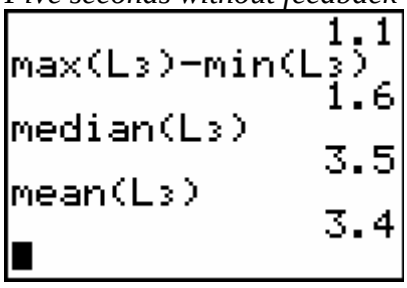
One second without feedback



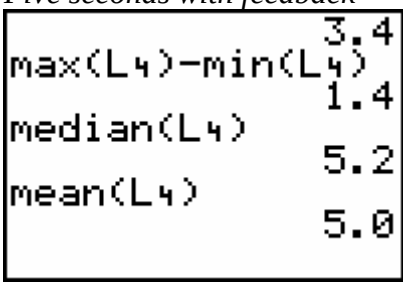
One second with feedback



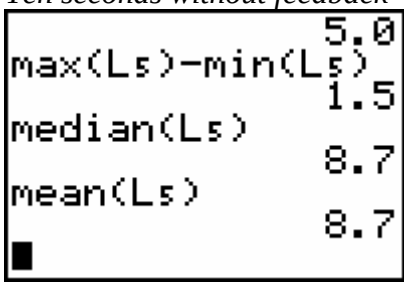
Five seconds without feedback



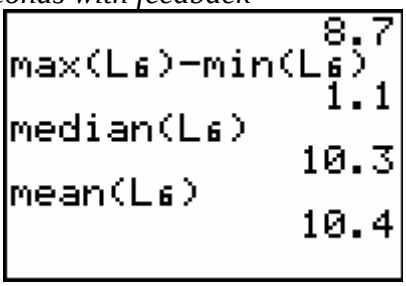
Five seconds with feedback



Ten seconds without feedback



Ten seconds with feedback



We believe that feedback on estimating elapsed time helps you become a better estimator of elapsed time when estimating times greater than 1 second. The data for 1 second appear similar because they are, with one exception, no more than 0.4 second from 1 second. The data with feedback for 5 seconds and 10 seconds appear to represent more accurate estimates than the data without feedback.

How does technology assist you in answering this question?
One may import the data directly into the spreadsheet. One can write formulas that may be "cut and pasted" to increase efficiency. One may generate scatterplots quickly and efficiently. One can edit an imported chart from a spreadsheet without leaving the word-processing document. The graphing calculator allowed us to do the same activities with the greater efficiency than using paper-and-pencil methods. We had to "fiddle" with the graphing calculator to make it graph the data as we wanted. We like the spreadsheet for graphing because it does not limit the number of data points that we could graph in a bar graph, and it offers the option to provide titles and axes labels. If we didn't have access to a lab, we would like the graphing calculator. Students could sketch or record their screenshots by hand. The recording would be more tedious, but the calculator would support efficiency in graphing and calculation.

Part 4: Evaluating the Answer and the Plan (30 min)

This part of the Elaborate phase is designed for paired and whole-group discussion. Listen to the participants' responses to assess the learning that is taking place as a result of the Explore/Explain phases.

1. *Distribute the **Evaluating the Answer and the Plan** activity page to each participant.*

2. *Prompt the participants to reflect upon and respond to the questions posed on the **Evaluating the Answer and the Plan** activity page.*

Facilitation Questions

- What might you have done differently? Why?
  Answers may vary. A sample response: We might have gathered more data in order to draw a more reliable conclusion.
- What other means might you have used to answer the question?
  Answers may vary. A sample response: We might have used handheld stopwatches and recorded our data on paper, looking for numerical patterns. We could have used the graphing tools to represent the data to see how it compared to our numerical observations.
- What other ways might you have analyzed the data?
  Answers may vary. A sample response: We might have determined "how far" from the goal time each estimate was and analyzed that data.

Evaluating the Answer and the Plan Activity Page

1. Is your answer reasonable? Why?
   Answers may vary. A sample response: Our answer would have been more reliable had we gathered more data or collected the data of other groups.

2. Did you alter your plan while carrying it out? Why?
   Answers may vary. A sample response: Yes, we decided not to continue our exploration of the data using circle graphs because the distribution of the data did not tell us what we hoped to learn.

3. What other representations might you have used to communicate your solution to the question?
   Answers may vary. A sample response: We might have used a table that summarized all of our data instead of using separate tables for each data collection.

4. If you did this again, which technology tool(s) would you select to carry out your plan? Why?
   Answers may vary. A sample response: We would use the on-line stopwatch and the spreadsheet. The spreadsheet allowed us to label our graphs.

