HIGHER-ORDER THINKING VERSUS LOWER-ORDER THINKINING SKILLS: DOES SCHOOL-DAY SCHEDULING PATTERN INFLUENCE ACHIEVEMENT AT DIFFERENT LEVELS OF LEARNING?

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Abstract

Historically, one of the most constant features of America's high schools is the structure of the school day. However, in the 1990s, "The most visible and perhaps significant change in the organization of the high school is the block schedule" (Cawelti, 1997, p. 41). There have been conflicting results regarding the effects of block scheduling on student achievement. Researchers in agricultural education have supported instructional practices that improve student learning at higher levels of cognition. Yet, little is known about the effects of scheduling on agricultural education and its influence on student cognition. This study compared higher- and lower-order thinking skills (HOTS and LOTS) achievement of students enrolled in animal science on a Traditional schedule to the achievement of students on a Block schedule. The responding sample included 45 teachers representing 23 Traditional scheduled schools with 341 students and 22 Block scheduled schools with 325 students. Student achievement was measured by two examinations/scales based on an extension of Newcomb and Trefz' (1987) "levels of learning" model. The scales consisted of 33 HOTS and 23 LOTS items. Teachers answered a questionnaire describing themselves and their schools. Student achievement was slightly more than half of the "conventional" 70 % passing standard. T-tests revealed that neither HOTS nor LOTS performance of students on a Traditional schedule was significantly different than that of the Block scheduled students. Multiple regression analyses with hierarchical order of entry were performed. The moderator variables student length of FFA membership and teacher tenure significantly explained student variability for both levels of achievement (longer FFA membership and longer teacher tenure resulted in greater achievement); the scheduling variable Traditional versus Block did not explain additional student variability in achievement. One could not conclude that one schedule was superior to the other in improving student achievement.

Introduction/Theoretical Framework

Elmore (1995) stated, "Over the past decade the United States has been engaged in the most sustained period of educational reform since the Progressive Era" (p. 356). Evidence of impetus for reform has been well documented by reports such as *Prisoners of Time* (National Education Commission on Time and Learning, 1994) and *Breaking Ranks: Changing an American Institution* (NASSP, 1996). These reports called for a restructuring of the American educational system, and frequently targeted "time" and its use in school-day scheduling patterns as a basic element to be altered**.** Moreover**,** learning theorists (Bloom, 1974; Carroll, 1989) have stated that time and its use is a significant and essential component of student learning. Karweit and Slavin (1981) maintained "the ambiguity of the research studies to date, make the continuation of studies of time and learning important" (p. 158).

Researchers (Carroll, 1990; Kirby, Moore, & Becton, 1996) have maintained that one of the most constant features of America's high schools is the structure of the school day. In support, Carroll (1990) contended, "For three-quarters of a century–a period characterized by immense social, political, economic, and technological changes–the high school has not changed its basic form of organization" (p. 360). Moreover, investigators have said, "The way time is organized in schools may have contributed to the educational deficiencies in American education identified in such reports as A Nation at Risk" (Wortman, Moore, & Flowers, 1997, p. 440). This "basic" or "traditional" school-day schedule is one in which students attend between six and eight classes each school day, with a class lasting approximately 50 or so minutes (York, 1997).

However, Cawelti (1997) concluded, "The most visible and perhaps significant change in the organization of the high school is the block schedule" (p. 41). DiRocco (1998/1999) asserted, "Intensive schedules [i.e., block scheduling] can be a powerful catalyst for change and for improved instruction in our secondary schools when implemented properly" (p. 83). Although many "variations" of block scheduling exist (Canady & Rettig, 1995), two of the more common are the Modified A/B (Alternating Day) Block Schedule and the Nine-Week Accelerated (4X4) Semester Block Schedule. On the Modified A/B Block Schedule, the school day is divided into four instructional blocks of approximately 90 minutes each. Students alternate class attendance between "A" day classes and "B" day classes, and may be simultaneously enrolled for as many as eight different courses. On this schedule, most courses meet every other day for an 18-week semester. On the Nine-Week (4X4) Block Schedule, the school day is also divided into four instructional blocks of about 90 minutes each, but students attend the same four classes each day for the nine-week period.

