A Comparison of Behaviorist and Constructivist-Based Teaching Methods in Psychomotor Instruction

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Abstract

The authors conducted an experimental comparison of two different teaching strategies, one based on behaviorist principles and the other on social constructivist principles, in teaching a linear psychomotor skill. Two randomly selected groups of gifted students were provided instruction on making an origami piece. The purpose of the study was to determine which teaching method produced better short-term retention of the selected task. The pieces were evaluated using a scoring rubric developed and field tested by the researchers. Analysis on the scores showed that there was no significant difference in the performance between the two groups. In addition, the University's official teacher/course evaluation form was used to compare the students' evaluations of the different teaching styles. Analysis of the course evaluation scores showed a significant preference for the behaviorist-based instruction. This study does not support the current trend of shifting instruction from the behaviorist method to the constructivist method of teaching for linear psychomotor tasks. However, there was a definite student preference for the behaviorist method of teaching.

Behaviorism formed the traditional basis for schooling in western societies for most of the past century, but in recent years there has been a visible shift to in educational practice toward social constructivism as the dominant learning theory (Doolittle and Camp, 1999). Using behaviorist principles, teachers often instruct their students using a linear step-by-step approach (Dobbins, 1999). Educators who base their pedagogies on social constructivism, believe that students learn in a less structured and more social environment in which they "construct" their own knowledge (Dobbins, 1999).

Background

In 1956 Benjamin Bloom developed a taxonomy of learning. He identified three domains: cognitive, affective, and psychomotor. Cognitive learning involves fact-based knowledge and affective learning involves student attitudes. The third domain, psychomotor, involves teaching a student to perform a manipulative task. Many educators focus on cognitive and affective learning, but it is equally important to teach psychomotor skills (Gagne, 1975). These psychomotor skills, Gagne (1977) wrote, progress throughout a student's life. Children begin by learning how to sing or throw a ball. They then progress by learning how to use certain tools such as protractors and microscopes as well as learning foreign languages and how to cook or sew.

Dobbins (1999) pointed out that career and technical education curricula tend to be heavily weighted with psychomotor tasks and are often very linear in nature, meaning the tasks must be mastered in a sequential manner. Doolittle and Camp (1999) examined the efficacy of constructivist principles in teaching the kinds of domain-specific tasks that are so common in career and technical education curricula. They concluded that social constructivist principles have serious limitations in terms of the teaching of content that must be learned in a specific sequence and to specific standards. Beyond that, they suggested:

Career and technical education remains, in fact if not expressly, founded on the learning principles of behaviorism. Many scholars and reformers in the profession have advocated changes that implicitly relied on cognitive constructivist principles. Indeed, many of the changes we have seen in recent years implicitly rely on constructivist principles. Nevertheless, scholars in the profession (career and technical education) have yet to explicitly address the shift from behaviorism to constructivism. (Doolittle & Camp, 1999, p 40)

Conceptual/Theoretical Framework

Behaviorism is the basic learning theory underlying most traditional teaching in American schools. According to behaviorist principles, it is the teacher's job to transmit knowledge (Dobbins, 1999). B. F. Skinner, one of the main early proponents of behaviorism, theorized that a job should be broken down into tasks and that students learn best in a linear step-by-step format. Skinner posited that repetition and constant reinforcement of the step-by-step processes were essential for students to learn a skill properly (Entwistle, 1981).

Some psychologists in current times still praise behaviorism and its learning benefits. Derbyshire (*National Review,* 1999) discussed a book written by Andy Koestler in 1967. Although he conceded that behaviorism had become a somewhat out-of-date theory, Koestler argued that behaviorism still has validity.

However, beginning around the 1970s with such writers as Vygotsky, there has been a move towards constructivism and a decrease in the popularity of behaviorism (Eisner, 1999). Constructivists believe that the learner creates his or her own knowledge, and the teacher is simply a facilitator. "They contend that these methods involve students in realistic contents in which 'active' learning can occur and in which the social construction of knowledge can best be fostered" (Sikula, 1996, p. 152). Vygotsky (cited in Dixon-Krauss, 1996) wrote "teaching and

learning occur in a social context as a dynamic process rather than as a preconceived one." The learner must use his or her own previous knowledge about a particular subject to further learning. The teacher's job is to create an environment in which the student can carry out this process. According to Gagne (1977), as a student uses constructivist methods more often, he or she also becomes more self-sufficient and able to create his or her own knowledge.