5. Summarize your responses to these questions in your **Answering the Question** document.
   Answers may vary. A sample response: Our answer would have been more reliable had we gathered more data or collected the data of other groups. We decided not to continue our exploration of the data using circle graphs because the distribution of the data did not tell us what we hoped to learn. We might have used a table that summarized all of our data instead of using separate tables for each data collection. We would use the on-line stopwatch and the spreadsheet. The spreadsheet allowed us to label our graphs.

3. If jump drives are available, prompt participants to save their word processing document to the jump drive. Prompt participants to disconnect the jump drive using the "Safely Remove Hardware" tool on the bottom menu bar and move the jump drive to the presenter computer. Display the documents for comparison purposes.

Facilitation Questions

- How do the summary documents compare?
  Answers may vary. Each participant copied and pasted a chart from the spreadsheet document to the word processing document. Each participant used the average function on the spreadsheet.
- What mathematical understandings does the document communicate?
  Answers may vary. Each participant explained the meaning of the mean of the data.
- What skills with the spreadsheet and the word processor do you need to create the document?
  Answers may vary. Each participant demonstrated how to change the format of data in a cell and how to use these data to generate summary data such as the mean.
- What skills with the graphing calculator do you need to create the document?
  Answers may vary. One needed to be familiar with the mathematical functions available to describe the data found in the lists.

Part 5: Extending the Question (10 min)

This part of the Elaborate phase is designed for paired and whole-group discussion. Listen to the participants' responses to assess the learning that is taking place as a result of the Explore/Explain phases.

1. *If time allows, complete the part of the Elaborate activity. If you are running short on time, continue on to* ***Part 6: Technology Reflection****.*

2. *Distribute the* ***Extending the Question*** *activity page to each participant.*

3. *Prompt the participants to reflect upon and respond to the questions posed on the* ***Extending the Question*** *activity page.*

4. *Prompt participants to share their responses in a whole group setting.*

Facilitation Questions

- Who responded similarly?
  Answers may vary.
- What about the question prompts similar responses?
  Answers may vary.
- Who responded differently?
  Answers may vary.
- What about the question prompts different responses?
  Answers may vary.

Extending the Question

1. Based on the data that you have collected, organized, represented, and analyzed, answer the questions:
   a. What do you predict the average time for estimating one minute of elapsed time without feedback will be?
   b. What do you predict the average time for estimating one minute of elapsed time with feedback will be?
   c. How might you test your predictions?
   Answers may vary.

2. How might you connect this question to everyday experiences, investigations in other disciplines, and activities in and outside of school?
   Answers may vary.

3. How might answering this question provide opportunities for communication through informal and formal mathematical language, representations, and models?
   Answers may vary. As we work together, we will use informal language. As we begin to use the spreadsheet, we will need to use the formal terminology to enter formulas where needed.

4. How might answering this question provide opportunities for you to use logical reasoning to make conjectures and verify conclusions?
   Answers may vary. As we gather initial data, we may notice trends that result from their data collection and that their approach impacts those trends. We may adjust our approach by reasoning through the impact of the possible changes.

5. Summarize your responses to these questions in your **Answering the Question** document.
   Answers may vary. As we work together, we will use informal language. As we begin to use the spreadsheet, we will need to use the formal terminology to enter formulas where needed. As we gather initial data, we may notice trends that result from our approach to data collection impacts the trends that result from the data collection. We may adjust our approach by reasoning through the impact of the possible changes.

Part 6: Technology Reflection (30 min)

1. *Upon completing the use of these two technology tools, prompt participants to work in pairs to brainstorm the role(s) technology played in the process of gathering, representing, and analyzing data. How does this compare to using paper-and-pencil only for this activity?*

2. *Repost the Venn diagram summaries from the Engage phase.*

3. *Prompt participants to collect the "green sheets" from each Explore/Explain phase, the summaries about the intentional use of data that followed each Explore/Explain phase.*

4. *Display the **Transparency: Teaching Strategies** and prompt participants to reflect on the following question, "How do the summaries on the Venn diagrams, our summaries about the use of data, and the activities reflect the following four teaching strategies for developing judicious users of technology?"*

Facilitation Questions

- How have the experiences in this professional development promoted careful decision-making about the appropriate use of technology?
  Answers may vary.
  E/E 1: When the participants generated data that would cause specified changes in the box-and-whisker plot.
  E/E 2: When selecting a graphical representation.
  E/E 3: When the participants compared and contrasted the use of technology-free and technology-based probability simulations.
  Elaborate: The graphing calculator was limited in its ability to graph data using a bar graph, so the participants chose to rely more on the spreadsheets graphing functions.
- How was technology integrated into the teaching and the learning of the TEKS?
  Answers may vary.
  E/E 1: The web tools for stem and leaf plots were used to help students generate the processes for creating stem and leaf plots.
  E/E 2: The technology allowed participants to organize, represent, and describe data.
  E/E 3: The participants explored theoretical and experimental probability using a probability application on the graphing calculator.
  Elaborate: Using technology, the participants determined two measures of central tendencies so that conjectures about the effect of feedback could be verified.

