DOCUMENT RESUME

ED 228 212 SP 022 090

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TITLE Student Characteristics Mediating Engagement-Outcome Relationships in Physical Education.
PUB DATE 12 Apr 83
NOTE 33p.; Paper presented at the Annual Meeting of the American Educational Research Association (Montreal, Quebec, Canada, April 12, 1983).
PUB TYPE Reports - Research/Technical (143) -- Information Analyses (070) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Attention; Educational Research; Higher Education; *Motor Development; Performance Factors; *Physical Education; *Physical Fitness; Psychomotor Skills; Sex Differences; *Skill Development; *Swimming; Time Factors (Learning); *Time on Task

ABSTRACT

This study investigated the relationship between engagement and achievement for college students in an intermediate swimming class. It also examined this relationship for students who entered the class with different initial skill levels, different previous experience with the subject matter, and for students of different gender. The methodology used is discussed under the following headings: subjects, instructors, skill rating, skill testing, instruction, and engagement coding. The original research premise is reported along with the results, which indicate that engaged time overall does not improve residualized achievement (i.e., students' breaststroke mechanics did not improve in correlation with the time they spent in class and practicing). Because the results did not agree with the hypothesis, four alternate hypotheses are discussed: (1) Engagement does not play a major role in predicting residualized gain; (2) The system for rating the skill was not sophisticated enough to measure relatively subtle aspects of improvement; (3) The method for coding engagement within the categories was not specific enough to detail important qualitative differences in the categories; and (4) Other factors mediate the power of engagement to predict residualized achievement. (JM)

STUDENT CHARACTERISTICS MEDIATING ENGAGEMENT-OUTCOME RELATIONSHIPS IN PHYSICAL EDUCATION

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PRINTED IN U.S.A.

Running Head: Student Characteristics in Physical Education

Manuscript prepared for the Annual Meeting of the American Educational Research Association, Montreal, Quebec, April 12, 1983.

ABSTRACT

This study investigated the relationships among student achievement, student engagement, and the selected student characteristics of initial skill, previous experience, and sex. The setting was university intermediate swimming classes. Breaststroke was the focus of instruction.

Students (N=47 after attrition) were pretested, received instruction, and were posttested on the breaststroke. The four instructional periods were videotaped with elapsed time superimposed on the picture. Videotapes were coded for the amount of time students spent in motor engagement, cognitive engagement, and the nonengaged categories of management, waiting, and off-task behavior.

When all students were grouped together, no engagement variable was a significant predictor of residualized achievement for either skill. When the analysis was performed, however, for students divided by gender, previous experience and three levels of initial skill significant relationships were found. Motor engagement did not predict achievement for the subgroup classifications. Cognitive engagement had a negative relationship with residualized posttest scores for two sub-population groups. All engaged

time had both positive and negative part correlations with achievement.

STUDENT CHARACTERISTICS MEDIATING ENGAGEMENT-OUTCOME RELATIONSHIPS IN PHYSICAL EDUCATION[1]

The most frequent question asked by readers of research on teaching is "What makes a good teacher?" This question infers another more precise question, that being, "What teacher or student behaviors relate to student learning?" These questions have been asked frequently by researchers interested in the correlates of teacher effectiveness in the classroom. A far smaller body of research exists, however, relating teacher or student behaviors to learning when a motor skill is the focus of instruction.

One of the strongest predictors of student achievement in the classroom has been academic learning time (ALT) or student engaged time. The premise of these studies is that as student engagement (in the form of instruction attended and practice executed) with the material to be learned increases, achievement in the subject matter will also increase. A strong positive relationship between achievement and engagement has repeatedly been demonstrated in the classroom through process-product research at a variety of age levels and for a variety of subject matters (Berliner, 1979; Fisher, Berliner, Filby, Marliave, Cahen, & Dishaw, 1981; Fisher, Filby, Marliave, Cahen, Dishaw, Moore, & Berliner, 1978). Despite the existence of considerable literature describing student engagement levels in physical

education (Auferderheide, Olson, & Templin, Note 1; Metzler, 1980; Placek, Silverman, Shute, Dodds, & Rife, 1982; Shute, Dodds, Placek, Rife, & Silverman, 1982; Whaley, 1981) and a smaller body of process-product literature focusing on motor skill learning (Oliver, 1978; Taylor, 1977; Yerg, 1977, Note 2), the piviotal relationship between engagement and achievement has not been investigated when a motor skill is the focus of instruction.

