

USING MINITAB TO ENHANCE CRITICAL THINKING SKILLS

Cathleen M. Zucco
Department of Mathematics
Le Moyne College
Syracuse, New York 13214-1399
Email: ZUCCO@MAPLE.LEMOYNE.EDU

Too often in introductory college statistical courses, standard statistical software, such as Minitab, is just used on a superficial level to analyze data. A wonderful opportunity is lost to develop students' critical thinking skills. This paper will explore how, in an introductory college statistical course, these skills can be enhanced in the Minitab environment.

The essence to strengthening students' critical thinking skills is learning to ask students the proper questions. Two major types of questions should be examined when statistical analysis is conducted by using Minitab. First, good interpretive questions should be raised. Why is a particular statistical procedure used? What results should be expected? What do the results mean in the context of the real world setting of this problem? Second, explorative questions should be raised. These types of questions are many times overlooked in introductory statistical courses. They deal with the "what if possibilities".

Consider Minitab exercises that deal with descriptive statistics. To direct students to use Minitab merely to find graphs, measures of central tendencies, measures of dispersions and measures of location reduces descriptive statistics to a series of mechanical exercises. Instead, students should be asked to look for patterns in graphs and to observe any relationships between data sets and the summary statistics which describe these sets.

The Minitab data used in Figure 1 is a random sample of the heights in inches of thirty Statistics I students at Le Moyne College. The DESCRIBE feature of Minitab provides the basic descriptive statistics for this data set such as the mean, the median, and the standard deviation. A good exploratory exercise could be developed, if the data set was altered by replacing the largest height of 74 inches by 84 inches, as indicated in Figure 1. Students then could be asked what effect this alteration had on such basic descriptive statistics as the mean and median of this data set and to explain why these measures changed or did not change. Furthermore, this exploratory exercise could be extended. Students could be asked, in general, if the maximum or minimum values of a data set are altered, what changes occur or do not occur to the basic descriptive statistics of a data set and why these changes occur.

Figure 1 : Minitab Descriptive Statistics of Heights

```
MTB > Set C1
DATA > 62 63 70 66 69 74 62 63 66 65 64 71 67 70 65
69
DATA > 71 69 68 68 65 67 67 68 69 64 62 64 62 68
```

```
MTB > name C1 'height'
MTB > describe C1
```

	N	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN
height	30	66.600	67.000	66.500	3.147	0.575
	MIN	MAX	Q1	Q3		
height	62.000	74.000	64.000	69.000		

```
MTB > let C1(6)=84
MTB > describe C1
```

	N	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN
height	30	66.933	67.000	66.500	4.283	0.782
	MIN	MAX	Q1	Q3		
height	62.000	84.000	64.000	69.000		

When teaching hypothesis testing it is necessary to first require that students justify why a certain test procedure can be used. Hence assumptions need to be verified and critical questions answered before any procedure is applied. Minitab can facilitate this process. Various simple graphing techniques can be used to confirm that normality assumptions and common variances assumptions are satisfied. The data found in Figure 2 is a random sample of the weights of 14 students in Statistics I at Le Moyne College. Their weights were recorded in pounds. Most statistics students would know that to determine whether the mean weight of students in Statistics I exceeds 140 pounds a t-test procedure should be used. However, it is more important that students know the answer to the question why it should be used. Students can use Minitab to assure that the sample is from a Normal distribution. Minitab has an NSCORE feature which finds the standard normal values of a column of data values. The normal probability plot that will be obtained for this example is seen also in Figure 2.

