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Microsoft Excel as a supplement in a high school statistics course

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This study was conducted in the spring of 2002 at Arlington High School in a Probability and Statistics course for junior and senior level students. Two sections of the class were compared with respect to the use/non-use of EXCEL in the course. The experimental group (the one using EXCEL) outperformed the control group on five of the six teacher-created unit tests and on both of the criterion referenced assessments used by the district; however, the differences were not statistically significant at the 0.05 level. Furthermore, the experimental group expressed very positive feelings towards the use of the software in a survey administered at the conclusion of the course.

1. Introduction

There has been little research performed involving software integration at the high school level in statistics courses. Most of the research to this point has been conducted in college settings in mathematics classes other than statistics. Stephens and Konvalina [1] used MAPLE in intermediate algebra and college algebra courses to compare achievement with respect to the use/non-use of software. The experimental group was given MAPLE assignments, in addition to traditional lectures, while the control group was given only traditional lectures. Even though the results of the study were not statistically significant at the 5% level, the authors considered them to be very positive because the experimental group did perform better than the control group and the students in both experimental groups were supportive of the software usage.

In another study, Lawson [2] used DERIVE and GCAL to compare two groups of engineering students in a mathematics class. One group was taught using traditional lectures and tutorials while the other group received both of these plus computer-assisted learning assignments. The results of this study indicated that the computer-assisted group performed significantly better on two of the three phase tests and on the final examination at the end of the year.

One of the elements looked at in another study by Stephens and Konvalina [3] was the relationship between the amount of MAPLE 'test booster' problems worked in an intermediate algebra class and achievement on the final exam.

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A positive correlation was found between the final exam and the number of booster points.

As was stated earlier, research in statistics classes is difficult to come by, but two researchers have begun work in helping other teachers use MICROSOFT EXCEL in such scenarios. Whigham [4] wrote an article detailing how EXCEL can be used to develop, compare and extend simple models for normal probability distributions. Hunt [5] has shown how EXCEL can be utilized to create statistical tables for cumulative binomial and Poisson probabilities, normal distributions, t and F distributions and chi-squared distributions. Hunt concludes that while these EXCEL-created tables should not replace standard tables, they are a practical option in days of limited resources.

A study by Warner and Meehan [6] focuses directly on the use of EXCEL to teach basic statistics at the college level. This study gives many reasons for using EXCEL. Among them is that EXCEL is simple to use, is easily transferable and most students and universities already have EXCEL on their computer systems. Students were given EXCEL assignments and handouts to accompany their coursework. The results of this study were positive. In an evaluation, students indicated the assignments were useful and challenging. The authors concluded that while EXCEL does have limitations that would inhibit its use in upper-level statistics courses, it is a useful tool for elementary statistics. It is this concept that makes the use of EXCEL logical in statistics classes at the high school level.

The purpose of the current research is to investigate the supplementation of a beginning statistics course at the high school level with EXCEL. Was there a relationship between EXCEL use and statistics achievement? Prior student knowledge of EXCEL, past mathematical achievement and exposure to EXCEL in mathematics classes were surveyed at the beginning of the course and an opinionnaire was administered at the course's conclusion to determine student feelings toward the use of EXCEL.

2. Course details

This course was offered in the spring semester of 2002. Two sections, made up of junior and senior level students who had above average mathematical abilities, were used. The experimental section had 11 members and the control group had 16 members. The experimental group was selected on the basis of computer lab availability. In the experimental group, 64% rated their computer skills as average and 36% as excellent. 64% of the students indicated they had some experience with EXCEL, 27% had none and 9% had considerable experience. Perhaps the most interesting result of this initial survey was that 91% of the students said they had no experience with EXCEL in a math class.

In the class, there were six unit exams, two criterion referenced assessments (CRA) and daily homework that determined the final grade. The CRAs were tests designed by teachers to measure student achievement in statistics according to the Nebraska State Standards. The CRAs were administered at the end of the course. This study used the exams and assessments as indicators of achievement. In the experimental group, ten EXCEL assignments served as daily grades. Though not an all-inclusive list, examples of the EXCEL topics and concepts are shown in table 1. A handout with instructions and examples accompanied each assignment. Excel was used only to complete homework assignments. Since this was a first step

Intersection and Union
Use the MATCH function to determine the intersection of data sets.

Bar Graphs and Histograms
Create histograms of the various data sets using the Analysis ToolPak.

Mean, Variance and Standard Deviation
Determine the mean, variance and standard deviation using AVERAGE, VAR, and
  STDEV.

Normal Distributions
Use NORMSINV and NORMSDIST to solve problems involving the standard normal
  distribution curve.
Use NORMINV AND NORMDIST to solve problems for a specified mean and standard
  deviation.

Permutations and Combinations
Use the COMBIN and PERMUT functions to determine the possible number of outcomes
  from a given situation.