Transfer of results from the classroom setting to a physical education setting is risky. Evidence is strong that the characteristics of the student, the setting, and the educational objectives for the lesson are important in determining the relationship between student engagement and achievement (Berliner, 1976; Gage, 1978, pg. 78; Peterson, 1979a, 1979b; Rosenshine, 1979; Stallings, 1980). Since physical education classes occur in an environment other than a classroom and the goals and objectives of the physical education class are generally focused on the psychomotor domain, it seems reasonable to conclude that the relationship between student engagement and achievement in physical education must be subject to independent verification. In addition, since the relationship between achievement and engagement has differed for different groups of students in the classroom, the role of stable student characteristics in mediating the engagement-outcome relationship in physical education requires investigation.

The purpose of this study was to investigate the relationship between engagement and achievement for students enrolled in intermediate swimming classes and to examine these relationships for students who enter the class with different initial skill levels, different previous experience with the subject matter, and for students of ditferent gender.

Methods

Subjects

One hundred two (102) students enrolled in five intermediate swimming classes at a large state university created the pool of subjects for the study. Each student had at least beginner level skills (see American Red Cross, 1968), although some students may have had more advanced skills. Students were from 17 to 31 years of age. All classes were coeducational.

Each subject participated in an orientation session, at which time they signed a letter of informed consent indicating voluntary participation in the study. The students also completed a questionnaire indicating previous experience with aquatic education.

Instructors

The instructors were the regularly assigned swimming instructors for each class. All of the instructors were American Red Cross certified Water Safety Instructors. Each class had an assistant instructor who also was certified by the American Red Cross.

A brief, general overview of the study and the requirements related to instructor and class participation were provided each instructor at an initial meeting. Specific information related to the exact nature of the study was not provided; instructors were informed that the investigator was interested in teaching and learning and that greater detail would be provided after completion of the study. Instructors and their assistants completed a brief questionnaire and a letter of informed consent at this meeting.

An orientation also was held for the instructors. After a review of the material covered in the initial meeting guidelines were provided for testing and instruction.

It was important that each instructor realize precisely what was being tested. To accomplish this, the swimming instructors and the assistant instructors were trained in the use of the pretest and posttest measures to a reliability criterion of .90 with three of the skill evaluators to be employed in the study. In this way

assurance was obtained that each swimming instructor was fully cognizant of the skills being evaluated and would incorporate this knowledge into planning and executing instruction.

Skill Rating

Each student was pretested prior to instruction and posttested at the conclusion of instruction. The evaluation instrument required each skill rater to rate each of the five componets of the breaststroke (arm action, leg action, body position, breathing, and coordination).

Five experienced teachers of swimming were selected as skill raters. Only three raters were used at any one time, but five raters were trained to allow for flexibility of scheduling.

All skill raters were trained to reliably use the rating instrument. Behavioral anchors for each level of the five componets of the stroke were developed for the breaststroke and used for training and testing purposes. Training consisted of discussion of the behavioral anchors, discussion of videotaped skill performance, silent rating of videotaped skill performance followed by discussion, and silent coding for reliabilty. Reliability was calculated using Pearson's product-moment correlation coefficient for five performances of the skill. These procedures were repeated until all five raters were reliable among

themselves at a .90 criterion. To insure that interrater reliabilty transfered to the actual swimming pool setting, all skill evaluators rated the skill under actual testing conditions on the first day of the skill rating.

Skill Testing

On the day of the skill evaluation, the skill was modeled for the class prior to testing. One length of breaststroke was demonstrated. Students, one at a time, were evaluated by three skill raters located at the deck on the side the pool where they were swimming. Skill levels for each student were calculated by summing the scores for each of the five parts of the stroke and taking the mean for the three scores.

Instruction

Instruction consisted of four 15 minute classes. Instructors were permitted to use the class time any way that they wished. The breaststroke, however, was not to be taught or practiced at any other time once pretesting had taken place. Each class session was videotaped for subsequent coding of student engagement. Two cameras, each covering a portion of the pool so that the entire pool area was within view of one camera or the other, fed a special effects generator to create a split screen image. This combined image received a superimposed elasped time display

by passing the image through a videotimer. The split screen image, the elasped time display, and a concurrent audio signal were recorded on tape for playback when coding was performed.

This study focused on engagement of individual students in each of the five classes. Therefore it was important that each student be readily identifiable on videotape. For this purpose students wore white swim caps marked with a black geometric shape unique to each. One swim cap was available for each student. The student wore the cap assigned to them throughout the entire videotaped instructional sessions.

