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ABSTRACT

A study compared modular industrial technology education instruction with traditional laboratory instruction and industrial technology education instruction in contemporary laboratories. Seventh-grade middle school students were assessed prior to their enrollment in a 9-week industrial technology education course. Their achievement gain was measured with an identical posttest after completion of the course. The analysis of covariance was used to compare the three different instructional settings based on students' achievement gains as measured by the pretest-posttest instrument. A total of 160 seventh-grade industrial technology education students from a Midwest school district comprised the sample: 67 students from the middle school with the traditional laboratory, 65 middle school students from the modular school, and 30 seventh graders from the school with a contemporary laboratory. Findings indicated the following: overall there was no significant gain from the industrial technology education course; seventh-grade students who received instruction in the contemporary industrial technology education laboratory posted an achievement gain of 11.5 percent; contemporary laboratory instruction also provided significantly better achievement than modular technology education in the areas of general industrial technology education knowledge, drafting technology, manufacturing processes, construction technology, and power/energy. Appendixes contain 8 tables. (Contains 12 references.) (YLB)

Technology Education Modules: Blessing or Curse

A Research Paper

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American Vocational Association Convention

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by

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Across the nation, schools are converting traditional industrial arts laboratories into modular industrial technology education classrooms. Even the focus of recent literature in industrial technology education has been on the acceptance and use of modular industrial technology education systems (deGraw & Smallwood, 1997). However these manuscripts have centered on module titles, inter-disciplinary teaching, and the importance of technology. Little inquiry has been conducted as to the effectiveness of modular instruction in achieving the academic goals of industrial technology education.

Despite this lack of research, modular industrial technology education laboratories are being installed by many school districts across the country (Pullias, 1997). According to Pullias, modular industrial technology education laboratories are the current trend. In many cases vendors not educators have been a driving force in this conversion to modular instruction (Burke, 1995). Shendow (1996) noted that in modular industrial technology education "learning occurs at self-sufficient workstations" (p. 32). However the learning effectiveness of these workstations has not been examined.

Harnisch (1997) assessed the use of modular industrial technology education laboratories in two Illinois middle schools. His study examined the operation of modular laboratories and included critiques from observers, educators, and students as to their feelings about the modular instruction. Harnisch's study did not discuss or assess student achievement in the modular learning environment. Studies on modular industrial technology education instruction by Dobrauc, Harnisch, and Jerich (1995) and Dean and Crockett (1996) also failed to report on the educational effectiveness of modular industrial technology education instruction. Furthermore, Pullias (1997) noted that:

> Student experiences provided with modular labs are what can be considered lower level. All the students have to do is follow directions. They really don't have an opportunity to develop and use creative problem-solving skills, or to demonstrate a true understanding of the various concepts being addressed. A great deal of money is being spent on environments with an impressive, attractive ambiance that attract attention but do not provide students opportunities to go beyond the cut-and-dried rote activities of the modular lab. (p. 29-29)

Without first assessing the true effectiveness of the modular laboratories in assisting industrial technology education students to develop identified knowledge and skills, school districts are spending their budgets on activities that may be absent of any educational purpose. No research is currently available that examines and compares the effectiveness of modular instruction in achieving student outcomes in industrial technology education.

Purpose

The purpose of this study was to compare modular industrial technology education instruction with traditional laboratory instruction and industrial technology education instruction in contemporary laboratories. Thus, this study identified which type of instructional environment is most appropriate for middle level industrial technology education.

Research Questions

More specifically, this study addressed the following research questions:

1. Is there a significant difference in industrial technology education achievement between seventh grade students who receive instruction in a modular laboratory compared to seventh grade students who receive instruction in a traditional industrial technology education laboratory.

2. Is there a significant difference in industrial technology education achievement between seventh grade students who receive instruction in a modular laboratory compared to seventh grade students who receive instruction in a contemporary industrial technology education laboratory.