Binomial Probability Distributions
Create binomial probability distributions for varying situations using BINOMDIST and
  answer questions based upon those situations.

Sampling Distributions
Investigate the sampling distribution of the sample mean for samples of size
  $n = 2, 3, 4,$ and 5.

Table 1.   Examples of Excel topics and concepts covered in the course.

in using Excel, it was felt that the amount of Excel that should be used should be
limited to homework assignments. However histograms, constructed by using
Excel, were discussed in class.

   The students in the experimental group were not allowed to use Excel on
exams. Even though students in the experimental group used built-in functions
such as AVERAGE, STANDARD DEVIATION, and the functions involving
the normal distribution on their homework, they were not allowed to use these on
their tests. They were required to use standard normal tables on exams. Seeing two
different approaches to representing area under the normal curve seemed to help
their understanding of the topics.

3.   Results

   Table 2 gives a comparison of the means and standard deviations of the six tests
and the two CRA tests. The p-values are two-tailed p-values for testing that means
are unequal (column 5).

   With the exception of test 3, the means of the experimental group exceeded the
means of the control group and the standard deviations of the experimental group
were less than the standard deviations of the control group. Test 3 was the only test
on which the control group outperformed the experimental group and where there
was more variation in the experimental group. Problems on that test were aimed at
tree diagrams, conditional probability and proving independent events, topics not
covered in the EXCEL assignments. This is one possible explanation for the
reversal. Table 3 shows the very positive opinions regarding the inclusion of
EXCEL into the statistics course.

Test	Group	Mean	Standard deviation	p-value $H_a: \mu_1 \neq \mu_2$
Test 1	Experimental	92.8	3.3	0.238
	Control	90.3	6.3	
Test 2	Experimental	88.1	6.4	0.488
	Control	85.4	11.3	
Test 3	Experimental	94.2	6.2	0.260
	Control	96.4	3.7	
Test 4	Experimental	93.1	4.8	0.466
	Control	91.0	8.5	
Test 5	Experimental	93.7	4.3	0.482
	Control	91.7	8.7	
Test 6	Experimental	90.9	3.9	0.139
	Control	87.3	7.1	
CRA1	Experimental	91.7	6.1	0.068
	Control	78.6	22.1	
CRA2	Experimental	81.2	13.0	0.948
	Control	80.8	18.8	

Table 2. Comparison of the two groups on eight measures of achievement.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I enjoyed the Excel assignments and I felt they increased my understanding of statistics.				
0%	0%	0%	64%	36%
The Excel assignments increased my enjoyment in the course. Sometimes statistics is boring and the computer assignments made it more interesting.				
0%	0%	18%	46%	36%
Because Excel assignments counted as part of my grade, I always made an effort to do the problems by hand to make sure that I had given the correct commands in the computer solution to the problem.				
18%	27%	9%	27%	18%
I did not like the computer aspect of the course. The Excel assignments seemed to confuse me more than help me understand statistics.				
36%	55%	9%	0%	0%
I would recommend that you give Excel assignments in the future when you teach statistics.				
0%	0%	9%	46%	46%
The Excel assignments blended well with the statistics and contributed to my total understanding of the course.				
0%	0%	9%	46%	46%
The Excel assignments increased my overall understanding of computer software and technology.				
0%	0%	18%	36%	46%

Table 3. Opinions regarding statistics and Excel at the end of the statistics course.

4. Conclusions

Even though none of the results of this study were statistically significant at the 5% level, they are nonetheless encouraging concerning the potential benefits of using MICROSOFT EXCEL in a high school level statistics course. On the whole, the experimental group did outperform the control group by a consistent margin except for test 3. With the exception of test 3, the standard deviation

was less in the experimental group than in the control group because there were fewer low scores in the experimental group. This may have indicated that everyone's interest was stimulated by the inclusion of Excel. In addition, student responses toward the use of EXCEL were extremely favorable. This suggests that the continued utilization of EXCEL will benefit future students.

Even though no attempt was made to determine whether students in the experimental group developed better data interpretation skills, the instructor noted that in the sections on estimation and testing, that students were able to make use of the functions AVERAGE and STANDARD DEVIATION and concentrate on computing test statistics and finding critical values and making conclusions. In the control group, the students would have to compute the mean and the standard deviation before proceeding to the calculation of the test statistic and finding the critical values. In the experimental group, the student could simply enter the data and give the AVERAGE and STANDARD DEVIATION commands and then immediately proceed with the computation of the test statistic and make their conclusion. The students could concentrate on what they were doing and not get bound up in the mean and standard deviation computation.

There was no apparent reason why the p-value was so low on CRA1 assessment measure in favor of the experimental group. The material on that test was comprised mainly of probability and counting techniques.

References
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