Relationship between Academic Learning Time in Physical Education (ALT-PE) and Skill Concepts Acquisition and Retention

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Abstract

The purpose of this study was to investigate the relationship between time-related variables of the physical education lesson and skill concepts acquisition and retention. One hundred and four students aged 6.4 to 7.9 years, and their six physical educators participated. The motor behavior of thirty-six selected students was videotaped during a four-week instruction, and analyzed with Academic Learning Time-Physical Education (ALT-PE) observation instrument (Siedentop, Tousignant, & Parker, 1982). Students were also pre-, post-, and retention tested on overhand throwing and catching concepts by completing a cognitive test. Regression analysis was applied to calculate students' residual acquisition and retention gain scores, and correlation analysis to identify their relationship with ALT-PE categories. Results indicated significant correlations between residual acquisition and retention gain scores in skill concepts and a) "ALT", and b) "student motor engaged". Significantly negative correlations were found between residual acquisition and retention gains and "general content". Moreover, the category "subject matter motor" was significantly correlated with skill concepts learning. It was concluded that time spent in developmentally appropriate skill practice, in contrast to the time spent in activities irrelevant to the instruction's goals, contributes to fundamental skill concept learning.

Review of Literature

Theories

Physical education, apart from guiding children to acquire psychomotor and affective skills, aims to enhance their cognitive skills as well. Cognition has been described as the capacity to acquire and use information in order to adapt to environmental demands (Lidz, 1987). The process, through which information is organized, stored in memory and made available for recall and application in various settings has been described as cognitive learning (Gallahue & Cleland, 2003). Piaget (1952) was among the first theorists to highlight the importance of movement in the cognitive development of infants and young children, but also the dependence of motor development on intellectual abilities (Payne & Isaacs, 1995). Similarly, in motor skill learning models described by Fitts and Posner (1967), Adams (1971), and Gentile (1972), cognition is considered a critical aspect of motor skill acquisition. Besides, higher thought processes are required for all voluntary movements to occur (Payne & Isaacs, 1995).

Gallahue and Cleland (2003) consider perceptual-motor learning and concept development as crucial aspects of cognitive learning during childhood. Among the elements of cognitive concept learning in physical education are the skill concepts, which deal with the ways the body should move while performing fundamental or

sport skills. Sage (1984) supported that skill learning does not begin with practice but earlier, with the cognitive understanding of the skill's performance criteria. Buschner (1994) also stated that practicing mentally the learnable criteria enhances the chance of achieving mature movement forms and that thinking and moving integration occurs with time and practice. Improvement in the task specific knowledge base may lead to a better task-specific sport performance and to the reduction of motor performance deficits due to the lack of a sufficient knowledge base (Payne & Isaacs, 1995; Rink, 1996). In general, cognitive concept learning aids retention, recall, decision making, and application, providing children with tools for critical thinking.

Fundamental movement skill learning, one of the most important topics in the physical education curriculum during the early elementary years (e.g., Graham, 1991), is achieved by an active learning process interrelated with cognition (Gallahue & Cleland, 2003). Graham (1987) stressed that students do not learn to perform correctly a fundamental movement skill by being "exposed" to the correct way but by learning its qualitative aspects. In relation to that, Pangrazi (2001) and Wood (1997) emphasized the use of cues to help students become involved cognitively in class, especially during the initial stage of skill learning. Taking also into account the insufficient amount of time allotted for physical education as well as other factors which influence negatively skill development, learning the concepts that are related to successful skill performance will enable children's effective participation in movement activities in a variety of settings (Gallahue & Cleland, 2003).