Facilitation Questions

- When was technology use promoted? Why?
  Answers may vary.
  E/E 1: When representing the data so that representations would be accurate
  E/E 2: When testing conjectures about data sets that would produce certain distributions.
  E/E 3: When the participants were asked to compare and contrast the use of technology-free and technology-based probability simulations to promote critical thinking about tools.
  Elaborate: The rubric encouraged the use of word-processors, spreadsheets and graphing calculators during the entire process of answering the question so that technology would be perceived as an integral tool for the activity.
- When was technology use restricted? Why?
  Answers may vary.
  E/E 1: When generating physical models of the distribution of the data so that participants would focus on the conceptual modeling
  E/E 2: When working "by hand" to provide a comparison to "with technology"
  E/E 3: When the participants were asked to compare and contrast the use of technology-free and technology-based probability simulations to promote critical thinking about tools.
  Elaborate: When the participants were seeking to understand the question so that they would focus on the question rather than on how to answer the question.
- How did the technology support anticipatory, or "what if…", thinking about "statistical insight"?
  Answers may vary.
  E/E 1: When the participants made conjectures about data that would cause specified changes in the box-and-whisker plot and tested their conjectures.
  E/E 2: When the participants made conjectures about potential data sets and tested their conjectures.
  E/E 3: The participants were able to generate more trials using technology to address conjectures about experimental probability.
  Elaborate: Participants made conjectures about which statistical measures to use. The technology allowed them to quickly determine these measures for evaluative purposes.

5. *Prompt the participants to respond to the following statement and question: "A successful teacher is one who uses technology judiciously. What does this ideal teacher look like and sound like?" as described on* ***Transparency 1: Looks Like – Sounds Like****. Have the participants record their responses on sentence strips. Post the sentence strips randomly so that they are visible to the entire group. Use participants as scribes as needed to facilitate the recording process.*

6. *Prompt the participants to respond to the following statement and question: "A successful student is one who uses technology judiciously. What does this ideal student look like and sound like?" as described on* ***Transparency 2: Looks Like – Sounds Like****. Have the participants record their responses on sentence strips. Post the sentence strips randomly so that they are visible to the entire group. Use participants as scribes as needed to facilitate the recording process.*

7. *Direct the participants to work in small groups to brainstorm categories for classifying the "looks like" and "sounds like" responses.*

Facilitation Questions

- Do any of these responses require the teacher or the student to make decisions about technology use? Is this important? Should we add some responses?
  Answers may vary.
- Do any of these responses reflect decision making about how best to integrate technology? Is this important? Should we add some responses?
  Answers may vary.
- Do any of these responses reflect decision making about when to use or when not to use technology? Is this important? Should we add some responses?
  Answers may vary.
- Do any of these responses reflect the need for thinking about how the technology provides "statistical insight"? Is this important? Should we add some responses?
  Answers may vary.

8. *As a whole group, debrief the categories created within the small group discussions. Reorganize the sentence strips into broad categories. As a whole group, create titles for each of these categories. Record each title on a separate sheet of chart paper. Post the chart paper and reorganize the related sentence strips as shown below. Enlist participants to help with this process.*

Sample Category: Student Choice
The teacher allows students to select the computer or the graphing calculator and refrains from commenting while students decide.
The student chooses to use a scatterplot instead of a table to represent her data.

9. *Prompt the participants to consider adding additional statements to any of the categories listed above that are not already posted. Reorganize "looks like, sounds like" sentence strips as needed.*

10. *Distribute sentence strips to each group that are a different color than the previously used sentence strips. Prompt each group to generate two classroom suggestions for each category. Examples may include "The teacher should ask, 'Should we use the spreadsheet to make our prediction or verify our prediction? Why?'", "Students monitor their own use and misuse of technology.", "Include examples that require technology use.", "Do not allow students to use technology until after predictions are made and justified", etc.*

11. *Prompt participants to post their sentence strips as shown below.*

Sample Category: Student Choice
The teacher allows students to select the computer or the graphing calculator and refrains from commenting while students decide.
The teacher posts a transparency that says, "Which tool will you use? Go there!"
The teacher provides students with a "pros and cons" chart to develop for the computer and the graphing calculator and then directs students to select a tool.