Methodology

The methodology used in this study was a pretest-posttest non-equivalent group design as suggested by Campbell and Stanley (1963), Best and Kahn (1989), and Gray (1992). Seventh grade middle school students were assessed prior to their enrollment in a nine-week industrial technology education course. Their achievement gain was then measured with an identical posttest after completion of the course. Best and Kahn noted that the "gain scores may be compared and subjected to a test of the significance of the difference between the means" (p. 127). The authors further indicated that this was an appropriate research design when coupled with the analysis of covariance (ANCOVA) statistical treatment. The ANCOVA was used to compare the three different instructional settings based on students' achievement gains as measured by the pretest-posttest instrument. However, as noted by Borg and Gall (1983) when interpreting the results of this type of study, "the possibility that group differences on the posttest are due to preexisting group differences rather that the treatment effect" must be taken into account (p. 683).

Instrumentation

In order to assess seventh grade student achievement gain, a middle level industrial technology education evaluation instrument was developed. A list of 100 questions was developed from the Nebraska Industrial Technology Education Framework (Nebraska Department of Education, 1995). These questions were then evaluated by a panel of middle school and junior high school industrial technology education teachers. After initial review, 72 questions were revised and a second draft instrument was reviewed by the panel. Panel members were asked to carefully review these questions for content validity referencing the Nebraska Industrial Technology Education Framework. The final review yielded a set of 58 questions that had direct content validity to the State's curriculum Framework.

The final 58 questions included general industrial technology education knowledge (n=8), drafting technology (n=12), manufacturing processes (n=10), electricity/electronics (n=9), construction technology (n=7), power/energy (n=6), and knowledge of industrial materials (n=6). Each question was a multiple-choice construction and included the correct response and three distracters.

Population and Sample

The population for this study consisted of seventh grade industrial technology education students from a Midwest school district. Three middle schools from this district were selected as the test sites based on their industrial technology education laboratories. One middle school used the modular approach to teach its industrial technology education classes. This school's modular laboratory was current and state of the art. A second middle school provided a contemporary laboratory location for its instruction. This school's industrial technology education classroom had both modern equipment, such as computer-numerical-control machining, computer-aided drafting, injection molding, and a wind tunnel, and traditional work benches and industrial machinery. Traditional laboratory instruction was measured at a third middle school. This school's laboratories are original 1960 industrial arts shops without contemporary industrial technology education equipment.

A total of 160 seventh grade industrial technology education students from these three middle schools comprised the sample for this study. Sixty-seven students from the middle school with the traditional laboratory participated in the study. Sixty-five middle school students from the modular school were included in this research. While 30 seventh graders from the school with a contemporary laboratory completing the assessment instruments.

Data Analysis

The pretest was administered during the first week of the second quarter during the 1997-1998 school year. The posttest was administered during the last week of the second quarter. The 160 sets of pretest and posttest instruments were electronically scored. Achievement scores were then divided by instructional setting, traditional laboratory, contemporary laboratory, and modular lab. Statistical significance was tested using the ANCOVA treatment. The pretest achievement scores were used by the

ANCOVA statistical treatment as the covariant to control for differences in the samples.

Additional analyses of achievement differences were based on the curricular content of industrial technology education as identified during the instrument development. Comparisons were made with regard to general industrial technology education knowledge, drafting technology, manufacturing processes, electricity/electronics, construction technology, power/energy, and knowledge of industrial materials.

Findings

The research results noted that seventh grade students scored an average of 22.19 on the 58-item pretest and 22.01 on the identical posttest. Thus overall there was no significant achievement gain from the industrial technology education course. However, dividing the achievement results into the perspective instructional locations indicated one instructional environment provided achievement gains. Seventh grade students who received instruction in the contemporary industrial technology education laboratory posted an achievement gain of 11.5% (25.11 to 28.00). The contemporary laboratory achievement gain tested significant to both the traditional laboratory instruction and modular technology education (F=11.09, P=.0001) (See Table 1).

Insert Table 1 about here.