Engagement coding

Measurement of student engagement was an integral part of this study. Many of the previous studies of student engagement in physical education have used the time and student sampling procedures of the Academic Learning Time in Physical Education observation instrument (ALT-PE) (Siedentop, Birdwell, & Metzler, Note 3). The ALT-PE instrument is based on the ALT instrument developed at the Far West Regional Laboratory for Educational Research and Development. In the only study comparing time sampled ALT-PE to actual engaged time, coded second-by-second from videotapes, the correlation was only .62 (Metzler, 1980). As with the method used by Costello and Laubach (1978), this

study employed the coding categories of ALT-PE, but substituted second-by-second recording of a substantial portion of the class for the usual ALT-PE time sampling procedures.

Students' actions were categorized into the following exclusive and non-overlapping categories: 1) motor engagement; 2) cognitive engagement; 3) managerial activities; 4) waiting; 5) off-task; and 6) other/noncodeable.[2]

Two one-minute periods were randomly selected for coding from each third of the 15-minute instructional period. Thus, each student was coded for a total of six minutes in each class. Students missing any of the testing or instruction sessions were dropped from coding and subsequent analysis of learning for that skill. The total number of students completing all phases of the study (pretest, instruction, and posttest) were 47.

Due to the exclusive and non-overlapping nature of the coding categories, definitions served as the basic ground rules for coding. These were supplemented by a decision log containing additional ground rules for coding special instances.

The investigator and two trained assistants performed all coding operations. The summed total in seconds in each engaged and non-engaged category were used for computation for reliability using Pearson's product-moment correlation

coefficients. Initially, all three coders practiced coding the same individuals. When an intercoder reliability of .90 was reached, actual coding of the videotapes began. In order to ensure that the same level of reliability was maintained for coding the entire study, intercoder reliabilities were calculated at periodic intervals. At all times, intercoder reliabilty checks showed reliability to be at the .90 level or better.

Student Characteristics

Levels of three student characteristics were measured. Previous experience in aquatic instruction and activity was determined by having each student complete an investigator designed questionnaire. Point values were assigned to each answer and possible scores ranged from 0 to 18. Students also indicated gender on the questionnaire. The mean pretest score of the three raters served as the initial skill level score of the student. Previous experience and initial skill level scores were trichotomized into high, medium, and low groups.

Data Analysis

To determine the relationship between engagement and outcome forward multiple regression was used. Regression analysis was performed by the Statistical Package for the Social Sciences (Nie, Hull, Jenkins, Steinbrenner, & Bent,

1975). Posttest score was the dependent variable and pretest score was entered into the regression equation first. The engagement variable calculated as total seconds spent in each category (motor, cognitive, or the summed total of motor and cognitive engagement - all engaged time) then was entered into the equation. If the engagement variable accounted for a significant portion of the residual variance there was a significant relationship between the engagement variable and the posttest score after accounting for the pretest score. This procedure is analogous to part or semi-partial correlation (Kerlinger & Pedhazur, 1973, pg. 92) and was perfromed with the student as the unit of analysis for all students grouped together and for each of the trichotomized levels of student previous experience and initial skill level, and for males and females.

To determine if the coded variables significantly predicted differential posttest scores for the sub-groupings of student characteristics (male vs. female; high vs. medium vs. low initial skill and experience levels), regression slopes were compared for equality for posttest on pretest and motor engagement, posttest on pretest and cognitive engagement, and posttest on pretest and all engaged time. This procedure was selected instead of a test of significance of the part correlation coefficients because a restriction of the range of scores would not present a problem with the analysis. Comparison of slope equality was

accomplished using BMDP-1R of the Biomedical Computer Programs (Dixon & Brown, 1979).

Results

When all students were analyzed together no engagement variable was a significant predictor of residualized achievement. When posttest was the dependent variable and pretest was entered into the regression equation as the first variable and then motor engagement time, cognitive engagement time, or all engaged time were entered individually as the second variable, none accounted for a significant portion of the variance over and above that portion of the variance accounted for by initial skill level.

Approximately one-third, 31.3%, of the variance (R^2) in posttest scores was accounted for by the pretest scores. No engagement variable explained even an additional one percent of the variance in posttest scores when all students were analyzed as one group.

Although no engagement variable was related to achievement for the entire sample of students, different engagement categories predicted residualized achievement for different levels of student characteristics. When high, medium, and low skill levels were analyzed with separate regression equations, each skill level revealed one engagement category which accounted for a significant

portion of the residualized posttest variance. Table 1 summarizes the significant relationships for all subgroupings of students.

insert Table 1 about here

For high skilled students, all engaged time was a significant positive predictor of achievement (part correlation = .606). For medium skilled students, all engaged time again again predicted achievement, but in this instance the relationship was negative as evidenced by a part correlation of -.743. Therefore, we observe the opposite relationship between residualized achievement and all engaged time for high and medium skilled students. This difference in the relationship between residualized achievement and all engaged time is confirmed by a significant slope interaction ($p < .005$) among skill levels when regression equations contain posttest scores as the dependent variable with pretest scores and all engaged time as the variables predicting posttest.