In the past few decades, teachers have shown a rapid movement towards constructivism. Results from a study conducted by researchers for *American Scientist* showed that "the past few decades have not been kind to the behaviorist school" (Robins et al., 1998, p. 310). There have been many studies supporting the idea that constructivism works best in the fact-based, problem-solving learning. Teachers also praise constructivism for its time- and monetary-efficiency.

To date, educational theorists and researchers have examined constructivist-based instructional methods primarily in the context of teaching cognitive content. Psychomotor tasks make up a significant part of the curricula in career and technical education in general and in agricultural education in particular. A review of the research literature in both career and technical education and in agricultural education produced no research in which constructivist-based pedagogies had been tested in the psychomotor domain.

Purpose and Objectives

The purpose of the experiment was to determine whether teaching methods using behaviorist or constructivist approaches are more effective for teaching students a psychomotor task. We had three objectives in our experiment:

1. To compare the ability of students to perform a psychomotor skill after learning the task through a behaviorist or constructivist-based approach.
   (Null hypothesis: There will be no differences between the mean scores on the **task performance** by treatment and gender.)
2. To compare the reaction of these students to the instruction based on the methods by which they were taught.
   (Null hypothesis: There will be no differences between the mean scores **instruction evaluation** by treatment and gender.)
3. To **qualitatively assess** the reactions of the subjects to the two different instructional paradigms: constructivism-based and behaviorism-based.

Procedures

Population and Sample

The Summer Residential Governor's School for Agriculture (GSA) is a program for rising juniors and seniors in Virginia public, private, and home schools who have been identified as gifted students. Admission is highly competitive and involves screening at both the local and state levels. Students accepted for the program spend a month on campus taking a series of short courses from university faculty and selected high school teachers. In addition, they are required to complete a major group project that is either research or developmental in nature.
Although the general population from which students at the school were drawn is much larger, the students in the GSA were self-nominated and competitively selected. Thus, the actual

population for the study consisted of 85 students attending the Governor's School for Agriculture at Virginia Tech in summer, 2002.

Although, Krejcie and Morgan (1970) suggested a sample size of 70 to represent a population of 85, we elected to select a smaller sample because of the mechanics involved in teaching a psychomotor task of this nature. We concluded that a "class" size above 20 would create instructional problems, therefore we decided on a sample size of 40, with 20 subjects being assigned to each of the two treatments. Because males and females were not equally represented in the total student body, and because gender was considered a variable of interest, a stratified random sample of students (n=40) consisting of equal numbers of males and females was selected to participate in the experiment. The sample was then randomly assigned to two groups so that each group had equal numbers of males and females.

Design

To accomplish the objectives of the study we designed a 2X2 factorial study. The independent variable of primary interest was treatment. Group 1 received the constructivism-based instruction and group 2 received the behaviorism-based instruction. The second independent variable was gender. Each cell was randomly assigned 10 subjects

The Psychomotor Task

The first step towards conducting our comparative study was to select a psychomotor task. The first criterion used was that the task must be psychomotor and linear in nature so that the steps had to be completed in a precise sequence. The second criterion was that the task must include enough steps that it would be difficult to complete. Finally, the task had to be uncommon enough that the subjects were unlikely to have pre-knowledge of it. We chose an unusual origami figure of a "pumpkin face" for the study (Chen, 1997). The researchers then taught themselves the skill using those instructions and practiced the skill so that they would be proficient enough to teach other students.

We next developed an evaluation rubric for grading the participants' final products. The rubric included three categories on which we graded the origami figure: size, shape, and neatness on a scale from one to four. We field tested our rubric to establish our inter-rater consistency by grading sample pumpkin faces.

Behaviorist-Based Treatment. To represent behaviorist principles we used a demonstration procedure based on the suggestions of Newcomb, McCracken, and Warmbrod (1993) and Hammonds (1968). In the behaviorist group, we taught the students how to make the origami pumpkin face using a traditional step-by-step approach.

1. We set up two tables in the middle of the room where two teachers provided the demonstration.
2. The teachers used the instruction sheet to teach the students in blocks of three steps at a time, sending the students back to their own desks in between to complete those three steps.