12. *Ask the participants to summarize any trends or patterns observed in the classroom suggestions.*

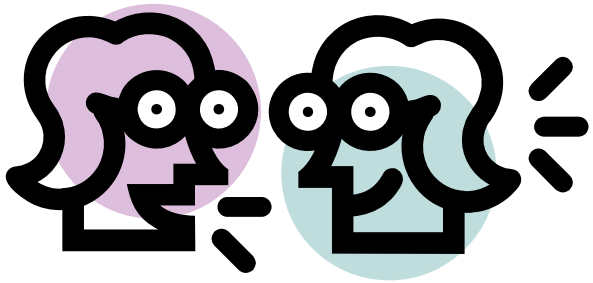
13. *Read the statement by Ball and Stacey found on* ***Transparency: Student Research*** *as a closing thought to this phase of the professional development. Pose the facilitation question to the whole group.*

Facilitation Question

- What is the value of this statement?
  Answers may vary. It is encouraging to read that technology use is teachable. It makes me consider how I might better meet the needs of the student who doesn't struggle with the math yet struggles with the technology.

Transparency: How's Your Timing?

When estimating elapsed time, does feedback help you become a better estimator?



How does technology assist you in answering this question?

Transparency: Data Collection

Collect data about your estimation skills for **one second** of elapsed time without feedback.

Collect data about your estimation skills for **one second** of elapsed time with feedback.

Collect data about your estimation skills for **five seconds** of elapsed time without feedback.

Collect data about your estimation skills for **five seconds** of elapsed time with feedback.

Collect data about your estimation skills for **ten seconds** of elapsed time without feedback.

Collect data about your estimation skills for **ten seconds** of elapsed time with feedback.

Transparency: Teaching Strategies

How do the summaries on the Venn diagrams, our summaries about the use of data, and the activities reflect the following four teaching strategies for developing judicious users of technology?

Judicious users of technology:

a. Promote careful decision-making about the appropriate use of technology.

b. Integrate technology whenever relevant to the mathematical learning goals.

c. Promote and restrict the use of technology when appropriate for promoting mathematical learning

d. Promote anticipatory thinking about "statistical insight."

Transparency 1: Looks Like – Sounds Like

A successful teacher is one who uses technology judiciously.

What does this ideal teacher look like and sound like?

Looks like…	Sounds like…

Transparency 2: Looks Like – Sounds Like

A successful student is one who uses technology judiciously.

What does this ideal student look like and sound like?

Looks like…	Sounds like…

Transparency: Research

Research by Pierce (2002) indicates that some students are always judicious users and others persist with passive or random, unthinking use. However, she found that a large, middle group can be helped to learn to work judiciously.

Ball & Stacey, 2005, p. 5

Ball, L., & Stacey, K. (2005). Teaching strategies for developing judicious technology use. In Masalski, W. J., & Elliott, P. C. (Eds.), *Technology-supported mathematics learning environments, sixty-seventh yearbook*, pp. 3-16. Reston, VA: National Council of Teachers of Mathematics.

Understanding the Question

1. Have you answered a question or conducted an investigation similar to this one before? If yes, what was the problem or investigation? How did you answer the question?

2. How might you restate the question?

3. What is the unknown you are investigating?

4. What data might you gather to answer the question: When estimating elapsed time, does feedback help you become a better estimator? Why might this data be appropriate?

5. What data collection tools are available to help answer this question?

Making a Plan

1. How might you gather data?

2. What statistical concepts might you address after collecting data related to estimating elapsed time?

3. How might you use spreadsheet software to organize, represent, and analyze this data?

4. How might you use a graphing calculator to organize, represent, and analyze this data?

5. How might you create a summary document that explains and justifies our answer to the question?

6. After discussing your plan with another participant, use a word processor to open the **Making a Plan** document. Record your plan on this document. As you work, save this file.

Carrying Out the Plan and Answering the Question

1. Open a new spreadsheet document. Use this document to organize, represent, and analyze the data resulting from your plan. Save this document as **Gathering the Data**.

2. Open a new word-processing document. Use this document to hold imported screen shots from the graphing calculator. Save this file as **Gathering the Data with a Graphing Calculator**.

3. Open another new word-processing document. Use this document to summarize and explain your answer to the questions: *Does feedback on estimating elapsed time help you become a better estimator of elapsed time?* and *How does technology assist you in answering this question?* Save this file as **Answering the Question**.