For low skilled students, cognitive engaged time was the only predictor which accounted for a significant portion of residualized posttest variance. In fact, pretest score by itself accounted for zero percent of the posttest variance. The combination of pretest and cognitive engaged time as predictors of posttest score accounted for 28.2% of

the variance. The variable of cognitive engagement time was negatively related to the residualized posttest score (part correlation = -.531). The slope interaction was significant ($p < .015$) for the three skill levels between cognitive engagement and achievement.

Cognitive engaged time was also a significant negative predictor of residualized posttest score for males. The part correlation between cognitive engaged time and achievement was -.496. No significant predictors were found in any other engagement category for either sex.

For students with a high level of previous experience, all engaged time was a significant predictor of residualized posttest score. This relationship was in the same positive direction and approximately of the same magnitude (part correlation = .648) as that for high skilled students. No significant relationships were found for medium or low previous experience levels.

Summarizing the engagement data as a predictor of final achievement, after accounting for initial skill level, when the scores of all students were analyzed together there were no significant predictors. When students were grouped by some characteristic (initial skill, previous experience, or sex) significant relationships were found. Interestingly, there was about an equal split between instances where engagement categories were positive and negative predictors of residualized achievement. Looking closely, we find that

for both instances in which cognitive engagement was a significant predictor, the part correlation was negative. All engaged time was both a positive and negative predictor of achievement.

Discussion

It would be expected that motor engagement, cognitive engagement, or all engaged time as the sum of motor and cognitive engaged time would be a potent predictor of residualized achievement for all students. As noted, this was not the case. In fact, when the student was the unit of analysis and all students were pooled together, engaged time, whether motor, cognitive, or total, did not account for significant portions of the variance in posttest scores over and above that accounted for by the pretest scores.

A variety of hypotheses may account for the failure of engagement time to appear as a significant predictor of residualized achievement in this study. These hypotheses are: 1) engagement does not play a major role in predicting residualized gain; 2) the system for rating the skill was not sophisticated enough to measure relatively subtle aspects of improvement; 3) the method for coding engagement within the categories was not specific enough to detail important qualitative differences in the categories; and 4) other factors mediate the power of engagement to predict residualized achievement. Each of these possibilities are discussed further.

To suggest that skill practice and attending to explanation and demonstration is not important in learning motor skills is to strike at the heart of what many physical educators and teacher educators believe (Anderson, 1980, pg.26). We have all heard the maxim that "practice makes perfect." This seems true in the classroom where studies of engagement and achievement have been completed. Engagement rates in arithmetic and language arts classes have accounted for significant portions of the residualized achievement variance (Fisher, et al, 1978).

Why then, in this study as in others (Oliver, 1979; Taylor, 1976; Yerg, 1977), did none of the observed variables account for a significant portion of the residual posttest score variance? Perhaps our ability to measure the form and execution of a fluid skill is not adequate to capture small increments of improvement. It is possible that raters were not sensitive to small increases in skill level in each of the five parts of the breaststroke. If the student improved just slightly, but not enough to receive the next highest score, in one or more parts of the skill, this improvement was not noted when scores were totaled nor was it accounted for in subsequent analysis.

It also is possible that a single performance of the skill during the pretest or posttest is not an accurate reflection of the absolute skill level of the subject. The skill level of the student may not be stable and it may be

necessary to measure skill on three or four separate attempts and take the mean of these scores as the true skill level of the student. Elimination of the measurement error in the estimate of true skill level may help account for larger portions of the residualized achievement variance by the coded engagement variables. The multiple measurement of skill level for cognitive objectives within one written examination is common practice in teaching effectiveness research conducted in the classroom (Filby & Dishaw, 1976). Multiple trials of a physical skill may provide more information on which to base a pretest or posttest score, but also may confound scores by providing additional practice.

Another and perhaps stronger possibility for the failure of engagement to predict residualized achievement when all students were grouped together, is that the observation instrument used in this study treated all types of motor engagement and cognitive engagement as equal. For example, if a student practiced breaststroke leg movement on the deck of the pool for 30 seconds and another student practiced the entire skill for a length of the pool which also took 30 seconds, both would be coded as engaged in motor practice for that period. There is strong reason to believe that the two forms of practice are not equally effective in developing motor skill.