3. Each student had an instruction sheet and ruler to use as he or she wished and each table had a completed pumpkin head to serve as a model. The students could ask question from the teachers but could not speak to other students.

Constructivist-Based Treatment. To represent social constructivist principles, we used a cooperative learning procedure based on suggestions from McKeachie (1994) and Borich (2000). We let the constructivist group learn in an interactive manner.

1. Students were stationed around larger tables to facilitate cooperative learning.
2. Each student had a sample pumpkin face, ruler, and instruction sheet to use in the process.
3. The students were encouraged to talk with and help each other in order to learn how to replicate the example pumpkin face.
4. Two instructors provided coaching and answered questions.

Pilot Study

We then conducted a pilot study using four students who had not been selected for the sample. We taught one boy and one girl how to complete the task using the behaviorist method and the same was done using the constructivist method. This allowed us to secure an appropriate time frame for the experiment, make sure the pumpkin face was feasible, and work out any other problems in the experimental design. Based on the pilot study, we decided to give each student a ruler to use in order to standardize the instructions and increase accuracy. We also decided to teach the behaviorist students in a series of three step blocks rather than have them complete the task one step at a time. We believe that this change made the study more time efficient and about the same difficulty level as the constructivist teaching method.

Data Collection and Analysis

The two treatments were presented simultaneously in neighboring laboratories. Two of the of the researchers had rehearsed each of the instructional methods and presented the instruction independently. Two additional researchers were assigned to move from one laboratory to the other to observe the process for qualitative assessment.
In the experiment, we provided instruction/facilitation to each group for precisely thirty minutes, based on the results of the pilot study. We then collected all supplies including samples, instruction sheets, and practice figures. We passed out one sheet of origami paper to each person and allowed ten minutes to make a pumpkin face.

Three members of our group formed a scoring committee and used the evaluation rubric to score each pumpkin face. The composite scores were recorded. The instructional evaluation scores were recorded. Both the task performance and the instruction evaluation scores were analyzed using SPSS 11.0. In both cases, the students' gender and the dependent variable of interest were analyzed using univariate, the General Linear Model (GLM) two-way analysis of variance (ANOVA) procedures in SPSS.

At the conclusion of the experiment, each student who participated completed a survey designed to provide an evaluation of the instruction. This survey used was the same

teacher/course evaluation form used by Virginia Polytechnic Institute as described in Virginia Tech University Faculty Handbook (2000). The evaluation from asks for Likert-type ratings of nine additive items and then asks for open-ended comments regarding the instruction.

For the qualitative portion of the study, assessment began during the instruction with observations by the two of the researchers who were not involved as instructors. That was followed by the analysis of the written comments for themes using the general procedures described in Creswell (1994).

Results and Discussion

Findings

Of the 40 subjects selected to for the sample, 20 males and 20 females, only 37 actually participated. A total of 18 females and 19 males participated with 1 being in the behaviorist treatment and 18 in the constructivist treatment. The means were very close with a slight difference favoring the group taught using behaviorist-methods. See Table 1.

Table 1.
Mean composite scores for the completed origami piece using a scoring rubric based on size, shape, and neatness, each scored on a 1-4 scale. Total composite score was on a 3 to 12 scale.

	Behaviorist Based		Constructivist Based	
	n	Mean	n	Mean
Females	10	7.00	9	7.66
Males	8	8.12	10	6.20

Objective 1, Task Performance. The first objective was to compare the ability of the students to perform a psychomotor task after being instructed using the two different approaches. The result of the GLM ANOVA is shown in Table 2. After scoring the origami, both the behaviorist- and constructivist-taught groups had little difference in the final product. The final score was a composite of three scores on scales from one to four which looked at size, shape, and neatness. The results were not significant and the null hypothesis regarding task performance was not rejected.

Table 2.
Analysis of Variance for the composite scores on a completed origami piece representing a linear psychomotor task taught using behaviorist-based versus constructivist-based instruction, using a scoring rubric based on size, shape, and neatness with a 3 to 12 point scale.