Research on how children learn and develop particular content has been used across classroom subjects (e.g., reading, mathematics, science, writing, etc.), in some instances extensively, to guide the selection of curriculum design, instructional techniques, and national standards. Walkwitz and Lee (1992) reported that although the amount of similar research is not identical for physical education, it has been shown to contribute to pedagogical content knowledge. The use of motor development research as a basis for observing the learner's movement is widely evident in current elementary textbooks and has been used to create similar information about skills (Gallahue & Cleland, 2003). Describing the qualitative changes in coordination patterns as children's movement patterns become more mature (Roberton & Halverson, 1984; Wickstrom, 1983), this type of research guides the selection of tasks, cues, and feedback. The qualitative aspects, cues or otherwise skill concepts have aided children focus on the relevant aspects of the tasks in a rather constantly varying environment, and achieve motor skill learning (e.g., Ladewig & Gallagher, 1994; Masser, 1993; Winter & Thomas, 1981). Research in physical education also focused on the relationship between student/teacher behavior (process) and student learning (product). In related studies student learning is associated with the way the teacher uses qualitative aspects of teaching (e.g., cues, feedback, guidelines) and the lesson time to provide learning experiences to children.

Academic Learning Time

The process-product studies, conducted since the 1950s in order to determine the relationship between student/teacher behavior and student learning, have indicated that correct practice is the most crucial component of such a relationship (Graham & Heimerer, 1981; Metzler, 1989). According to Bloom (1974), the time needed to learn a skill is one of the fundamental variables in studies for school learning. Academic Learning Time (ALT), which is considered to be the connection between teaching and learning, is a unit of time in which students are engaged in activities and instructional materials to be learned at an appropriate level of difficulty, resulting in high success and low error rates (Rink, 2002). According to Rink (1996) a task is at an "appropriate level of difficulty" when the learner can be successful with effort. "High success"

depends on the level of complexity of the skill and is defined as the performance of an instructional task with no errors (Lee & Poto, 1988).

Related studies, in which ALT was used to assess student behavior, had as subject matter math and language (Brophy & Good, 1986). Similarly, the Academic Learning Time-Physical Education (ALT-PE) systematic observation instrument in physical education (Parker, 1989; Siedentop, Tousignant & Parker, 1982) has been applied to determine the relationship between student behavior and motor learning (Lee & Poto, 1988; Metzler, 1989). Even though the reported results were not always consistent, time appeared to be one of the variables for predicting sport skill learning. Specifically, process-product studies in physical education attempted to identify the relationship between time-related variables and quantitative or qualitative sport skill performance. Based on the findings, motor engaged time seems to be a necessary condition for learning ice hockey (Godbout, Brunelle, & Tousignant, 1987), badminton (Beckett, 1989), volleyball (Godbout et al., 1987; Silverman, Devillier & Ramirez, 1991), and golf skills (Metzler, 1983). Similar findings were reported for swimming skills (Silverman, 1985) but only for high-skilled participants. On the other hand, Silverman (1985) found negative correlations between cognitive engagement and the achievement score in a swimming skill only for low- and moderately-skilled participants. The author attributed this finding either to the inappropriate level of cognitive information or to the lag between cognitive understanding and translation of this knowledge into improved performance. On the contrary, high-skilled participant scores were positively related to the cognitive engagement time.

Despite the importance of the above findings, research on the relationship between time-related variables and skill concepts learning seems insufficient, meaning that it has been focused in subject areas like math and language. With regard to physical education, only few studies examined the relationship between ALT-PE and fundamental motor skill learning and none to our knowledge that of ALT-PE and cognitive concepts related to physical education. To describe and analyze the relations between student ALT-PE categories and skill concepts acquisition and retention the following questions were posed as framework of the study: a) What is the mean ALT in the observed classes, b) Is there a significant correlation between student ALT and skill concepts learning, c) Which variables of the context level or of the student involvement level of ALT-PE are related to student skill concepts learning?

Therefore, the purpose of the present study was to investigate the relationship between time-related variables of the physical education lesson and fundamental skill concept acquisition and retention by first grade students, taking into consideration the importance of the qualitative performance and cue learning in early elementary years. First grade students were selected because they are those who begin to participate in a structured physical education program. It was hypothesized that there would be significant correlations between student skill concepts acquisition and retention and the categories of ALT-PE.

Method

A data base that includes students pre-, post and retention scores for concepts of throwing and catching and their behaviour, as analyzed with the ALT-PE instrument was used for the study. Relations between ALT-PE categories and students achievement were examined.