Figure 2 : Minitab T-test Analysis of Weights

```
MTB > SET C1
DATA > 115 130 150 125 150 155 100 110 127
DATA > 126 116 170 134 145
DATA > END
MTB > name c1 'weights'
MTB > nscores of c1 put in c2
MTB > plot c2 c1
```

```

;; HMF V1.23 TEXT
;; (Windows DOS Intel 386 3.1) HOOPS 3.30-33
(Color_By_Value "Line,Marker,Text,Edge" "RGB" 0 0 0)
(Color_By_Value "Window" "RGB" 1 1 1)
(Color_By_Value "Face" "RGB" 0 0 0)
(Window_Frame "off")

; ;      ( D r i v e r _ O p t i o n s      " d e b u g = 1 6 , d i s a b l e
input,subscreen=(-0.999844,-0.0904674,-0.9
;; 99792,-0.0872897),subscreen stretching,no update interrupts,use
window id=84
;; 68")
(Heuristics "no hidden surfaces")
(User_Options "mtb aspect ratio=0.691781")
(Front ((Segment "seg 3" (
  (Visibility "on")
  (Front ((Segment "geom 2" (
    (Streaming_Mode "on")
    (Visibility "faces=off")
    (Color_By_Value "Face" "RGB" 1 1 1)
    (Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
    (Window_Frame "off")
    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
    (Edge_Pattern "----")
    (Edge_Weight 1)
    (Line_Pattern "----")
    (Line_Weight 1)
    (Polygon ((0 0 0) (1 0 0) (1 1 0) (0 1 0) (0 0 0))))))
  (Segment "text 2" (
    (Streaming_Mode "on")
    (Window_Frame "off")
    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
    (Text_Font "transforms=character position only,rotation=follow
path"))))
  )))
(Segment "seg 4" (
  (Visibility "on")
  (Front ((Segment "geom 2" (
    (Streaming_Mode "on")
    (Visibility "polygons=off,lines=off")
    (Color_By_Value "Face" "RGB" 1 1 1)
    (Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
    (Window_Frame "off")
    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
    (Edge_Pattern "----")
    (Edge_Weight 1)
    (Line_Pattern "----")
    (Line_Weight 1)

```

```

(Polygon ((0.025 0.01 0) (0.725 0.01 0) (0.725 0.12 0) (0.025
0.12 0) (
    0.025 0.01 0))))))
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(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
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(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))
(Segment "text 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
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(Window_Pattern "clear")
(Window -0.93 0.43 -0.96 -0.78)
(Camera (0.375 0.065 -1.7) (0.375 0.065 0) (0 1 0) 0.68 0.09
"Stretched
"))))
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(Window_Frame "off")
(Window_Pattern "clear")
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(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
(Segment "geom 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))))

```

```

    (Segment "text 2" (
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      (Color_By_Value "Text" "RGB" 0 0 0)
      (Window_Frame "off")
      (Window_Pattern "clear")
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      (Text_Font "name=arial-gdi-vector,size=0.02807
sru,transforms=character
position only,rotation=follow path")
      (Text_Spacing 1)
      (Text 0.539681 -0.929906 0 "p-value: 0.822")
      (Text 0.539681 -0.845 0 "A-Squared: 0.211")
      (Text 0.348575 -0.760094 0 "Anderson-Darling Normality Test")
      (Text -1.28948 -0.929906 0 "N of data: 14")
      (Text -1.28948 -0.845 0 "Std Dev: 19.5315")
      (Text -1.28948 -0.760094 0 "Average: 132.357"))))))
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    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")))
    (Segment "text 2" (
      (Streaming_Mode "on")
      (Window_Frame "off")
      (Window_Pattern "clear")
      (Window -1 1 -1 1)
      (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
      (Text_Font "transforms=character position only,rotation=follow
path"))))
  )))
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    (Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
    (Window_Frame "off")
    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
    (Edge_Pattern "---")
    (Edge_Weight 1)
    (Line_Pattern "---")
    (Line_Weight 1)
    (Polygon ((0 0 0) (1 0 0) (1 1 0) (0 1 0) (0 0 0))))))
    (Segment "text 2" (
      (Streaming_Mode "on")
      (Window_Frame "off")

```

```

(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
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(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polygon ((0.2 0.25 0) (0.85 0.25 0) (0.85 0.85 0) (0.2 0.85 0)
(0.2
0.25 0))))))
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(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
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(Window_Pattern "clear")
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(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))
(Segment "text 2" (
(Streaming_Mode "on")
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))))
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(Streaming_Mode "on")

```

```

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(Line_Pattern "---")
(Line_Weight 1)
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(Polyline ((0.729796 0.25 0) (0.729796 0.24 0)))
(Polyline ((0.648163 0.25 0) (0.648163 0.24 0)))
(Polyline ((0.566531 0.25 0) (0.566531 0.24 0)))
(Polyline ((0.484898 0.25 0) (0.484898 0.24 0)))
(Polyline ((0.403265 0.25 0) (0.403265 0.24 0)))
(Polyline ((0.321633 0.25 0) (0.321633 0.24 0)))
(Polyline ((0.24 0.25 0) (0.24 0.24 0))))
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(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
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sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)
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(Text 0.66436 -0.55 0 "160")
(Text 0.428353 -0.55 0 "150")
(Text 0.192346 -0.55 0 "140")
(Text -0.0436613 -0.55 0 "130")
(Text -0.279669 -0.55 0 "120")
(Text -0.515676 -0.55 0 "110")
(Text -0.751683 -0.55 0 "100")))))))
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(Streaming_Mode "on")
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(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polyline ((0.2 0.78771 0) (0.19 0.78771 0)))
(Polyline ((0.2 0.72895 0) (0.19 0.72895 0)))
(Polyline ((0.2 0.676527 0) (0.19 0.676527 0)))
(Polyline ((0.2 0.61474 0) (0.19 0.61474 0)))