Source	Sum of Squares	df	Mean Square	F	Probability
Corrected Model	19.201	3	6.40	.83	.487
Intercept	1927.30	1	1927.30	249.93	.000
Treatment	3.631	1	3.631	.471	.497
Gender	.268	1	.268	.035	.853
Interaction	15.401	1	15.401	1.997	.167
Error	254.475	33	7.711		
Total	2186.000	37			
Corrected Total	273.676	36			

R^2 = .070, Adjusted R^2 = -.014

Objective 2, Instruction Evaluation. Unfortunately, we failed to collect gender data on the evaluation form and were unable to use that as a second independent variable. In addition, one evaluation instrument was not usable. Using our sample, we computed a Cronbach's alpha the with a result of $\propto = 0.97$. The treatment group means are shown in Table 3. The ANOVA results showed a significant difference favoring the behaviorist teaching method. See Table 4.

Table 3.
Mean composite scores for the evaluation of instruction comparing two methods of instruction. Total composite score was on a 9 to 36 point scale.

	n	Mean	Standard Deviation
Behaviorist Based	18	23.50	4.315
Constructivist Based	18	16.11	11.146
Total	36	19.81	9.133

Table 4.
Analysis of Variance for the composite scores for the instructional evaluation comparing a behaviorist-based and a constructivist-based instruction for a linear psychomotor task .

Source	Sum of Squares	df	Mean Square	F	Probability
Corrected Model	491.361	1	491.361	6.880	.013
Intercept	14121.361	1	14121.361	197.723	.000
Treatment	491.361	1	491.361	6.880	.013
Error	2428.278	34	71.420		
Total	17041.000	36			
Corrected Total	2919.639	35			

R^2 = .168, Adjusted R^2 = -.144

Objective 3, Qualitative assessment. The subjects being taught the skill in a linear, structured, behaviorist setting proceeded in an orderly manner. They followed the instructions quietly and efficiently. They exhibited a very receptive manner. The subjects in the group-centered, less structured, constructivist setting quickly became disruptive and surly. They were unwilling to grapple with the problem-solving and group-based requirements of the task. The

room became very noisy and the subjects' attention was clearly not focused on the task at hand. Repeated trips to both rooms not only confirmed the initial reactions but increased divergence in the reactions of the treatment groups continued throughout the experiment. The level of apparent focus became progressively more intense with the behaviorist group and the level of noise and expressed dissatisfaction became increasing intense with the constructivist group.

When we examined the written responses on the evaluation forms to identify themes, it was clear that the students preferred the behaviorist method to the constructivist method. Typical responses from the constructivist group included illustrate this conclusion:

"Give verbal instructions and demo."
"I get too frustrated."
"It was really hard [*sigh*] and if we had been taught it would have been better."

These statements essentially describe the behaviorist method of teaching. Thus, even though there was virtually no difference between the end origami products of the two groups, the surveys still showed a preference for the traditional behaviorist teaching method.

Conclusions

Our group found no significant difference between the performances of behaviorism-taught students and those taught using the constructivist approach. We conclude hat, based on this experiment, using a select group of gifted students learning a linear psychomotor task is done as efficiently and effectively by teacher-centered linear instruction and open-group, self-directed instruction. Neither the behaviorist-based nor the constructivist-based approach offer an advantage in terms of actual task performance in a short-term setting.

We did, however, determine that there is a significant and meaningful difference in the subjects' evaluation of the quality of the instruction between the two groups of students. The students strongly preferred the instruction based on a teacher-centered, behaviorist approach over the less structures, group-centered, self-instruction of the constructivist method.

In terms of the qualitative aspect of the study, the of students taught in the constructivism-based room became very frustrated and responded with negative comments both during the actual instruction and on the open-ended portion of the survey.

We found a strong preference among students for the teaching style based on behaviorist concepts. On the student survey, the majority of people from the constructivism room responded with negative comments explaining their frustration over the lack of formal teaching. We, therefore, believe that behaviorist method provides a more organized learning environment, which consequently produces better student satisfaction.

Discussion

Given the ambiguous outcome of this study on the actual task performance combined with the strong preference for the behaviorism-based instruction method, our study provides qualified support for the use of a behaviorist teaching style for linear psychomotor tasks.

A number of variables that may have affected the outcome of this study. The small number of test subjects involved was a limitation. Different instructors presented the behaviorist and constructivist instruction. Although the instructors did rehearse the task as well as the instruction, it is inevitable that their presentations would be different. Finally, the reader should consider the select nature of the population.

Further studies should be conducted to either refute or support the results from this one. Future experimentation could also include using different psychomotor tasks and different groups of test subjects such as elementary-school students or non-gifted high school students.

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