Analysis of the eight questions related to general industrial technology education knowledge noted that contemporary laboratory instruction yielded the greatest achievement gain in this area. This gain of

6.9% was significant when compared to modular instruction as indicated by the ANCOVA treatment (F=6.56, P=.002) (See Table 2).

Insert Table 2 about here.

Drafting technology questions are examined in Table 3. Seventh grade students from the contemporary laboratory posted an achievement gain of 23.5%. This achievement gain tested significant to the gains of students from both the modular and traditional instructional settings (F=14.61, P=.0001).

Insert Table 3 about here.

Students in the contemporary laboratory instructional setting achieved significantly better than students from a traditional setting with regard to manufacturing processes (F=4.38, P=.014). There was no significant difference between modular laboratory students and the contemporary laboratory environment. The achievement results for the 10 manufacturing process questions can be seen in Table 4.

Insert Table 4 about here.

Achievement gains related to electricity/electronics are displayed in Table 5. There was no significant difference between the seventh grade students with regard to electricity/electronics scores (F=2.11, P=.125). Table 6 displays the results of the seven construction technology questions. Seventh grade students from the contemporary laboratory tested significantly better in the area of construction technology than students who received their instruction in the modular or traditional environments (F=5.47, P=.005). The contemporary instructional setting provided construction technology an achievement gain of 19.9%.

Insert Tables 5 & 6 about here.

An achievement gain of 18.5% in the power/energy area was posted by students who received instruction in a contemporary industrial technology education laboratory. The seventh grade students who received their instruction in a contemporary laboratory scored significantly higher than their traditional or modular counterparts (F=3.80, P=.025) (See Table 7). Achievement gain relating to knowledge about industrial materials indicated no significant difference between students with regard to industrial technology education instructional setting (F=.74, P=.477). Achievement gains for knowledge of industrial materials can be seen in Table 8.

Insert Tables 7 & 8 about here.

Discussion

To the extent that this study was based on an intact group design, its results indicated that industrial technology education instruction in a contemporary laboratory provided seventh grade students the greatest overall achievement gain when compared to traditional laboratory or modular instruction. The results also noted that contemporary laboratory instruction provided significantly better achievement than modular technology education in the areas of general industrial technology education knowledge, drafting technology, manufacturing processes, construction technology, and power/energy.

This study provides data that modular industrial technology education does not produce significantly better achievement gains in seventh grade industrial technology education students. It is also evident that traditional "industrial arts" laboratories do not provide the learning environment necessary for seventh grade student to master the objectives of the Nebraska Industrial Technology Education Framework (Nebraska Department of Education, 1995).

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Table 1

Overall Score For Industrial Technology Education Achievement

Pre-Test and Post-Test Scores

School	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	Adjusted Post-Test M
Traditional (n = 67)	20.88	6.94	20.01	6.43	20.86
Contemporary (n = 28)	25.11	6.62	28.00	6.04	26.95
Modular (n = 65)	22.29	6.77	21.49	6.75	21.70
Total (n = 160)	22.19	6.94	22.01	7.06	

ANCOVA

Source of Variance	SS	df	MS	F	Sig of F
Between groups	734.19	2	367.09	11.09	.0001
Regression	1467.33	1	1467.33	44.31	
Within groups	5165.90	156	33.11		

Table 2

General Industrial Technology Education Achievement Scores

Pre-Test and Post-Test Scores

School	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	Adjusted Post-Test M
Traditional (n = 67)	3.39	1.77	2.97	1.98	3.09
Contemporary (n = 28)	4.21	1.73	4.50	1.73	4.33
Modular (n = 65)	3.57	2.07	2.86	1.83	2.92
Total (n = 160)	3.61	1.90	3.19	1.97	

ANCOVA

Source of Variance	SS	df	MS	F	Sig of F
Between groups	40.54	2	20.27	6.56	.002
Regression	70.57	1	70.57	22.84	
Within groups	482.12	156	3.09		

