

Influence of Time-of-Day on Overall Chemistry Grade Student Scores

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Introduction

Since 1995, Connecticut has mandated that yearly standardized testing be performed in the spring of each year for all 10th graders, coining Connecticut Aptitude Performance Testing (CAPT). This testing has been created to comply with the No Child Left Behind (NCLB) act that President Bush signed into law in January 2002 (Sjosten-Bell, 2005). In March of 2007, a northeastern board of education mandated that the CAPT would be administered after 9 am in hopes that this would increase student scores because the students would be more alert and less sleepy.

Statement of Problem

The purpose of this study is to determine if there is a statistically significant difference in the means of four different classes students' scores at different times during the day. Therefore, this study is attempting to investigate if there is a statistically significant relationship between students' scores and the time of days those scores are obtained from.

Review of Related Literature

There is no consensus among scholars as to whether the time of day affects student performance. In a study of third grade elementary school children computing mathematical algorithms, the analysis of the variance of the quizzes taken was not statistically significant, but the "mean scores showed a trend toward higher scores in the morning" (Sjosten-Bell, 2005).

Since this study centers on the scores of third graders, a more applicable study of adolescents shows a rise in the ability to focus in the morning and remains stable until mid day and then a significant drop from 1 to 4 pm and then an increase again, but not as much as in the morning. (Sousa, 2001). Conflicting data is obtained from Davis, where student achievement is greater in the morning for reading (1987a) and was not determined (statistically) whether math scores increased depending on the time of day (1987b).

Statement of Hypothesis

The research question is whether or not the time of day impacts students grade performance. The null hypothesis is that there is no statistically significant difference in the mean overall grade scores (\bar{X}) of Classes 1, 2, 3, and 4 that meet at different times during the day at a 0.01 two-tailed level of significance (H_0). The alternate null hypothesis is that there is a statistically significant difference in the mean overall grade scores (\bar{X}) of Classes 1, 2, 3, and 4 that meet at different times during the day at a 0.01 two-tailed level of significance (H_A).

Description of Variables and Associated Definitions

The independent variable is which class the students are in and therefore the time of day. Class 1 is period 1 from 7:38 – 8:24am. Class 2 is period 3 from 9:20 – 10:06am. Class 3 is period 5 from 11:29am – 12:20pm. Class 4 is period 7 from 1:16 – 2:02pm. The dependent variable is the students overall percentage grade for the year in Chemistry.

Subjects

The research was obtained from four average level Chemistry classes taught in the same year by the same teacher in a northeast high school. The four classes contain a mixture of 10th, 11th and 12th graders. The ages of students range from 15 – 17 years old. The four classes contain a mixture of males and females of about 50% each. Class 1 contains 22 students, class 2 contains 23 students, class 3 contains 24 students, and class 4 contains 23 students.

Instrument

The overall grade used in this study was calculated from a combination of different assessment techniques. Tests were multiple choice, fill in the blanks and short answer (100 pts). Quizzes were calculations and explanations (20 pts). Notebook checks (50 pts) and journals checks (50 pts) were performed monthly. Labs were performed 1-2 times per week (20 pts). Homework was assigned, on average, 4 nights out of 5 (5 pts). Classroom assignments were performed daily (10 pts). The topics covered are as follows: lab safety, web safety, the scientific method, history of Chemistry, history of the atom, atomic structure, modern atomic theory, scientific notation, the periodic table, electron configurations, naming & writing compounds. Additions topics covered are: energy, temperature, matter, molecular geometry, balancing & classifying equations, significant digits, molar conversions, percent composition, empirical formulas, molecular formulas, percent yield, limiting reactants, and thermochemistry. These topics produced a possible 2,948 points. Students grades were calculated from the amount of points they received divided by the amount of points possible (2,948) times 100.

Experimental Design

The research was conducted on the overall grade scores calculated from individual grade scores collected throughout the 2007-2008 school year by a Chemistry teacher in a northeast high school. The four classes in question were given the same materials, performed the same activities and lessons each day.

