

THE EFFECTS OF TEMPERATURE AND PROTECTIVE CLOTHING  
UPON TASK COMPLETION TIME, WORK QUALITY, AND  
STUDENT ATTITUDE TOWARD LEARNING

Stanley Burke  
Supervisor  
Virginia

and  
Bob R. Stewart  
Teacher Education  
University of Missouri-Columbia

As a result of the energy shortage, the American public has heard a plethora of recommendations regarding ways in which energy can be conserved. One such recommendation has been the reduction of environmental temperatures. Presidential requests have suggested that thermostats be set at 65°F. Some universities now set classroom and office temperatures at 68°F, and one high school was noted to publicly announce that school temperatures would be reduced to 50°F during a severe energy curtailment period. Bear (1976) recommended that vocational agriculture mechanics laboratory temperatures may be maintained at 55°F to 60°F.

Observations of vocational agriculture mechanics laboratories indicate that many facilities are not equipped to adequately maintain an optimum cool weather temperature. As was noted by Rutgers (1973), many secondary vocational program laboratories were designed "with a quantity of heat thrown in." The situation has been further compounded by schools lowering operating temperatures to save energy in critical fuel shortage situations. Recent efforts to develop national exemplary standards for programs of agricultural/agribusiness education failed to identify optimum temperature settings for mechanics laboratories. A lack of consistency exists among schools and teachers concerning optimum temperature settings, particularly when viewed in conjunction with the national energy shortage. Past research by Bensel and Lockhart (1974), Crowden (1948), and Bruce (1963) has shown that temperature settings do influence the learning performance of students and indicated that attitudinal changes do result when uncomfortable temperatures are encountered. Bear (1976) noted that students of vocational agriculture engaged in laboratory activities should have protective clothing over regular school dress, which will reduce the need for environmental heat. Observers would note, however, that many laboratory classes have students with varying amounts of protective work clothing, which adds another dimension to the correctness of an optimum laboratory temperature setting. Where individual temperature controls for laboratories exist, Rutgers in *Modern School Shop Planning* (1973) noted that environmental temperatures may be adjusted to the comfort of the instructor and not the student. The comfort differential may vary as much as five degrees between student and teacher.

Based on these findings, it was evident that further exploration was needed to identify a range of temperatures optimum

for learning in vocational agriculture mechanics laboratories. Therefore, the focal point for this study was to collect and evaluate data related to student activities under different laboratory conditions.

### *Purpose of the Study*

The purpose of this study was to ascertain the effects of temperature and protective clothing in the vocational agriculture laboratory setting on student psychomotor performance and perceptions about the learning environment. The following null hypotheses were formulated and were tested at an alpha level of .05.

- Ho<sub>1</sub>: There is no significant difference between group mean scores on task completion time for students who wore protective clothing and those who did not at different laboratory temperatures.
- Ho<sub>2</sub>: There is no significant difference between group mean work quality scores on task completion time for students who wore protective clothing and those who did not at different laboratory temperatures.
- Ho<sub>3</sub>: There is no significant difference between group mean scores on perceptions about the learning environment for students who wore protective clothing and those who did not at different laboratory temperatures.

The study was limited by the extent to which instruments used for data collection were valid and reliable and to the extent that students worked at their normal rate and responded honestly to each question. The study was also limited by the length of time the students were involved in the experiment.

### *Procedures*

This study was conducted as a posttest-only control group experiment with three dependent variables. Campbell and Stanley (1963) stated that the posttest-only control group design has the advantage of eliminating pretest conditioning in attitudinal studies.

Nine schools were chosen at random from the population of 23 high schools in the Blue Ridge supervisory area in Virginia that offered the Agricultural Science and Mechanics I course. All students from each class were asked and agreed to serve as part of the research sample from each school. Subjects were randomly assigned to the experimental groups and randomness was used in assigning treatments to the groups.

Group I worked in the agricultural mechanics laboratory in normal school clothes at the assigned temperatures of either 50°F, 60°F, or 70°F while Group II worked in coveralls at the assigned temperatures. Group III became the control group which worked in school clothing at 67°F. Five classes from three schools worked at 50°F, five classes from four schools worked at 60°F, and five classes from four schools worked at 70°F. Each class had students assigned to the 67°F control group. The number of students involved in the study by groups is presented in Table 1.