Table 3

Drafting Technology Achievement Scores

Pre-Test and Post-Test Scores

School	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	Adjusted Post-Test M
Traditional (n = 67)	4.67	1.83	4.27	1.87	4.39
Contemporary (n = 28)	5.50	1.84	6.79	1.87	6.66
Modular (n = 65)	5.03	1.97	5.06	2.02	5.07
Total (n = 160)	4.96	1.91	5.03	2.12	

ANCOVA

Source of Variance	SS	df	MS	F	Sig of F
Between groups	99.93	2	49.97	14.61	.0001
Regression	53.98	1	53.98	15.78	
Within groups	533.65	156	3.42		

Table 4

Manufacturing Processes Achievement Scores

Pre-Test and Post-Test Scores

School	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	Adjusted Post-Test M
Traditional (n = 67)	2.91	1.69	2.69	1.53	2.76
Contemporary (n = 28)	3.29	1.61	3.82	1.68	3.70
Modular (n = 65)	3.00	1.76	3.31	1.52	3.36
Total (n = 160)	3.19	1.77	3.14	1.60	

ANCOVA

Source of Variance	SS	df	MS	F	Sig of F
Between groups	20.75	2	10.38	4.38	.014
Regression	9.15	1	9.15	3.87	
Within groups	369.22	156	2.37		

Table 5

Electricity/Electronics Achievement Scores

Pre-Test and Post-Test Scores

School	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	Adjusted Post-Test M
Traditional (n = 67)	3.27	1.57	3.31	1.60	3.41
Contemporary (n = 28)	3.68	1.36	4.11	1.23	4.06
Modular (n = 65)	3.68	1.36	3.52	1.58	3.47
Total (n = 160)	3.51	1.46	3.54	1.55	

ANCOVA

Source of Variance	SS	df	MS	F	Sig of F
Between groups	8.79	2	4.39	2.11	.125
Regression	44.39	1	44.39	21.31	
Within groups	324.92	156	2.08		

Table 6

Construction Technology Achievement Scores

Pre-Test and Post-Test Scores

School	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	Adjusted Post-Test M
Traditional (n = 67)	2.64	1.31	2.61	1.46	2.63
Contemporary (n = 28)	2.86	1.24	3.43	1.32	3.41
Modular (n = 65)	2.75	1.32	2.37	1.40	2.37
Total (n = 160)	2.73	1.30	2.66	1.45	

ANCOVA

Source of Variance	SS	df	MS	F	Sig of F
Between groups	21.25	2	10.63	5.47	.005
Regression	9.11	1	9.11	4.69	
Within groups	302.80	156	1.94		

Table 7

Power/Energy Achievement Scores

Pre-Test and Post-Test Scores

	Pre-Test		Post-Test		Adjusted Post-Test
School	M	SD	M	SD	M
Traditional (n = 67)	2.45	1.35	2.40	1.33	2.42
Contemporary (n = 28)	2.71	1.30	3.21	1.10	3.19
Modular (n = 65)	2.51	1.38	2.46	1.37	2.47
Total (n = 160)	2.52	1.35	2.57	1.34	

ANCOVA

Source of Variance	SS	df	MS	F	Sig of F
Between groups	12.85	2	6.42	3.80	.025
Regression	7.14	1	7.14	4.22	
Within groups	263.85	156	1.69		

Table 8

Industrial Materials Achievement Scores

Pre-Test and Post-Test Scores

School	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	Adjusted Post-Test M
Traditional (n = 67)	1.55	1.27	1.76	1.18	1.79
Contemporary (n = 28)	1.85	1.11	2.14	1.33	2.12
Modular (n = 65)	1.75	1.12	1.91	1.16	1.90
Total (n = 160)	1.69	1.18	1.89	1.20	

ANCOVA

Source of Variance	SS	df	MS	F	Sig of F
Between groups	2.07	2	1.04	.74	.477
Regression	7.61	1	7.61	5.46	
Within groups	217.44	156	1.39		

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