Procedure

- 1) Start SPSS 16.0.
- 2) Click on the variable View tab in the lower left-hand corner of the desktop.
- 3) In the first Name row type Class, then use the down arrow and type OverallGrade (no space) in the second Name row.
- 4) Then click the Data View tab.
- 5) In the Class column type twenty-two 1's, twenty-three 2's, twenty-four 3's and twenty-three 4's.
- 6) Now in the scores column type 86, 91, 89, 67, 84, 83, 89, 94, 86, 96, 89, 80, 74, 73, 75, 87, 79, 100, 58, 82, 82, 76, 91, 92, 88, 81, 80, 96, 92, 88, 87, 90, 97, 80, 84, 91, 98, 80, 79, 86, 70, 96, 90, 95, 86, 74, 96, 83, 74, 89, 79, 98, 89, 91, 72, 91, 79, 96, 69, 60, 71, 72, 69, 86, 24, 88, 92, 67, 84, 79, 76, 92, 79, 88, 91, 89, 80, 81, 68, 83, 73, 83, 80, 73, 77, 86, 70, 88, 84, 79, 74, and 63. (See Appendix A for data in table format)
- 7) Next, click Analyze, Compare Means, and One-Way ANOVA...

- 8) When the One-Way ANOVA dialog box appears, click on Post Hoc... and check the Scheffe box and click Continue.
- 9) Then click on Options... and check Descriptive and Homogeneity of variance test and then click Continue.
- 10) Next highlight Class with your mouse and use the right arrow to put it in the Factor: box.
- 11) The highlight OverallGrade and use the right arrow to put it in the Dependent List: box.
- 12) Then click OK.

Results

See Appendix A for raw data

Descriptives

OverallGrade									
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
1	22	82.7273	9.72587	2.07352	78.4152	87.0394	58.00	100.00	
2	23	87.6957	7.02227	1.46424	84.6590	90.7323	70.00	98.00	
3	24	88.8750	15.75440	3.21585	72.2225	85.5275	24.00	98.00	
4	23	79.8261	7.50547	1.56500	76.5805	83.0717	63.00	92.00	
Total	92	82.2391	11.05170	1.15222	79.9504	84.5279	24.00	100.00	

Test of Homogeneity of Variances

OverallGrade			
Levene Statistic	df1	df2	Sig.
3.584	3	88	.017

ANOVA

OverallGrade					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1095.577	3	365.192	3.208	.027
Within Groups	10019.163	88	113.854		
Total	11114.739	91			

Post Hoc Tests

Multiple Comparisons

OverallGrade
Scheffe

(I) Clas s	(J) Clas s	Mean Difference (I- J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-4.96838	3.18204	.490	-14.0383	4.1016
	3	3.85227	3.14946	.684	-5.1248	12.8294
	4	2.90119	3.18204	.842	-6.1688	11.9711
2	1	4.96838	3.18204	.490	-4.1016	14.0383
	3	8.82065	3.11354	.052	-.0540	17.6954
	4	7.86957	3.14648	.108	-1.0990	16.8382
3	1	-3.85227	3.14946	.684	-12.8294	5.1248
	2	-8.82065	3.11354	.052	-17.6954	.0540
	4	-.95109	3.11354	.993	-9.8258	7.9236
4	1	-2.90119	3.18204	.842	-11.9711	6.1688
	2	-7.86957	3.14648	.108	-16.8382	1.0990
	3	.95109	3.11354	.993	-7.9236	9.8258

Homogeneous Subsets

OverallGrade

Scheffe

Clas s	N	Subset for alpha = 0.05
		1
3	24	78.8750
4	23	79.8261
1	22	82.7273
2	23	87.6957
Sig.		.056

Means for groups in homogeneous subsets are displayed.

Since the F-test statistic significance is **0.017** for 0.01 TT df(3,88), the alpha significance level is **0.010**. Since the test statistic is greater than or equal to the critical value, we Do Not Reject/Accept the null hypothesis. Therefore, there is NO significant difference in the variances

(s^2) of Classes 1, 2, 3, and 4. Since this study displays homoscedacity, the means can be compared. Since the F-ratio statistic significance is **0.027** for 0.01 TT df(3,88), alpha significance level is **0.010**. Since the test statistic is greater than or equal to the critical value, we Do Not Reject/**Accept** the null hypothesis. Therefore, there is no statistically significant difference in the mean overall grade scores (X) of Classes 1, 2, 3, and 4 that meet at different times during the day at a 0.01 two-tailed level of significance and therefore a Scheffe post hoc test is not necessary.