Watson (1998) asserted, "In a block schedule, the [learning] tasks can be designed to take more time, be of greater depth, [and] require more inductive or higher-order thinking skills" (p. 97). Torres and Cano (1995) stated, "The use of thinking skills in problem situations is universally recognized as a prominent objective for all educational academies" (p. 46), including agriculture. Moreover, researchers Cano and Newcomb (1990) concluded that agriculture teachers "should purposefully create learning situations which assist in the development of higher cognitive abilities in students" (p. 51).

Bloom, Engelhart, Furst, Hill, and Krathwohl (1956) described six levels of cognition, that is, levels of thinking often referred to as Bloom's Taxonomy. This approach to describing thinking behaviors delineated cognition into lower- and higher-order thinking skills and conceptualized them in a hierarchical fashion (Bloom et al., 1956; Newcomb & Trefz, 1987; Torres & Cano, 1995; Whittington, Stup, Bish, & Allen, 1997). Using Bloom's model as a framework, Newcomb and Trefz (1987) developed a similar model for classifying cognitive behaviors into "four levels of learning": remembering, processing, creating, and evaluating (Figure 1). Whittington et al. (1997) stated, "Research supports the theory that thinking at higher levels of cognition (thinking critically) is an indispensable skill and must be reinforced in schools" (p. 47). Cano and Martinez (1989) recommended, "Students of vocational agriculture should be challenged to develop stronger cognitive abilities and critical thinking abilities at higher levels through the instruction they receive" (p. 364). However, Cano (1990) stated that there was "a paucity of findings regarding vocational education students' level of cognitive performance. Specifically, research in determining the level of cognitive performance of vocational agriculture students was lacking" (p. 74). Whittington (1995) recommended that additional research was needed to investigate non-teacher variables that may be influencing the level of cognition obtained during instruction.

Block scheduling has been accompanied by conflicting results regarding its effect on student thinking skills and achievement (Wortman et al., 1997). Kirby et al. (1996) found agriculture teachers to be "neutral or undecided" (p. 357) when responding to the statement "Student achievement has improved with block scheduling" (p. 358). However, Brannon, Baker, Morgan, Bowman, and Schmidt (1999) concluded, "Agriculture teachers agreed that as a result of block scheduling learning is more meaningful for all students" (p. 197). Yet, little is known about the effects of scheduling on secondary-level agricultural education and its potential for influencing the cognitive development of students (Kirby et al., 1996; Wortman et al., 1997). Is there a difference in achievement for students enrolled in an agriscience course, depending on the school-day scheduling pattern?

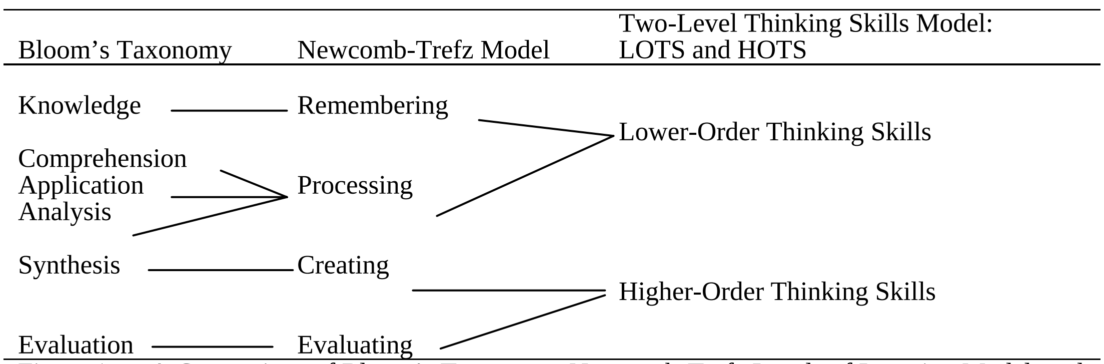

Figure 1. A Comparison of Bloom's Taxonomy, Newcomb-Trefz Levels of Learning Model, and a Two-Level Thinking Skills Model: LOTS and HOTS (Extended from a comparison of Bloom's Taxonomy and the Newcomb-Trefz Model (Whittington, 1995), *Journal of Agricultural Education*)