```

```

(Polyline ((0.2 0.55 0) (0.19 0.55 0)))
(Polyline ((0.2 0.48526 0) (0.19 0.48526 0)))
(Polyline ((0.2 0.423473 0) (0.19 0.423473 0)))
(Polyline ((0.2 0.37105 0) (0.19 0.37105 0)))
(Polyline ((0.2 0.31229 0) (0.19 0.31229 0))))
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  (Color_By_Value "Text" "RGB" 0 0 0)
  (Window_Frame "off")
  (Window_Pattern "clear")
  (Window -1 1 -1 1)
  (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
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sru,transforms=character
position only,rotation=follow path")
  (Text_Spacing 1)
  (Text -0.939604 0.575421 0 ".999")
  (Text -0.939604 0.4579 0 ".99")
  (Text -0.939604 0.353054 0 ".95")
  (Text -0.939604 0.22948 0 ".80")
  (Text -0.939604 0.1 0 ".50")
  (Text -0.939604 -0.0294802 0 ".20")
  (Text -0.939604 -0.153054 0 ".05")
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  (Text -0.939604 -0.37542 0 ".001"))))))))
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  (Polyline ((0.729796 0.25 0) (0.729796 0.85 0)))
  (Polyline ((0.648163 0.25 0) (0.648163 0.85 0)))
  (Polyline ((0.566531 0.25 0) (0.566531 0.85 0)))
  (Polyline ((0.484898 0.25 0) (0.484898 0.85 0)))
  (Polyline ((0.403265 0.25 0) (0.403265 0.85 0)))
  (Polyline ((0.321633 0.25 0) (0.321633 0.85 0)))
  (Polyline ((0.24 0.25 0) (0.24 0.85 0))))))
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  (Streaming_Mode "on")
  (Window_Frame "off")
  (Window_Pattern "clear")
  (Window -1 1 -1 1)
  (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")

```



```

(Text_Font "transforms=character position only,rotation=follow
path"))))
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(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "...")
(Edge_Weight 1)
(Line_Pattern "...")
(Line_Weight 1)
(Polyline ((0.2 0.78771 0) (0.85 0.78771 0)))
(Polyline ((0.2 0.72895 0) (0.85 0.72895 0)))
(Polyline ((0.2 0.676527 0) (0.85 0.676527 0)))
(Polyline ((0.2 0.61474 0) (0.85 0.61474 0)))
(Polyline ((0.2 0.55 0) (0.85 0.55 0)))
(Polyline ((0.2 0.48526 0) (0.85 0.48526 0)))
(Polyline ((0.2 0.423473 0) (0.85 0.423473 0)))
(Polyline ((0.2 0.37105 0) (0.85 0.37105 0)))
(Polyline ((0.2 0.31229 0) (0.85 0.31229 0))))))
(Segment "text 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
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))))
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(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
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(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
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(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)

```

```

(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "*>")
(Text_Font "name=arial-gdi-vector,size=0.03509
sru,transforms=character
position only,rotation=follow path")
(Text_Path -4.37114e-8 1 0)
(Text_Spacing 1)
(Text -1.16772 0.1 0 "Probability")

(Text_Path 1 0 0))))))
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(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polyline ((0.21 0.25 0) (0.84 0.25 0))))))
(Segment "text 2" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "^*")
(Text_Font "name=arial-gdi-vector,size=0.03509
sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)
(Text 0.0722773 -0.659891 0 "C1"))))))))
(Segment "seg 17" (
(Visibility "on")
(Front ((Segment "geom 4" (
(Streaming_Mode "on")
(Color_By_Value "Marker" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -0.58 0.68 -0.48 0.68)
(Camera (0.525 0.55 -1.575) (0.525 0.55 0) (0 1 0) 0.63 0.58
"Stretched
")
(Marker_Size 0.365625)
(Marker_Symbol "@")
(Marker 0.811429 0.681532 0)
(Marker 0.68898 0.642653 0)
(Marker 0.648163 0.609416 0)
(Marker 0.648163 0.609416 0)