Discussion

Although there was a slight difference in the mean scores between Classes 2 and 3, the results did not show a statistically significant difference between the students overall grade sores and the times of the day that were taken (based on the ANOVA results). The null hypothesis, that there is no statistically significant difference in the mean overall grade scores (X) of Classes 1, 2, 3, and 4 that meet at different times during the day at a 0.01 two-tailed level of significance, is therefore not rejected/accepted.

Conclusions

Since the means overall grade scores of 4 classes are statistically equal, it appears that the time of day does not affect students' overall grade scores and therefore, their ability to learn. Using these findings, it can be hypothesized that more factors are involved in student learning, measured via grade scores, besides the time of day. Future studies may test whether gender

(parametric), grade level (parametric) or peer groups (nonparametric) have a significant statistical difference on the mean overall grade scores of different groups of students.

Classification of Educational Research by Purpose

The educational research purpose used in this study is the evaluation research method. This type of research method employs the scientific method to analyze and assess the worth of effectiveness of an education program or policy (Gay, 1996). Here, the correlation, or lack thereof, of the independent variable (time of day), appears to not be statistically related to the dependent variable (overall grade scores of groups of students) in Chemistry at this northeastern high school.

Classification of Educational Research by Method

The educational research method used in this study is the correlational research method. This method attempts to determine whether, and to what degree, a relationship exists between two or more quantifiable variables (Gay 1996). Here, the two variables are time of day (independent) and overall grade scores of groups of students (dependent). There appears to be a lack of relationship, statistically speaking, between these two variables.

References

- Davis, Z. (1987a). Effects of time-of-day of instruction on beginning reading achievement. *Journal of Educational Research*, 80(3), 138-134.
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- Gay, L.R. (1996). *Educational Research: Competencies for analysis and application*. Englewood Cliffs, NJ: Merrill an imprint of Prentice Hall.
- Sjosten-Bell, W. (2005) *Influence of Time-of-Day on Student Performance in Mathematical Algorithms*. Master's thesis. San Rafael, CA: Dominican University of California
- Sousa, D.A. (2001) *How the brain learns* (2nd ed.). Thousand Oaks, CA: Corwin Press, Inc.

Appendix A- Raw Data

	Class	OverallGrad
1	1	86.00
2	1	91.00
3	1	89.00
4	1	67.00
5	1	84.00
6	1	83.00
7	1	89.00
8	1	94.00
9	1	86.00
10	1	96.00
11	1	89.00
12	1	80.00
13	1	74.00
14	1	73.00
15	1	75.00
16	1	87.00
17	1	79.00
18	1	100.00
19	1	58.00
20	1	82.00
21	1	82.00
22	1	76.00
23	2	91.00
24	2	92.00
25	2	88.00
26	2	81.00
27	2	80.00
28	2	96.00
29	2	92.00
30	2	88.00
31	2	87.00
32	2	90.00
33	2	97.00
34	2	80.00
35	2	84.00
36	2	91.00

	Class	OverallGrad
37	2	98.00
38	2	80.00
39	2	79.00
40	2	86.00
41	2	70.00
42	2	96.00
43	2	90.00
44	2	95.00
45	2	86.00
46	3	74.00
47	3	96.00
48	3	83.00
49	3	74.00
50	3	89.00
51	3	79.00
52	3	98.00
53	3	89.00
54	3	91.00
55	3	72.00
56	3	91.00
57	3	79.00
58	3	96.00
59	3	69.00
60	3	60.00
61	3	71.00
62	3	72.00
63	3	69.00
64	3	86.00
65	3	24.00
66	3	88.00
67	3	92.00
68	3	67.00
69	3	84.00
70	4	79.00
71	4	76.00
72	4	92.00

	Class	OverallGrad
73	4	79.00
74	4	88.00
75	4	91.00
76	4	89.00
77	4	80.00
78	4	81.00
79	4	68.00
80	4	83.00
81	4	73.00
82	4	83.00
83	4	80.00
84	4	73.00
85	4	77.00
86	4	86.00
87	4	70.00
88	4	88.00
89	4	84.00
90	4	79.00
91	4	74.00
92	4	63.00