Participants

One hundred and four first grade students, 6.4 to 7.9 years of age (M = 6.9, SD = 0.3) from six elementary schools in Northern Greece, and their physical education teachers participated in the classes observed in this study. Teachers (N=6) had a Bachelor Degree in Physical Education and Sports, and 5 to 10 years of teaching experience,

but no more than three years in the elementary school. Each participating physical education teacher recommended six students, two high, two medium and two low skilled to participate in the ALT-PE observations (N=36). None of the student participants had ever received instruction in throwing or catching. Once permissions were obtained from the Ministry of Education, all elementary school principals and physical education teachers, schools were randomly selected from a greater sample located in varied socio-economic areas.

Measurement

A knowledge test and ALT-PE observation instrument were used in the study to provide descriptive data on student skill concepts and motor behavior during class time, respectively.

Skill Concepts. The knowledge test in this study concerned the identification of throwing and catching skills among other manipulative skills (e.g., ball rolling, striking), and the identification of the correct performance of each skill. It was created based on the indicative ways of assessing skill concepts in early elementary ages, proposed by Hopple (1995) and Graham, Holt/Hale and Parker (2003). It consisted of four tasks: two of them required matching each skill's name (e.g. throwing, catching) with the correct figure out of five with different skills, and two required the student to circle the picture with the correct performance of the skill out of five pictures of the same skill. The score ranged from 0 to 4 points (each answer was graded with one point if it was correct and with zero point if it was wrong). The reliability of the test was estimated with a test-retest measure and the intra-class correlation coefficient was .90. The test has logical validity and internal consistency (Cronbach's a =.75).

Observation Instrument. Student behavior was measured with the Academic Learning Time—Physical Education (ALT-PE) observation instrument (Siedentop, Tousignant, & Parker, 1982), which uses a twelve second interval observation/record technique. A student was observed for the first six seconds of the interval and two decisions were made and recorded on the coding sheet for the next six seconds: one for the context level (general, subject matter knowledge, subject matter motor), and the other for the learner's involvement level (not motor or motor engaged). The intervals and their percentage in all categories and subcategories of the instrument were calculated. According to Parker (1989), the intervals in which the context level was subject matter motor and the learner's involvement level was motor appropriate, were considered to be the amount of academic learning time (ALT). In the present study, ALT was recorded when the activities in the subject matter motor intervals were relevant to the lesson purpose, and learner involvement was motor appropriate. This occurred because teachers in some cases used activities irrelevant to throwing and catching like tag and rope games.

Procedure

Initially, all students completed the knowledge test. Afterwards, the physical education teachers were required to teach only catching and overhand throwing for eight 40-minute consecutive lessons, twice a week, during the regular school program. They were encouraged to use lesson time as best as they can and choose the type of task, and the number of repetitions for student improvement in the two skills. A total number of 48 lessons (8 lessons per 6 physical educators) were videotaped. The 36 chosen students wore pinafores to be ever identifiable on videotapes. Students were post tested the day after the completion of the lessons, and re-tested after ten days (during a regular physical education lesson), that is two days before the end of the school year. The focus of the lessons between the last two measures was on dance activities.

Videotaped lessons were analyzed with the ALT-PE instrument by two trained observers, separately. Their training was based on learning the behavior categories and the coding procedure, on coding videotapes to identify ambiguous patterns, on discussion of disagreements and on

coding separately until an interobserver agreement of over .90 was established on all subcategories. Interobserver agreement (IOA) was determined by percent agreement, IOA= agreements/[agreements+disagreements] for individual subcategories and context levels. After actual data analysis had begun, four lessons were randomly selected for interobserver agreement control. At all lessons reliability was at or above the .92 level. The six target students from each school were observed in sequence (i.e. the first time interval was assigned to the first student, followed by the second, third, etc) and that order was repeated until the end of each lesson. A total number of 5544 intervals were coded for 36 students while a preprogrammed audiotape provided the observation and recording intervals.