```

```

(Marker 0.607347 0.584862 0)
(Marker 0.517551 0.57045 0)
(Marker 0.484898 0.556744 0)
(Marker 0.460408 0.543256 0)
(Marker 0.452245 0.52955 0)
(Marker 0.444082 0.515138 0)
(Marker 0.370612 0.499337 0)
(Marker 0.362449 0.480967 0)
(Marker 0.321633 0.457347 0)
(Marker 0.24 0.418468 0)))
(Segment "text 4" (
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(Window_Frame "off")
(Window_Pattern "clear")
(Window -0.58 0.68 -0.48 0.68)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
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(Front ((Segment "geom 2" (
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(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))))
(Segment "text 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
(Segment "seg 19" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 1 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polyline ((0.24 0.430008 0) (0.321633 0.467072 0) (0.362449
0.485605 0
) (0.370612 0.489311 0) (0.444082 0.522669 0) (0.452245
0.526376 0)

```

```

(0.460408 0.530082 0) (0.484898 0.541202 0) (0.517551 0.556027
0)
(0.607347 0.596799 0) (0.648163 0.615331 0) (0.648163
0.615331 0)
(0.68898 0.633863 0) (0.811429 0.68946 0))))))
(Segment "text 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
(Segment "seg 1" (
(Visibility "on")
(Front ((Segment "geom 1" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))))
(Segment "text 1" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "<")
(Text_Font "name=arial-gdi-vector,size=0.04211
sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)))))))))
(Segment "seg 2" (
(Visibility "on")
(Front ((Segment "geom 1" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))))
(Segment "text 1" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "^*")
(Text_Font "name=arial-gdi-vector,size=0.04211
sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)

```

(Text 0 0.98 0 "Normal Probability Plot"))))))))

Using Minitab to analyze ANOVA problems, presents a golden opportunity to analyze whether a particular experimental design is appropriate. If, for instance, the averages of three or more populations are being compared should a completely randomized design be used or should a randomized block design be used ?

In Central New York Hometown Markets, Wegmans, Price Chopper and P & C are the four major grocery store chains. Examine the following Minitab ANOVA analysis in Figure 3 of the prices in dollars from a typical week. If students are to be asked to determine whether the average prices are the same for the four grocery store chains then they should be directed to test first to see if the proper experimental design was used. Hence for this example, students, need to decide initially whether blocking according to store items was effective here ? If blocking was not effective then students should be encouraged to see if they can find a more appropriate design.

Figure 3 : Minitab ANOVA Analysis of Grocery Store Prices

```
MTB > read c1-c3
DATA> 1 1 2.39
DATA> 1 2 2.25
DATA> 1 3 1.8
DATA> 1 4 2.9
DATA> 2 1 2.95
DATA> 2 2 3.25
DATA> 2 3 3.1
DATA> 2 4 3.15
DATA> 3 1 1.49
DATA> 3 2 1.59
DATA> 3 3 1.69
DATA> 3 4 1.55
DATA> 4 1 .89
DATA> 4 2 .75
DATA> 4 3 .80
DATA> 4 4 .78
DATA> 5 1 1.69
DATA> 5 2 1.49
DATA> 5 3 1.59
DATA> 5 4 1.50
DATA> 6 1 1.99
DATA> 6 2 2.10
```

```

DATA> 6 3 2.00
DATA> 6 4 1.85
DATA> end
      24 rows read.
MTB > name c1 'item' c2 'store' c3 'price'
MTB > anova price = item store

```

Factor	Type	Levels	Values
item	fixed	6	1 2 3 4 5 6
store	fixed	4	1 2 3 4

Analysis of Variance for price

Source	DF	SS	MS	F	P
item	5	12.3142	2.4628	52.41	0.000
store	3	0.0476	0.0159	0.34	0.799
Error	15	0.7049	0.0470		
Total	23	13.0667			

Minitab computer output for linear regression problems provides students with opportunities to synthesize data and to explore "what if possibilities." In Figure 4 is the data obtained from a random sample of 25 students at Le Moyne College that completed Statistics I. They provided their final grade average in Statistics I as well as their Math SAT score, the average number of hours that they studied for this course and their G.P.A. Students, currently taking statistics, can use Minitab to do a regression analysis of this data. To merely ask students to find the prediction equation of the final grade average (STAAGE in the Minitab output) based on the three predictors MATH SAT scores, average number of study hours and G.P.A. overlooks the complexities of this problem. While the overall F-test indicates that this model is significant, the individual t-tests indicate that not all the variables are significant and the low percentage for the coefficient of variation does indicate that there are other variables that should be found to predict the final G.P.A. Further regression analysis and residual analysis are all easily accomplished using Minitab. Students, therefore, should be required to probe if the regression model selected is appropriate and how all the variables selected contribute to predicting the dependent variable.