Table 1  
NUMBER OF STUDENTS PARTICIPATING IN EACH TREATMENT

Test Classes	Temperature Settings	Experimental Group I	Experimental Group II	Control Group III
Class 1	50°F	5	6	8 (67°F)
Class 2	53°F	6	6	3 (67°F)
Class 3	53°F	4	5	4 (66°F)
Class 4	50°F	5	4	5 (65°F)
Class 5	49°F	5	4	2 (65°F)
Class 6	58°F	4	4	3 (61°F)
Class 7	59°F	5	6	2 (67°F)
Class 8	60°F	6	5	4 (67°F)
Class 9	59°F	5	5	2 (65°F)
Class 10	63°F	4	6	4 (68°F)
Class 11	71°F	3	2	4 (68°F)
Class 12	68°F	8	5	4 (68°F)
Class 13	72°F	3	4	3 (73°F)
Class 14	73°F	4	4	3 (74°F)
Class 15	70°F	3	5	5 (68°F)

The entire class was taught how to construct a drill bit stand by a self-instructional package given by the classroom instructor on the day prior to the experiment. Each instructor was asked to condition his students to the experimental temperature for at least one week prior to the experiment. The dependent variables of task completion time, work quality and perceptions about the learning environment were measured for the control group on one day and for the experimental groups on another day. Each group worked on the activity for a 40-minute period.

Efforts were made to maximize the effect of the treatment by keeping the disruption of normal vocational mechanics laboratory

instruction pattern to a minimum; having the regular teacher of agriculture to issue the instructions and supervise the study required for the experimental task; having all students in the class participate; using standardized instructions and researcher-prepared materials; requesting that students wear normal clothing into the mechanics laboratory on the day of the experiment; having the timing, recording and scoring performed by the researcher; having students conditioned to the experimental temperatures for at least one week prior to the experiment; having the basic hand tools and supplies provided by the researcher; and providing the coveralls when worn by the students.

Forms were devised to record task completion time and to determine work quality for the steps of the experimental activity. The instruments were reviewed by a panel of experts to validate the steps used. Both scorecards were used in a pilot study to determine their appropriateness for use in the study. The instrument used to measure student perceptions about the learning environment was a researcher-prepared semantic differential scale. An expert committee was asked to review the instrument and establish face validity for the purposes of this study.

Two dry bulb thermometers were located at table height in the work area to record the environmental temperature. Temperature readings were taken at twelve-minute intervals to maintain the desired conditions. A hot wire anemometer was used to record air velocity and a humidistat was used to record relative humidity.

Local directors of vocational education and teachers of vocational agriculture were surveyed to determine the lowest temperature under which students had been or would be allowed to work in mechanics laboratories. This information was used to select the lower temperature setting for the study.

Data for this experiment were collected during the months of January, February, and March, 1979. Two consecutive class periods (days) were used to collect data from the two experimental groups and the one control group which made up the sample at each school.

A two-way analysis of variance procedure was used to analyze null hypotheses one and two, and a multiple analysis of variance procedure was used to test the third hypothesis. The data were analyzed using a computer library program in the Statistical Analysis System.

### *Findings and Conclusions*

The data collected for the study are presented in Tables 2 and 3.

Table 2

## MEAN TASK COMPLETION AND WORK QUALITY SCORES BY GROUPS

	50°F		60°F		70°F		67°F
	<u>Without Protective Clothing</u>	<u>With Protective Clothing</u>	<u>Without Protective Clothing</u>	<u>With Protective Clothing</u>	<u>Without Protective Clothing</u>	<u>With Protective Clothing</u>	<u>Without Protective Clothing</u>
	(N = 25)	(N = 25)	(N = 23)	(N = 26)	(N = 23)	(N = 19)	(N = 56)
	mean	mean	mean	mean	mean	mean	mean
Task Completion	10.52	9.96	9.91	9.96	9.30	9.53	9.73
Work Quality	29.64	29.04	29.70	28.31	24.95	25.32	27.19

Table 3

## MEAN PERCEPTIONS OF THE LEARNING ENVIRONMENT BY GROUPS

	50°F		60°F		70°F		67°F
	<u>Without Protective Clothing</u>	<u>With Protective Clothing</u>	<u>Without Protective Clothing</u>	<u>With Protective Clothing</u>	<u>Without Protective Clothing</u>	<u>With Protective Clothing</u>	<u>Without Protective Clothing</u>
	(N = 25)	(N = 25)	(N = 23)	(N = 26)	(N = 23)	(N = 19)	(N = 56)
Comfort	38.68	37.04	33.70	37.96	40.34	40.66	40.84
Classmates	47.76	46.36	43.37	40.86	45.65	44.84	46.03
Temperature	39.92	38.96	36.31	42.96	46.93	49.16	47.83
Shopwork	48.36	42.72	42.39	43.70	45.61	46.54	47.15
School	44.04	48.12	44.87	42.46	43.77	40.11	48.84
Teacher	41.52	43.44	44.57	45.72	49.22	44.75	46.62
Tools	47.40	46.44	43.34	44.58	47.39	48.95	48.75

Task completion time scores were analyzed according to temperature levels and protective clothing. The observed F values for temperature, protective clothing and interaction did not exceed the critical values for significance, and  $H_{01}$  was not rejected. There were no significant differences on task completion time among the groups at different experimental temperatures or with protective clothing. Results of the analysis of variance procedure for the data are given in Table 4.