Data analysis

For each student achievement a residual score was calculated. For the entire sample a posttest on pretest and a retention test on pretest regression equation were determined. Based on this equation, predicted scores were calculated (Silverman, 1988). The actual post- and retention test scores minus the predicted scores were the residual acquisition and residual retention gain scores, respectively. These scores were positive if a student's performance was better than the predicted score, or negative if it was worse than the predicted score. Residual gain scores were selected because they separate out pretest skill level, and are reliable, uncorrelated with entry skill, and not subject to ceiling effects (Cronbach & Furby, 1970; Silverman, 1988). The mean of residual scores was calculated for each school and used for the correlation with ALT-PE percentages.

Results

A dependent samples t-test was used to identify changes in students' knowledge between measures. Results showed significant differences between pre- and posttest measures ($t = 3.1$, $p < .05$), as well as between pre- and retention test measures ($t = 4.15$, $p < .001$). The mean score increased from 2.96 in the pretest to 3.22 in the posttest and to 3.38 in the retention test, while the maximum score could be 4. These results show that acquisition and retention occurred.

Means and standard deviations for each school in all measures as well as the corresponding residual scores are presented in Table 1. The percentages of time allocated for each of the ALT-PE's categories and subcategories are depicted in Table 2.

Pearson Product Moment correlation was applied to identify possible correlations between the residual scores (acquisition and retention gains) in skill concepts and the percentages of intervals of ALT-PE categories and subcategories. Categories related to residual acquisition and retention gain scores in skill concepts were a) "ALT" ($r = .84$, $p < .05$ and $r = .92$, $p < .01$ respectively), and b) "student motor engaged" ($r = .73$, $p < .05$ and $r = .90$, $p < .01$ respectively). Although negative, correlations were also indicated between residual acquisition and retention gains and a) "student not motor engaged" variables, ($r = -.72$, $p < .05$ and $r = -.90$, $p < .01$ respectively) and b) "general content" ($r = -.83$, $p < .05$ and $r = -.88$, $p < .01$ respectively). The lesson content "subject matter knowledge" had no significant correlation neither with skill concept acquisition nor with their retention, while "subject matter motor" and "motor appropriate" were correlated with skill concepts retention ($r = .79$, $p < .05$ and $r = .85$, $p <. 05$ respectively). All correlations are presented in Table 3.

Discussion

The purpose of the present study was to investigate the relationship between time- related variables of the physical education lesson and skill concept acquisition and retention. Results indicated that after the implementation of an eight lesson unit, concept learning of throwing and catching occurred. Examining the way time was spent during practice, it appeared that almost half class time was devoted to a general lesson content and predominantly to managerial, organizational,

Table 1. Means and SDs for pre-, post- and retention tests, and residual acquisition and retention gain scores.

School	N	Pretest		Posttest		Retention test		Residual scores (acquisition)		Residual scores (retention)	
		M	SD	M	SD	M	SD	M	SD	M	SD
1st	6	3.35	.93	3.29	.77	3.67	.49	-.10	.67	.10	.52
2nd	6	2.00	1.47	3.00	1.57	3.46	.78	.04	1.47	.29	.69
3rd	6	3.24	1.2	3.52	.59	3.54	.50	.11	.72	.00	.63
4th	6	3.09	.95	2.91	1.04	3.12	1.13	-.17	.77	-.20	.87
5th	6	2.65	.98	2.95	1.43	3.00	1.35	-.18	1.18	-.25	1.10
6th	6	3.17	.94	3.81	.40	3.91	.30	.47	.54	.39	.43
Total	36	2.96	1.14	3.22	1.07	3.38	.93	.00	.93	.00	.78