Figure 4 : Minitab Regression Analysis of Statistics I Grades
MTB > print c1-c4

ROW	MathSAT	Study	GPA	StaAge
1	700	5.0	3.30	97.0
2	590	5.0	2.70	90.0
3	500	7.5	2.62	84.0

4	600	3.0	3.91	96.0
5	410	1.0	2.58	83.0
6	510	3.0	2.50	75.0
7	450	3.0	2.30	76.0
8	470	3.0	2.80	82.0
9	510	2.0	2.80	84.0
10	480	4.0	3.00	89.0
11	710	3.5	3.20	91.0
12	560	8.5	3.40	88.0
13	400	1.0	3.00	79.0
14	470	8.0	2.80	84.0
15	420	7.5	3.50	78.0
16	550	8.0	2.90	89.0
17	520	5.0	2.30	90.5
18	670	4.5	4.00	95.0
19	650	6.0	3.10	92.0
20	600	5.0	3.80	93.0
21	570	4.0	2.80	80.0
22	500	6.0	2.60	89.0
23	350	5.0	3.20	83.0
24	475	8.5	3.40	85.5
25	500	0.5	3.40	95.5

MTB > regress 'staAge' 3 'MathSat', 'Study', 'GPA'

The regression equation is

StaAge = 53.2 + 0.0381 MathSAT - 0.094 Study + 4.60 GPA

Predictor	Coef	Stdev	t-ratio	p
Constant	53.192	6.835	7.78	0.000
MathSAT	0.03805	0.01059	3.59	0.002
Study	-0.0945	0.3874	-0.24	0.810
GPA	4.596	2.106	2.18	0.041

s = 4.488 R-sq = 56.5% R-sq(adj) = 50.3%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	3	549.07	183.02	9.09	0.000
Error	21	422.99	20.14		
Total	24	972.06			

SOURCE	DF	SEQ SS
MathSAT	1	453.07
Study	1	0.10
GPA	1	95.90

Because of time constraints, one important topic generally overlooked or just given a cursory glance in elementary statistics courses is nonparametric statistics. The possibilities are endless for using Minitab to compare and to contrast parametric test results with nonparametric test results.

The data found in Figure 5 is a random sample of the ages in months from two sections of Statistics I at Le Moyne College. If students are asked to determine if there is any difference in the mean age in two sections of Statistics I, students must first answer the question whether a parametric test or nonparametric test procedure should be used. Again, Minitab normality graphical techniques as seen in Figure 5 can be used to assure that the most efficient test procedure is chosen.

Figure 5 : Minitab Analysis of Statistics I
Mean Age

```

MTB > set c5
DATA> 227 230 228 228 233 245 486 242 241 230 238 233 228 233
DATA> end
MTB > set c6
DATA> 228 228 235 262 250 232 216 225 335 236 240 241 251 250 254 234
DATA> end
MTB > name c5 'class1' c6 'class2'
MTB > nscores of c5 put in c9
MTB > nscores of c6 put in c10
MTB > plot c5 c9
;; HMF V1.23 TEXT
;; (Windows DOS Intel 386 3.1) HOOPS 3.30-33
(Color_By_Value "Line,Marker,Text,Edge" "RGB" 0 0 0)
(Color_By_Value "Window" "RGB" 1 1 1)
(Color_By_Value "Face" "RGB" 0 0 0)
(Window_Frame "off")

; ; (Driver_Options "debug=16,disable
input,subscreen=(-0.999844,-0.0904674,-0.9
;; 99792,-0.0872897),subscreen stretching,no update interrupts,use
window id=83
;; 40")
(Heuristics "no hidden surfaces")
(User_Options "mtb aspect ratio=0.691781")
(Front ((Segment "seg 1" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Visibility "faces=off")
(Color_By_Value "Face" "RGB" 1 1 1)
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polygon ((0 0 0) (1 0 0) (1 1 0) (0 1 0) (0 0 0))))))
(Segment "text 2" (
(Streaming_Mode "on")