Purpose/Research Questions

The purpose of this study was to compare the higher- and lower-order thinking skills achievement of students enrolled for a secondary-level course in animal science on a Traditional school-day schedule to the achievement of students enrolled for the course on a Block schedule basis (i.e., Modified A/B (Alternating Day) and Nine-Week Accelerated (4X4) Semester Block schedules). These research questions guided this study:

1. What are selected characteristics of students enrolled in and instructors teaching a secondary-level course in animal science?
2. What is the level of achievement for HOTS, as described by Newcomb and Trefz (1987), for students enrolled in animal science? a) Does level of achievement for HOTS of students on a Traditional schedule differ from that of students on a Block schedule?
3. What is the level of achievement for LOTS, as described by Newcomb and Trefz (1987), of students enrolled in animal science? a) Does level of achievement for LOTS of students on a Traditional schedule differ from that of students on a Block schedule?
4. Do moderator variables, e.g., student and teacher variables, explain variation in student achievement, and does scheduling pattern significantly explain variation in student achievement after effects of moderator variables have been removed?

Methods/Procedures

This was a descriptive study that employed the causal-comparative method to describe and explore possible cause-and-effect relationships between school-day schedules and the achievement of intact groups. Gall, Borg, and Gall (1996) stated that "the major advantage of the causal comparative method is that it allows us to study cause-and-effect relationships under conditions where experimental manipulation is difficult or impossible" (p. 383).

The target population (Gall et al., 1996) consisted of students enrolled in and the instructors teaching the agriscience course Animal Science (AGSC 332) in Texas public schools during the fall of 1998. Schools that had offered/taught this course for the school years 1996-97 and 1997-98 (n = 388) were obtained from the Texas Education Agency and served as the sampling frame. The "experimental units" for this study were individual agriscience classes and teachers, but individual students were the sampling units within an agriscience class. This was a form of cluster sampling, which, according to Gall et al. (1996), "is used when it is more feasible to select groups of individuals rather than individuals from a defined population" (p. 227). The responding sample consisted of 45 "volunteer" teachers and schools, representing 23 Traditional scheduled schools with 341 students and 22 Block scheduled schools with 325 students. Because the data for this study were provided by a volunteer sample, the results are generalizable only to subsequent similar volunteer samples.

The students completed a two-part instrument. Part one consisted of selected demographic items, e.g., length of FFA membership. The second part of the instrument was an end-of-course achievement examination. Glaser (1963) maintained that achievement tests were appropriate for determining "the degree to which the student has attained criterion performance" (p. 519). The examination was developed from recommended curriculum materials for the agriscience course Animal Science (AGSC 332) (Instructional Materials Service, n.d.; Instructional Materials Service, 1998). It included 56 multiple-choice items selected for content validity in the areas of nutrition, reproduction, health, and management of domestic animals. Three agricultural educators—a curriculum specialist, a classroom teacher, and a measurement specialist—reviewed the items for clarity and content.

The examination was divided into two scales based on an extension of Newcomb and Trefz' (1987) "levels of learning" model (Figure 1). The two scales consisted of 33 higher- and 23 lower-order thinking skills items, respectively. The LOTS portion of the examination was made up of remembering and processing items; the HOTS scale contained items at the creating and evaluating levels of learning (Newcomb & Trefz, 1987). The Cronbach's coefficient alpha reliability estimate for the LOTS scale was .79, while the HOTS scale had a reliability estimate of .78. Finally, teachers responded to a questionnaire that included selected multiple-choice items describing themselves and their schools.

A researcher-developed packet consisting of student questionnaires/examinations, teacher questionnaires, pre-coded scan sheets, and postage-paid return envelopes were mailed to the participating teachers. Due to varying end-of-course dates, two mailings were necessary. Teachers administered the student questionnaires/examinations and completed their questionnaires at or about the same time. The student scan sheets were coded so that they could be identified with their teacher and school-day schedule. The returned scan sheets were inspected to ensure the number codes were still intact. Following scanning, the data were entered into a Microsoft Excel 97 spreadsheet file and then imported into an SPSS 7.5 data file. T-tests were performed to compare means and explore differences for research questions two and three, with an a priori alpha of .05. Multiple regression analyses with hierarchical order of entry of predictor variables were performed to answer question four.