Work quality scores were analyzed according to temperature levels and protective clothing. The observed F values for temperature, clothing and interaction did not exceed the critical values needed for significance, and  $H_{02}$  was not rejected. There were no significant differences in work quality resulting from temperature duress or use of protective clothing. Results of the analysis of variance procedure for the data are given in Table 4.

Table 4  
ANALYSIS OF VARIANCE DATA FOR TASK COMPLETION  
AND WORK QUALITY

Task Completion	SS	DF	MS	F
Temperature	16.129	2		1.63
Protective Clothing	.478	1	4.118	.07
Interaction	3.983	2		.42
Within Groups	<u>647.594</u>	<u>135</u>	4.797	
	668.184	141		

  

Work Quality	SS	DF	MS	F
Temperature	490.125	2		1.34
Protective Clothing	5.189	1	102.493	.06
Interaction	17.148	2		.05
Within Groups	<u>24096.190</u>	<u>135</u>	178.490	
	24608.652	141		

Data for determining student perceptions toward the learning environment were collected as described for  $H_0_3$ . Correlations were computed among the seven factors on the instrument. A moderate degree of intercorrelation existed among the factors on the semantic differential instrument; hence, the multivariate analysis was selected as the appropriate statistical test. Univariate analysis of variance was used to determine which factors significantly contributed to perceptions of the learning environment. Least mean squares were then examined to extrapolate the combinations of temperature and clothing when a significant difference was found to exist.

A Hotelling-Lawley Trace multivariate analysis was performed and found significant at the .05 level as indicated in Table 5, and the null hypothesis was rejected.

Table 5

MANOVA TEST FOR TEMPERATURE, CLOTHING,  
TEMPERATURE AND CLOTHING EFFECT

Effect	H-LT <sup>a</sup>	F	D.F.	p
Temperature Clothing	.5403	1.80	54 and 1082	.0004

The univariate analysis of variance test revealed that the combined influence of temperature, clothing, and temperature and clothing upon student perceptions of coolness and of comfort in the learning environment were found to be significant at an alpha level of .05. An examination of least square means revealed that students working at 60°F without protective clothing related the most adverse perceptions toward coolness at different environmental temperatures. Students working at 70°F with protective clothing related the most positive perceptions toward coolness in the learning environment. The combined effects of temperature, clothing, and temperature and clothing were found not to significantly affect student perceptions toward classmates, shopwork, school, teacher and tools in the learning environment.

Based on the findings of this study, the following conclusions were drawn:

1. Students can be exposed to temperatures as low as 50°F for up to 40 minutes in length without adversely affecting their work quality and the time required to complete tasks in an agricultural mechanics laboratory.

2. When students are exposed to cooler temperatures, it can be expected that their perceptions of the learning environment related to comfort will be less positive, particularly when they do not wear protective clothing. It might be anticipated that as the length of exposure to coolness increases, the students would become more concerned about the comfort of the learning environment.

Although work quality and time required to complete a task were not adversely affected, when students were exposed to different temperatures for a 40-minute period, their perceptions of coolness and comfort in the laboratory did differ significantly, especially for students without protective clothing. Therefore, it would appear that we should be cautious in setting temperatures lower than the traditional 67°F if we desire to maximize the most positive learning environment for students as well as to maintain time and work quality efficiency.

### References

- Bear, Forrest W. and Thomas Hoerner. *Planning, Organizing, and Teaching Agricultural Mechanics*. St. Paul, Minnesota: Ho-bar Publications, pp. 85-95, 1978.
- Bear, Forrest W. "Facility Planning for Vocational Agriculture." *The Agricultural Education Magazine*, 3:61, 1976.
- Bensel, Carolyn K., and J. M. Lockhart. "Cold Induced Vasodilation Onset and Manual Performance in the Cold." *Ergonomics*, 17:717-730, November, 1974.
- Bruce, William C. "Two Studies on Thermal Environment and Learning." *American School Board Journal*, 147:22-24, 1963.
- Campbell, Donald T. and Julian C. Stanley. *Experimental and Quasi-Experimental Designs for Research*. Chicago: Rand-McNally College Publishing Company, pp. 25-26, 1963.
- Crowden, G. P. "The Physiological Aspects of Housing." *Health Education Journal*, 6:162, 1948.
- Rutgers, Norman L. "Heat: Its Effect on Teaching and Learning," *Modern School Shop Planning*. Ann Arbor, Michigan: Prakken Publications, Inc., 6 Ed.:pp. 21-23, 1973.
- Rutgers, Norman L. "Thermal Environments." U. S. Education Resource Information Center, ERIC Document ED025-116, 1967.
-