and warm-up activities whereas students were "motor engaged", that is, they participated in motor activities relevant to the goals of the setting only at 1/5 of the total class time. For the rest of the time, although students were on task they waited for instructions or opportunity to respond, and participated in activities irrelevant to the goal of the lesson. Also, the extremely low percentage of time in the category "knowledge subject matter", and especially in "technique", seems that teachers did not take into consideration students' need to cognitively rehearse the movement cues associated with throwing and catching. This finding might be attributed to the low experience of the physical education teachers to teach fundamental skill concepts along with skills since they started to teach the lesson in the early elementary years only a few years ago. As far as the basic time-concept, (ALT), is concerned, it occupied only 6% of lesson time. Given that the typical lesson time in Greece lasts 40 minutes, the above percentage, which is ALT, is translated in actual lesson time that is consistent with Silverman et al. (1991), and Silverman, Dodds, Placek, Shute and Rife (1984). However, ALT was lower than in previous descriptive studies (Cousineau & Luke, 1990; Godbout, Brunelle & Tousignant, 1983; Silverman et al, 1991; Silverman et al., 1984) in which it fluctuated from 10% to 34%. The low amount of ALT may be attributed to the type of activities, grade, and organization. Most classes included long warm-up and games in which only a few students were involved at a time whereas the rest were waiting.

Results showed that skill concepts acquisition and retention was significantly related to practice at an appropriate level of difficulty (ALT). Although ALT occupied a small portion of the lesson time, it is obvious that not only the movement skills but also the skill concepts can be enhanced if the content of the lesson is subject matter motor and children are appropriately motor engaged. This finding seems to support Yongue's (1998) statement that apart from verbal transmission of the skill from the teacher to the students, appropriate practice time develops understanding of how the body should move, and leads to a coordinated and successful performance. It also indicates the interrelation between movement and cognition.

The categories of "learner's involvement level" in ALT-PE, that is "motor engaged" and "not motor engaged" had a positive and a negative relationship respectively with skill concepts acquisition and retention. Analyzing the "motor engaged" category, it can be seen that retention of skill concepts in the present study was positively related to the time that children a) assisted others

Table 2. Percentage of time allotted for ALT-PE categories.

ALT-PE categories	**N**	**M (%)**	**SD**
	Context Level		
General Content			
Management	6	6.56	3.92
Transition	6	23.12	5.91
Break	6	1.76	1.12
Warm-up	6	8.91	7.86
Total	6	40.35	8.08
Subject Matter knowledge			
Technique	6	3.35	5.14
Strategy	6	6.65	2.47
Rules	6	1.47	0.66
Social Behavior	6	0.00	0.00
Background	6	0.00	0.00
Total	6	11.47	6.72
Subject Matter Motor			
Skill practice	6	27.76	11.40
Scrimmage	6	5.14	8.10
Game	6	13.91	10.50
Fitness	6	1.45	1.58
Total	6	48.26	11.58
	Learner's Involvement Level		
Not Motor Engaged			
Interim	6	1.17	1.36
Waiting	6	38.03	7.98
Off-Task	6	1.55	1.43
On-Task	6	29.06	8.91
Cognitive	6	11.26	6.61
Total	6	81.07	11.24
Motor Engaged			
Motor Appropriate	6	11.21	5.38
Motor Inappropriate	6	5.62	4.13
Supporting	6	2.37	2.14
Total	6	19.2	10.81
ALT	6	5.95	3.58

Table 3. Correlations between ALT-PE categories and student achievement in skill concepts.

ALT-PE categories	Achievement	
	Residual acquisition gains	**Residual retention gains**
	Context Level	
General Content		
Management	-.39	-.60
Transition	-.45	-.75
Break	-.22	-.56
Warm-up	-.33	.18
Total	-.83*	-.88**
Subject Matter knowledge		
Technique	.18	.00
Strategy	-.31	-.63
Rules	-.81*	-.79*
Social Behavior	-	-
Background	-	-
Total	-.04	-.37
Subject Matter Motor		
Skill practice	.08	.50
Scrimmage	-.06	.03
Game	-.08	-.13
Fitness	.17	.53
Total	.57	.79*
	Learner's Involvement Level	
Not Motor Engaged		
Interim	.35	.46
Waiting	-.54	-.60
Off-Task	-.43	-.55
On-Task	-.53	-.37
Cognitive	-.43	-.36
Total	-.72*	-.90**
Motor Engaged		
Motor Appropriate	.59	.85*
Motor Inappropriate	.76*	.76*
Supporting	.75*	.90**
Total	.73*	.90**
ALT	.84*	.92**