Results/Findings

As seen in Table 1, slightly more than one-half of the participating students were male and nearly 44 percent were female. Almost 70 percent of the students were Anglo, while three-in-ten identified themselves as "People of Color." Slightly more than three-in-ten had never been an FFA member, and approximately seven-in-ten had been members for one or more years. Nearly three-fourths indicated at least "some experience" with domesticated animals, while slightly more than one-fourth said they had "little" or no experience (Table 1).

Nearly 90 percent of the teachers were male while slightly more than one-in-ten were female (Table 1). Concerning their education, the teachers were nearly evenly divided, that is, slightly less than half held only a bachelor's degree while a slight majority had earned a master's degree. Years of experience as an agriscience teacher was also nearly evenly split with slightly less than half of the teachers having taught 12 or fewer years, and slightly more than half indicating 13 or more years of service. When asked about years of service at their current school, a slight majority replied that they had taught at their current school for 10 or fewer years, while slightly less than half indicated 11 or more years of service (Table 1).

Table 1.
Selected Characteristics of Students (N=666) Enrolled in and Instructors (N=45) Teaching Animal Science

Characteristic	N	Percent
Students		
Gender[a]	369	55.4%
Male	292	43.8%
Female		
Ethnicity[b]	459	68.9%
Anglo (White Non Hispanic)	197	29.7%
People of Color		
FFA Membership[c]	207	31.1%
Never	126	18.9%
Less than one year	140	21.0%
Two years	140	21.0%
Three years	51	7.7%
Four years		
Experience with Domestic Animals[d]	43	6.5%
None	140	21.0%
Little experience	175	26.3%
Some experience	116	17.4%
Much experience	191	28.7%
Great experience		
Instructors		
Gender	39	86.7%
Male	6	13.3%
Female		
Highest Level of Education	21	46.7%
Bachelor's degree	24	53.3%
Master's degree		
Years of Experience as an Agriscience Teacher	21	46.6%
1 – 12 years	24	53.3%
13 or more years		
Years of Service at Current School	23	51.2%
1 – 10 years	22	48.9%
11 or more years		

[a] Five students did not answer this question.
[b] Ten students did not answer this question.
[c] Two students did not answer this question.
[d] One student did not answer this question.

The HOTS achievement mean for all students was M=35.50, SD=12.34 (Table 2) or only very slightly more than half of the "conventional" 70 % passing standard. Students on a Traditional schedule scored higher (M=37.24, SD=15.22) than students on a Block schedule (M=33.69, SD=8.34) (Table 2). Further, the LOTS achievement mean for all students was M=37.78, SD=13.55 (Table 2) or slightly more than half of the "conventional" 70 % passing standard. Students on a Traditional schedule scored higher (M=39.08, SD=15.73) than students on a Block schedule (M=36.42, SD=11.03).

Table 2.
Means and Standard Deviations for End-of-Course Thinking Skills Achievement by Scheduling Pattern, (N=45)

School-Day Scheduling Pattern	N	Mean	SD
	Higher-Order Thinking Skills (HOTS)		
Traditional	23	37.24	15.22
Block[a]	22	33.69	8.34
Overall	45	35.50	12.34
	Lower-Order Thinking Skills (LOTS)		
Traditional	23	39.08	15.73
Block[a]	22	36.42	11.03
Overall	45	37.78	13.55

[a] Includes Modified A/B and Nine-Week (4X4) Block groups combined.

A t-test was used to compare the end-of-course achievement for HOTS for the Traditional scheduled students versus those who were Block scheduled (Table 3). This procedure produced a mean difference of 3.55, t (43) = .963 p = .341 (Table 3). The difference was not significant at an alpha level of .05. That is, the HOTS performance of students on a Traditional schedule was not statistically significantly superior to that of the Block schedule students. Further, a t-test was used to compare the end-of-course achievement for LOTS (Table 3). This procedure produced a mean difference of 2.66, t (43) = .652, p = .518 (Table 3). The difference was not significant at an alpha level of .05. That is, the LOTS performance of students on a Traditional schedule was not statistically significantly superior to that of the Block schedule students.