```



```

(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
(Segment "seg 2" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Visibility "faces=off")
(Color_By_Value "Face" "RGB" 1 1 1)
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polygon ((0.2 0.2 0) (0.8 0.2 0) (0.8 0.8 0) (0.2 0.8 0) (0.2
0.2 0)))
))
(Segment "text 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
(Segment "seg 3" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))
(Segment "text 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
(Segment "seg 4" (
(Visibility "on")
(Front ((Segment "geom 2" (

```

```

(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polyline ((0.79 0.2 0) (0.79 0.18 0)))
(Polyline ((0.645 0.2 0) (0.645 0.18 0)))
(Polyline ((0.5 0.2 0) (0.5 0.18 0)))
(Polyline ((0.355 0.2 0) (0.355 0.18 0)))
(Polyline ((0.21 0.2 0) (0.21 0.18 0))))
(Segment "text 2" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "^^")
(Text_Font "name=arial-gdi-vector,size=0.02807
sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)
(Text 0.838416 -0.67 0 "2")
(Text 0.419208 -0.67 0 "1")
(Text 0 -0.67 0 "0")
(Text -0.419208 -0.67 0 "-1")
(Text -0.838416 -0.67 0 "-2"))))))))
(Segment "seg 5" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polyline ((0.2 0.79 0) (0.18 0.79 0)))
(Polyline ((0.2 0.596667 0) (0.18 0.596667 0)))
(Polyline ((0.2 0.403333 0) (0.18 0.403333 0)))
(Polyline ((0.2 0.21 0) (0.18 0.21 0))))))
(Segment "text 2" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")

```

```

(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "*>")
(Text_Font "name=arial-gdi-vector,size=0.02807
sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)
(Text -0.968515 0.58 0 "500")
(Text -0.968515 0.193333 0 "400")
(Text -0.968515 -0.193333 0 "300")
(Text -0.968515 -0.58 0 "200")))))))
(Segment "seg 6" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "----")
(Edge_Weight 1)
(Line_Pattern "----")
(Line_Weight 1)
(Polyline ((0.21 0.2 0) (0.79 0.2 0)))))
(Segment "text 2" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "^*")
(Text_Font "name=arial-gdi-vector,size=0.03509
sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)
(Text 0 -0.779891 0 "C9")))))))
(Segment "seg 7" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "----")
(Edge_Weight 1)
(Line_Pattern "----")
(Line_Weight 1)
(Polyline ((0.2 0.21 0) (0.2 0.79 0)))))
(Segment "text 2" (
(Streaming_Mode "on")

```

```

        (Color_By_Value "Text" "RGB" 0 0 0)
        (Window_Frame "off")
        (Window_Pattern "clear")
        (Window -1 1 -1 1)
        (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
        (Text_Alignment ">")
        (Text_Font "name=arial-gdi-vector,size=0.03509
sru,transforms=character
position only,rotation=follow path")
        (Text_Path -4.37114e-8 1 0)
        (Text_Spacing 1)
        (Text -1.17854 0 0 "class1")

        (Text_Path 1 0 0))))))
    (Segment "seg 8" (
      (Visibility "on")
      (Front ((Segment "geom 3" (
        (Streaming_Mode "on")
        (Color_By_Value "Marker" "RGB" 0 0 0)
        (Window_Frame "off")
        (Window_Pattern "clear")
        (Window -0.58 0.58 -0.58 0.58)
        (Camera (0.5 0.5 -1.45) (0.5 0.5 0) (0 1 0) 0.58 0.58
"Stretched")
        (Marker_Size 0.5625)
        (Marker_Symbol "o")
        (Marker 0.512712 0.2738 0)
        (Marker 0.369872 0.264133 0)
        (Marker 0.512712 0.2738 0)
        (Marker 0.565715 0.283467 0)
        (Marker 0.448102 0.268 0)
        (Marker 0.595499 0.289267 0)
        (Marker 0.630128 0.2912 0)
        (Marker 0.747937 0.762933 0)
        (Marker 0.67465 0.297 0)
        (Marker 0.512712 0.2738 0)
        (Marker 0.369872 0.264133 0)
        (Marker 0.369872 0.264133 0)
        (Marker 0.448102 0.268 0)
        (Marker 0.252063 0.2622 0)))
      (Segment "text 3" (
        (Streaming_Mode "on")
        (Window_Frame "off")
        (Window_Pattern "clear")
        (Window -0.58 0.58 -0.58 0.58)
        (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
        (Text_Font "transforms=character position only,rotation=follow
path"))))
      )))
    (Segment "seg 9" (
      (Visibility "on")
      (Front ((Segment "geom 2" (
        (Streaming_Mode "on")
        (Window_Frame "off")