*p<.05 **p<.01
Note: - = no time was allotted for this category.

in learning or performing the manipulative skills ("supporting" subcategory), and b) were engaged in motor activities in such way as to produce a high degree of success ("motor appropriate" subcategory). It appears that participation in activities which require supporting others in the learning setting encourages questioning, analysis, integration, and application of cognitive concepts. Also, motor appropriate engagement has already been found to relate to the achievement in a volleyball skill (Silverman et al, 1991). On the other hand, participation in motor inappropriate activities ("motor inappropriate" subcategory) such as trying to hit a target which was placed too high for children does not seem to affect negatively concepts' retention. However, this finding might be different if the goal was not the cognitive but the motor skills learning.

On the contrary, negative were the relationships between skill concepts acquisition and retention and the total time devoted in actions irrelevant to the purpose of the lessons, such as managerial and organizational activities ("general content" categories). Similarly, time spent in not motor engaged tasks, such as waiting for instruction or opportunity to practice, was negatively related to skill concepts' acquisition and retention. It is obvious that such actions reduce the motor engagement time that produces gains in skills. These findings support the notion that it is more important to get actively in contact with the content than spending high amounts of time receiving instruction. Previous studies (Silverman et al., 1991; Silverman, Tyson & Morford, 1988) found similar relationships between non instructional categories (i.e. scrimmage, transition) and student achievement in sport skills.

It is notable that skill concepts learning was related to the time allotted on motor involvement ("subject matter motor") but not to the time allotted for cognitive involvement "subject matter knowledge content" and specifically to 'technique', which concerns the time that students are informed about the appropriate way of executing a motor skill. This finding contradicts that of De Knop (1986) who found that the more effective groups in tennis spent more time than the less effective groups receiving information about the tasks, remarking about the correctness or the results of the movement, and watching teacher's demonstration.

The fact that children in the current study received little or even in some instances erroneous instruction on the manipulative skill concepts but they improved their performance in the skill concept test, leads to the conclusion that it was the time of motor involvement which assisted them. That means that children acquired and retained skill concepts mostly through movement practice and watching or helping their peers to practice. However, as it has already been mentioned, the amount of time for physical education in the elementary curriculum is limited, and consequently adequate instruction seems necessary for learning more complex cognitive concepts as well as for effective skill practice outside the school setting.

On the other hand, the negative relation between skill concept learning and transmitting information for regulations and plans of action ("rules") indicates the necessity to provide students with brief, specific, and accurate guidelines. Based on the above, the hypothesis of the study, that there would be significant correlations between ALT-PE categories and skill concepts acquisition and retention, was not verified only for the "subject matter knowledge" category.

In general, the relationships between the categories of ALT-PE and skill concepts are in accordance with previous research findings in classroom concerning math and language (Brophy & Good, 1986) with which can not be directly compared. Also they are only partially in agreement with the findings of relevant studies in physical education (Beckett, 1989; Silverman, 1985; Silverman, et al., 1991) may be because the latter assessed product scores in sport skills rather than skill concepts.

Based on the findings of the current study, Academic Learning Time seems to be an

important factor for the acquisition and retention of skill concepts by first grade students. Specifically, practicing at an appropriate level of difficulty and helping classmates to perform correctly are important for the achievement of concept learning. On the contrary, class time spent in activities irrelevant to the instruction's goals, such as in managerial and organizational activities, in transmitting information concerning regulations and plans of action, and time spent waiting for instruction or opportunity to practice, affect negatively skill concepts acquisition and retention.

Teacher plays an important role on children's skill concept acquisition and retention through physical education, in terms of planning for reducing time spent in organizational and managerial activities, arranging the learning environment, and implementing motor appropriate activities. A learning environment that enables students to be actively involved most of the class time, and to think and act in ways that maximize learning opportunities is necessary.

Further research is needed to identify if an increase in ALT and in the knowledge content of the lesson would differentiate research findings. The relation between skill concepts and motor skill learning in conjunction with ALT could also be examined. In addition, research on how skill concept learning affects children's performance in real game situations could be of great interest.

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