Table 3.
End-of-Course Thinking Skills Achievement: Contrast of Traditional versus Block Scheduling

Source	Mean	Mean Difference	S.E.	t	df	sig.
		Higher-Order Thinking Skills (HOTS)				
Contrast[a]						
Traditional	37.24	3.55	3.68	.963	43	.341[c]
Block[b]	33.69					
		Lower-Order Thinking Skills (LOTS)				
Contrast[a]						
Traditional	39.08	2.66	4.07	.652	43	.518[c]
Block[b]	36.42					

[a] Contrast assumes equal variances.
[b] Includes Modified A/B and Nine-Week (4X4) Block groups combined.
[c] Not Significant.

To determine if school-day scheduling patterns significantly explain variability in student achievement after the effects of selected student and teacher variables were removed, multiple regression analyses with hierarchical order of entry of variables were performed. These procedures were done to control initial non-equivalence in the two research groups. Correlation analysis revealed that there was a statistically significant relationship between the student variable length of FFA membership and end-of-course higher- and lower-order thinking skills achievement, r = .53 and r = 46 (p < .01), respectively. That is, the greater the length of time the student had been a member of the FFA, the better they performed on the higher- and lower-order thinking skills achievement examination items.

Moreover, similar analysis demonstrated that there was a statistically significant relationship between the teacher variable teacher tenure and HOTS achievement ($r = .34$, $p < .05$). As a teacher's length of tenure increased, the HOTS achievement of their students increased. (The variable "teacher tenure" combined an instructor's years of experience as an agriscience teacher and their tenure at their current school. The resulting scale had a reliability coefficient estimate of .86.) Therefore, because of positive associations with student achievement, these two moderator variables were entered into a multiple regression analysis equation as step one in a hierarchical order of entry procedure. Then, to determine if school-day schedules significantly explained additional student variability for end-of-course achievement, the scheduling pattern variable was entered in step two of the procedure. Thus, step two included the variable Traditional versus Block.

In Table 4, step one portrays regression of the variable HOTS achievement on the variables student FFA membership and teacher tenure. A statistically significant amount of student variability for HOTS achievement was explained by this entry: $R^2 = .324$, $F = 10.046$, $p = .000$. But, when the variable Traditional versus Block schedule was entered, there was not a significant contribution to the explanation of variance, R^2 Change = .000, $F = .020$, $p = .888$. Further, when the dependent variable LOTS achievement was regressed on the independent variables entered in step one, i.e., student FFA membership and teacher tenure, the amount of variance explained was $R^2 = .231$, $F = 6.324$, $p = .004$ (Table 4), which was significant at an alpha level of .05. The variable Traditional versus Block schedule was entered into the regression equation in step two; it did not explain additional student variability for LOTS achievement, R^2 Change = .002,

$F = .103$, $p = .750$ (Table 4).

Table 4.
Hierarchical Regression of Thinking Skills Achievement on Selected Student and Teacher Variables and School-Day Scheduling Pattern

Variable(s) Entered	R Square	R Square Change	F Change	Sig. Of Change
Higher-Order Thinking Skills (HOTS)				
Step 1				
Student FFA Membership and Teacher Tenure	.324	.324	10.046	.000
Step 2				
Traditional versus Block	.324	.000	.020	.888
Lower-Order Thinking Skills (LOTS)				
Step 1				
Student FFA Membership and Teacher Tenure	.231	.231	6.324	.004
Step 2				
Traditional versus Block	.233	.002	.103	.750