4. How did you organize your data? Record your organized data in the **Answering the Question** document. Include text explanations of why you organized your data as you did. Use this word-processing document to record how you carried out your plan to answer the question: When estimating elapsed time, does feedback help you become a better estimator?

5. What representations of your data did you create? Record your representations in the **Answering the Question** document. Include text explanations of why you represented your data as you did.

6. What tools did you use to represent the data? Include text explanations of why you selected that tools that you used to represent the data.

7. What analyses of your data did you perform? Record your analyses in the **Answering the Question** document. Include text explanations of how you decided to analyze your data, including justification for the appropriateness of your analysis.

8. Record your answer to the following questions, using imported graphics from spreadsheet software and graphing calculators as needed, to justify your solution.
   Does feedback on estimating elapsed time help you become a better estimator of elapsed time? and *How does technology assist you in answering this question?*

Evaluating the Answer and the Plan

1. Is your answer reasonable? Why?

2. Did you alter your plan while carrying it out? Why?

3. What other representations might you have used to communicate your solution to the question?

4. If you did this again, which technology tool(s) would you select to carry out your plan? Why?

5. Summarize your responses to these questions in your **Answering the Question** document.

Extending the Question

1. Based on the data that you have collected, organized, represented, and analyzed, answer the questions:
    a. What do you predict the average time for estimating one minute of elapsed time without feedback will be?
    b. What do you predict the average time for estimating one minute of elapsed time with feedback will be?
    c. How might you test your predictions?

2. How might you connect this question to everyday experiences, investigations in other disciplines, and activities in and outside of school?

3. How might answering this question provide opportunities for communication through informal and formal mathematical language, representations, and models?

4. How might answering this question provide opportunities for you to use logical reasoning to make conjectures and verify conclusions?

5. Summarize your responses to these questions in your **Answering the Question** document.

Rubric for Answering the Question		Proficient	Developing	Emerging
Making a Plan	Content	Fully addresses the statistical concepts and representations to be found in the data.	Partially addresses the statistical concepts and representations to be found in the data.	Barely addresses the statistical concepts and representations found in the data.
	Technology	Includes strategies to address the spreadsheet and the graphing calculator.	Includes strategies to address the spreadsheet or the graphing calculator.	Includes one strategy to address the spreadsheet or the graphing calculator.
Carrying out the Plan - Spreadsheet	Organize Data	The data are organized and labeled.	The data are organized.	The data are not organized.
	Represent Data	The data are represented in multiple ways and labeled appropriately.	The data are represented in one way and labeled appropriately.	The data are not represented appropriately.
	Analyze Data	The data are analyzed.	The data are partially analyzed.	The data are analyzed inappropriately.
Carrying out the Plan – Graphing Calculator	Organize Data	The data are organized and labeled.	The data are organized.	The data are not organized.
	Represent Data	The data are represented in multiple ways and labeled appropriately.	The data are represented in one way and labeled appropriately.	The data are not represented appropriately.
	Analyze Data	The data are analyzed.	The data are partially analyzed.	The data are analyzed inappropriately.
Answering the Question		The answer to the question includes full justification of the answer.	The answer to the question includes partial justification of the answer.	The answer to the question does not address the question.
Evaluating the Answer and the Plan	Reasonableness	The answer to the question includes full justification of the reasonableness of the answer.	The answer to the question includes partial justification of the reasonableness of the answer.	The answer to the question does not address reasonableness.

Rubric for Answering the Question		Proficient	Developing	Emerging
	Reflection	The summary addresses reflections about the mathematics and the technology used to answer the question.	The summary partially addresses reflections about the mathematics and the technology used to answer the question.	The summary lacks reflections about the mathematics and the technology used to answer the question.
Extending the Question	Mathematics	The prediction is reasonable and fully justified based on the data gathered to answer the original question.	The prediction is reasonable and partially justified based on the data gathered to answer the original question.	The prediction is unreasonable.
	Connections	Connections are made to everyday experiences, investigations in other disciplines, and activities in and outside of school.	Connections are made to everyday experiences, investigations in other disciplines, or activities in and outside of school.	Connections are made to everyday experiences.
	Communication	Informal and formal mathematical language is used to describe how the data has been organized, represented, and analyzed.	Informal mathematical language is used to describe how the data has been organized, represented, and analyzed.	Lacks descriptions of how the data has been organized, represented, and analyzed.
	Reasoning	The conjectures and conclusions are logical.	The conjectures and conclusions are partially logical.	Lacks conjectures and conclusions.