```

```

(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))
  (Segment "text 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
  ))))

```

MTB > plot c6 c10

```

;; HMF V1.23 TEXT
;; (Windows DOS Intel 386 3.1) HOOPS 3.30-33
(Color_By_Value "Line,Marker,Text,Edge" "RGB" 0 0 0)
(Color_By_Value "Window" "RGB" 1 1 1)
(Color_By_Value "Face" "RGB" 0 0 0)
(Window_Frame "off")

; ; (Driver_Options "debug=16,disable
input,subscreen=(-0.999844,-0.0904674,-0.9
;; 99792,-0.0872897),subscreen stretching,no update interrupts,use
window id=83
;; 40")
(Heuristics "no hidden surfaces")
(User_Options "mtb aspect ratio=0.691781")
(Front ((Segment "seg 1" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Visibility "faces=off")
(Color_By_Value "Face" "RGB" 1 1 1)
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polygon ((0 0 0) (1 0 0) (1 1 0) (0 1 0) (0 0 0))))))
(Segment "text 2" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
  ))))
(Segment "seg 2" (

```

```

(Visibility "on")
(Front ((Segment "geom 2" (
  (Streaming_Mode "on")
  (Visibility "faces=off")
  (Color_By_Value "Face" "RGB" 1 1 1)
  (Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
  (Window_Frame "off")
  (Window_Pattern "clear")
  (Window -1 1 -1 1)
  (Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
  (Edge_Pattern "---")
  (Edge_Weight 1)
  (Line_Pattern "---")
  (Line_Weight 1)
  (Polygon ((0.2 0.2 0) (0.8 0.2 0) (0.8 0.8 0) (0.2 0.8 0) (0.2
0.2 0)))
))
  (Segment "text 2" (
    (Streaming_Mode "on")
    (Window_Frame "off")
    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
    (Text_Font "transforms=character position only,rotation=follow
path")))
  )))
(Segment "seg 3" (
  (Visibility "on")
  (Front ((Segment "geom 2" (
    (Streaming_Mode "on")
    (Window_Frame "off")
    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched"))
    (Segment "text 2" (
      (Streaming_Mode "on")
      (Window_Frame "off")
      (Window_Pattern "clear")
      (Window -1 1 -1 1)
      (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
      (Text_Font "transforms=character position only,rotation=follow
path")))
    )))
(Segment "seg 4" (
  (Visibility "on")
  (Front ((Segment "geom 2" (
    (Streaming_Mode "on")
    (Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
    (Window_Frame "off")
    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
    (Edge_Pattern "---")
    (Edge_Weight 1)

```

```

(Line_Pattern "---")
(Line_Weight 1)
(Polyline ((0.79 0.2 0) (0.79 0.18 0)))
(Polyline ((0.645 0.2 0) (0.645 0.18 0)))
(Polyline ((0.5 0.2 0) (0.5 0.18 0)))
(Polyline ((0.355 0.2 0) (0.355 0.18 0)))
(Polyline ((0.21 0.2 0) (0.21 0.18 0))))
(Segment "text 2" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "^*")
(Text_Font "name=arial-gdi-vector,size=0.02807
sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)
(Text 0.838416 -0.67 0 "2")
(Text 0.419208 -0.67 0 "1")
(Text 0 -0.67 0 "0")
(Text -0.419208 -0.67 0 "-1")
(Text -0.838416 -0.67 0 "-2")))))))
(Segment "seg 5" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "---")
(Edge_Weight 1)
(Line_Pattern "---")
(Line_Weight 1)
(Polyline ((0.2 0.79 0) (0.18 0.79 0)))
(Polyline ((0.2 0.707143 0) (0.18 0.707143 0)))
(Polyline ((0.2 0.624286 0) (0.18 0.624286 0)))
(Polyline ((0.2 0.541429 0) (0.18 0.541429 0)))
(Polyline ((0.2 0.458571 0) (0.18 0.458571 0)))
(Polyline ((0.2 0.375714 0) (0.18 0.375714 0)))
(Polyline ((0.2 0.292857 0) (0.18 0.292857 0)))
(Polyline ((0.2 0.21 0) (0.18 0.21 0))))))
(Segment "text 2" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "*>")