Conclusions/Implications/Recommendations

Glaser (1963) contended "achievement tests are employed to discriminate among treatments, that is, among different instructional procedures [e.g., scheduling patterns] by an analysis of *group* differences" (p. 520). This study compared the higher- and lower-order thinking skills achievement of students enrolled for a secondary-level course in animal science on a Traditional school-day schedule to the achievement of students enrolled on a Block schedule. The end-of-course HOTS achievement for all students was only very slightly more than half of the "conventional" 70 % passing standard, while their LOTS achievement was only slightly better (Table 2). Webster and Miller (1998) found similar results for an animal science examination administered to high school seniors in 12 Midwestern States. They concluded that the students were not strongly intrinsically motivated to excel on the test, and that "this factor most likely explains why the students did not perform better on the exam" (p. 318). Moreover, was there a significant lack of "alignment" or "congruence" between the curriculum these students were taught and the course content on which they were assessed? Hoyle, Steffy, and English (1994) suggested, "the result of incongruence is normally lower test performance on the part of the students, particularly if the test has been selected because it was congruent with the written curriculum" (p. 98). The examination used in this study was based solely on the recommended curriculum materials for the course Animal Science (AGSC 332). Was this a valid procedure if the requisite "alignment" did not exist?

The higher- and lower-order thinking skill performance of students on a Traditional schedule was not statistically significantly greater than that of the Block schedule students (Table 3). Moreover, when multiple regression analyses with hierarchical order of entry were performed, and the moderator variables student length of FFA membership and teacher tenure were entered in step one, variability in HOTS achievement was significantly explained (Table 4). However, in step two, when the scheduling pattern variable Traditional versus Block was entered, there was no additional significant explanation of student variability (Table 4). Further, in the case of LOTS achievement, when the moderator variables student length of FFA membership and teacher tenure were entered in step one, variability in LOTS achievement was significantly explained (Table 4). Similar to HOTS achievement, in step two, when the scheduling pattern variable Traditional versus Block was entered, there was no additional significant explanation of student variability in LOTS achievement (Table 4). Based on these findings, one could not conclude that one school-day schedule was significantly superior to the other for the purpose of improving end-of-course achievement of students. Recommendations for future practice and research include the following:

1. This study suggests that there may be an "incongruence" between the actual curriculum materials that teachers used to teach animal science and the recommended instructional materials. Hoyle et al. (1994) stated, "curriculum mapping can reveal what was taught, in what order, and for how long . . ." (p. 90). So, a form of "curriculum mapping" should be used to identify the curriculum materials used by the instructors for this course. It might also be useful to examine the relationship between this study's teachers' use of the recommended materials and the performance of their students.
2. This study should be "replicated" using quasi- or experimental design procedures that will control potential extraneous variables (i.e., student length of FFA membership and teacher tenure), and thereby improve the generalizability of future results.
3. This study did not find a significant difference in the performance of learners depending on which school-day schedule pattern they received instruction. Would this result have been similar for other agriscience courses? Mindful of this, it is recommended that this study be replicated for other agriscience courses.
4. Are there other moderator variables that significantly explain student variability in end-of-course achievement for the secondary-level course Animal Science? Further research should be performed to determine if additional variables do exist.
5. As a component to the study that yielded these findings, Edwards and Briers (in press) found that there was a significant difference in the achievement of students, when two different "block" scheduling patterns (i.e., Modified A/B and Nine-Week (4X4) Semester) were compared. In addition to the two patterns investigated by that study, it appears that there are numerous "variations" of block scheduling regimens (Canady & Rettig, 1995). Therefore, it is recommended that a two-part study be conducted. The purpose of the first part would be to identify and describe these varied block-scheduling patterns. Then, in part two one might conduct additional comparative studies to determine if there are significant differences in student achievement depending on the learner's school-day schedule.
6. Although the relationship between the use of school-day time (i.e., scheduling patterns) and student performance remains ambiguous, researchers (Canady & Rettig, 1995; Carroll, 1994) have suggested that there is a causal relationship between the use of block scheduling and an improvement in school climate (i.e., classroom environment), and further, the important role that "climate" can play in the behaviors of students and teachers (Bloom, 1974; Hoyle et al.,1994; Kruse & Kruse, 1995). So, research should be undertaken to investigate how changes in school-day scheduling patterns may positively influence factors that comprise a school's "climate," and, subsequently, create learning environments that are more conducive to improved student achievement. For example, instructors teaching on different scheduling patterns may be exhibiting different teaching behaviors that are related to their students' performance. Case studies or other qualitative techniques could be conducted profiling the teaching behaviors of these instructors.

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