Further, the ease with which students practiced the skill was not recorded. Students having great difficulty with the skill during practice and those making minor modifications in otherwise adequate performance were coded alike. It has been suggested that the rate of student practice at an easy level of difficulty (low rates of error) is the important variable in predicting achievement (Carroll, 1963). In the Beginning Teacher Evaluation Studies (BTES) it was engagement with the content at a low error rate which was the most potent predictor of residualized posttest scores (Fisher, et al., 1978). The development of coding instruments which make provisions for type of practice and difficulty level will assist in the investigation of engagement and achievement relationships.

The data related to student characteristics, however, provide important insights into why the overall relationship between residualized achievement and engagement was nonsignificant. On five occations when some subset of students was examined, cognitive engaged time or all engaged time was a significant addition to the regression equation for predicting posttest score after first entering pretest score into the equation. The data from this study and a variety of sources focusing on processes in the classroom (Berliner, 1976; Cronbach & Snow, 1977; Fisher, et al., 1981; Peterson, 1979a, 1979b; Rosenshine, 1979; Stallings, 1980) suggest that the characteristics of a subsample being

studied may have a powerful mediating effect on the relationship between student achievement and engagement rates. If this is true, then there may be little reason to expect a significant relationship between residual achievement and engagement when all students are grouped together.

Cognitive engagement was a negative predictor of residualized posttest scores for low skilled and male students. For low skilled students as the rate of cognitive engagement increased the residualized achievement in the breaststroke decreased. Most of the cognitive activity in all classes was directed to the entire class or group which the instructor or assistant was teaching. Low skilled students may require more time to practice the fundamentals of the skill before they can profit from explanations and demonstrations concerning the fine points of skill development.

All engaged time was a positive predictor of achievement for both high previous experience and high skilled students. There was a significant positive correlation between skill level and previous experience, therefore, it would not be unexpected to find a similar relationship for the two groups.

All engaged time was a significant negative predictor of residualized gain for medium skilled students. This poses a dilemma in the interpretation of the results from

this study. There were no apparent differences between the groups in motor or cognitive engagement rates. In addition, since high and medium skilled students were distributed among the classes and practice groups within the classes by apparently random processes, it seems reasonable that the qualitative aspects of motor and cognitive engagement were similar. Why then does this obvious and significant difference in regression equations occur between the two groups?

A possible explanation for the apparent conflict is that the high skilled students have the basic fundamentals of the skill and utilize specific cognitive information and practice time without portions of individual help from the instructor. For this reason high skilled students may profit from whole class transmission of cognitive information related to the skill and practice with little feedback provided on an individual or group basis. As was the case with low skilled students and cognitive engagement, however, medium skilled students may need less whole group cognitive information related to the finer aspects of skill in order to have more time in order for practice. In addition, the time spent engaged in motor practice for medium skilled students may not be relevant if they are not practicing at an appropriate level of difficulty.

The instructors, all of whom are highly skilled in aquatic activity, may be providing cognitive information and

structuring practice sessions which in combination are most appropriate for high skilled students. The medium and low skilled students, while receiving information and engaging in skill practice may be doing so at inappropriate levels for efficient skill improvement. Skill practice and cognitive information which is at an inappropriate level may be frustrating and confusing to the student and result in little skill improvement or a decrement in skill. The classroom studies conducted as a part of BTES (Fisher, et al., 1978) suppprt the contention that a relationship exists between level of difficulty and achievement in content areas associated with basic skills.

It is clear that research which combines process-product methodology with a knowledge of student characteristics will provide important advantages in the study of teacher effectiveness in the learning of motor skills. This study has demonstrated that process-product relationships are discernable in physical education classes when student characteristics are considered a mediating factor. Future research based on the conclusion that characteristics of the student are important in teaching and learning in physical education may yield further conclusions which, in time, will be directly applicable to the improvement of teaching.

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NOTES

1. This study was completed as part of a doctoral dissertation at the University of Massachusetts at Amherst under the direction of Lawrence F. Locke.
2. Definitions and a decision log are available from the author.

TABLE 1

Significant Engagement-Outcome Relationships

Subgroup	Engagement Variable	R^2 for Posttest on Pretest	Part Correlation Coefficient	Total R^2
High Skilled	all	.441	.606*	.646
Medium Skilled	all	.156	-.743**	.622
Low skilled	cognitive	.000	-.531*	.282
Males	cognitive	.417	-.496*	.560
High Previous Experience	all	.367	.648*	.633

Note: All engaged time is the combined total of motor and cognitive engaged times, entered as a single variable.

* $p < .05$
** $p < .01$