```

```

      (Text_Font      "name=arial-gdi-vector,size=0.02807
sru,transforms=character
position only,rotation=follow path")
      (Text_Spacing 1)
      (Text -0.968515 0.58 0 "340")
      (Text -0.968515 0.414286 0 "320")
      (Text -0.968515 0.248571 0 "300")
      (Text -0.968515 0.0828571 0 "280")
      (Text -0.968515 -0.0828571 0 "260")
      (Text -0.968515 -0.248571 0 "240")
      (Text -0.968515 -0.414286 0 "220")
      (Text -0.968515 -0.58 0 "200")))))))
(Segment "seg 6" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "----")
(Edge_Weight 1)
(Line_Pattern "----")
(Line_Weight 1)
(Polyline ((0.21 0.2 0) (0.79 0.2 0)))))
(Segment "text 2" (
(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "^*")
(Text_Font      "name=arial-gdi-vector,size=0.03509
sru,transforms=character
position only,rotation=follow path")
(Text_Spacing 1)
(Text 0 -0.779891 0 "C10")))))))
(Segment "seg 7" (
(Visibility "on")
(Front ((Segment "geom 2" (
(Streaming_Mode "on")
(Color_By_Value "Face Contrast,Line,Edge" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")
(Edge_Pattern "----")
(Edge_Weight 1)
(Line_Pattern "----")
(Line_Weight 1)
(Polyline ((0.2 0.21 0) (0.2 0.79 0)))))
(Segment "text 2" (

```



```

(Streaming_Mode "on")
(Color_By_Value "Text" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -1 1 -1 1)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Alignment "*>")
(Text_Font "name=arial-gdi-vector,size=0.03509
sru,transforms=character
position only,rotation=follow path")
(Text_Path -4.37114e-8 1 0)
(Text_Spacing 1)
(Text -1.17854 0 0 "class2")

(Text_Path 1 0 0))))))
(Segment "seg 8" (
(Visibility "on")
(Front ((Segment "geom 3" (
(Streaming_Mode "on")
(Color_By_Value "Marker" "RGB" 0 0 0)
(Window_Frame "off")
(Window_Pattern "clear")
(Window -0.58 0.58 -0.58 0.58)
(Camera (0.5 0.5 -1.45) (0.5 0.5 0) (0 1 0) 0.58 0.58
"Stretched")
(Marker_Size 0.5625)
(Marker_Symbol "o")
(Marker 0.442852 0.350857 0)
(Marker 0.643024 0.433714 0)
(Marker 0.569427 0.417143 0)
(Marker 0.610154 0.421286 0)
(Marker 0.533708 0.379857 0)
(Marker 0.511144 0.375714 0)
(Marker 0.488856 0.359143 0)
(Marker 0.756868 0.769286 0)
(Marker 0.314237 0.313571 0)
(Marker 0.243132 0.276286 0)
(Marker 0.417761 0.342571 0)
(Marker 0.569427 0.417143 0)
(Marker 0.685763 0.466857 0)
(Marker 0.466292 0.355 0)
(Marker 0.374231 0.326 0)
(Marker 0.374231 0.326 0)))
(Segment "text 3" (
(Streaming_Mode "on")
(Window_Frame "off")
(Window_Pattern "clear")
(Window -0.58 0.58 -0.58 0.58)
(Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
(Text_Font "transforms=character position only,rotation=follow
path"))))
))))
(Segment "seg 9" (
(Visibility "on")

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```

(Front ((Segment "geom 2" (
  (Streaming_Mode "on")
  (Window_Frame "off")
  (Window_Pattern "clear")
  (Window -1 1 -1 1)
  (Camera (0.5 0.5 -2.5) (0.5 0.5 0) (0 1 0) 1 1 "Stretched")))
  (Segment "text 2" (
    (Streaming_Mode "on")
    (Window_Frame "off")
    (Window_Pattern "clear")
    (Window -1 1 -1 1)
    (Camera (0 0 -5) (0 0 0) (0 1 0) 2 2 "Perspective")
    (Text_Font "transforms=character position only,rotation=follow
path"))))
))))))

```

Students will gain valuable insight into statistics if they are forced to look for patterns, to draw conclusions and to explore beyond the confines of problems. Minitab can indeed be a valuable tool if classroom professors move beyond just allowing their students to use it as a set of rigid command procedures that enable them to manipulate numbers. Students need to see statistics as a way to comprehend the world by exploring the meaning behind numbers and the relationships between them. Minitab used creatively will help students to become critical data thinkers.

References

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Minitab Inc., 1992.

Ryan, Barbara F., and Joiner, Brian L., Minitab Handbook,
Third Edition, Duxbury Press, Boston, 1994.