Comparison of Traditional and Alternative Methods for Teaching Exercise Physiology

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Abstract

The purpose of this study was to compare alternative and traditional approaches to exercise physiology course design within physical education teacher education (PETE). The participants formed the following groups: (a) PETE majors taking an alternative exercise physiology course (n=37); (b) Exercise physiology majors taking a traditional exercise physiology course (n=33); (c) PETE majors taking a traditional exercise physiology course (n=14); and (d) a control group of PETE majors taking an introductory course within the major that includes no exercise physiology content (n=53). Each participant completed an exercise physiology content knowledge pretest and posttest during a 15-week semester. A one-way ANCOVA using posttest scores as the dependent variable with pretest scores as the covariate indicated a significant difference of $F(4,132) = 85.92$, $p < .01$ *among groups. Post hoc comparisons revealed that PETE students enrolled in the alternative course significantly out performed both comparison groups on the content knowledge test, all of which out scored the control group.*

Course work in the area of exercise physiology is recognized as an important foundational component of the physical education teacher education (PETE) curriculum (National Association for Sport and Physical Education, 1998). It is generally assumed that the theoretical and applied exercise physiology concepts addressed within the PETE curriculum directly contribute to the prospective teacher's ability to effectively facilitate the development of the psychomotor, cognitive, affective, and fitness characteristics that enable a child to enjoy a physically active lifestyle into adulthood. The legitimacy of this basic assumption has been questioned in the literature, however, and there is evidence to suggest that effective delivery of exercise physiology content has been a problematic issue for some PETE programs (Barnett & Merriman, 1994; Kelley & Lindsay, 1977, 1980; Miller & Housner, 1998). More specifically, the course content, instructional strategies, and educational environment commonly associated with the exercise physiology component of the PETE curriculum are three possible areas of concern.

Review of Literature

For the purpose of this study, exercise physiology has been defined as "the study of how exercise alters the structure and function of the human body" (Robergs & Keteyian, 2003, p. 5). This field of study encompasses a wide range of topics including energy metabolism, chronic and acute training adaptations to exercise, measuring physical fitness and performance, training techniques, and so forth. This rather broad definition of exercise physiology encompasses the closely related concept of physical fitness and its health-related components (cardiovascular endurance, muscular strength, muscular endurance, flexibility, and body composition).

While courses in exercise physiology and physical fitness have long been identified as a primary source of knowledge for undergraduate PETE students (Mood, 1971), questions regarding the appropriateness of the associated course content remain. Relatively few studies, however, have directly investigated the role of exercise physiology within the PETE curriculum and the relevance of the associated course content (Barnett & Merriman, 1994; Kelley & Lindsay, 1977, 1980; Miller & Housner, 1998). Kelley and Lindsay conducted two studies to determine the

knowledge obsolescence of pre-service and in-service physical educators in several academic domains, including exercise physiology. The results of these studies suggested that research in exercise physiology was not being used to effectively update the related course content of the involved PETE programs.

Similarly, Barnett and Merriman (1994) compared the health-related physical fitness knowledge of physical education and non-physical education majors. The participating physical education majors demonstrated a significantly greater understanding of physical fitness than the non-physical education majors. The prospective physical educators exhibited incremental increases in physical fitness knowledge as they progressed through the first three years of the teacher education curriculum, but there were no significant differences between the junior and senior grades. In light of these findings, Barnett and Merriman called for additional investigation regarding the prerequisite level of fitness knowledge needed to teach physical education, the process by which prospective physical educators acquire fitness knowledge, and the ability of prospective physical educators to apply learned fitness concepts in an practical setting.

Miller and Housner (1998) assessed the health-related physical fitness knowledge of pre-service physical educators, in-service physical educators, and graduate students in physical education and exercise physiology. The findings indicated that the participating pre-service and in-service physical educators demonstrated an inadequate knowledge of health-related physical fitness. The poor performance of the pre-service group in this study may be related to a number of factors including the educational background of the participants prior to enrollment in the PETE program, the nature of the PETE curriculum, and the lack of adequate educational experiences in the area of health-related physical fitness. Miller and Housner also suggested that PETE programs should closely evaluate the content validity, pedagogical relevance, and instructional quality of exercise physiology courses for pre-service physical educators.

The previously described studies (Barnett & Merriman, 1994; Kelley & Lindsay, 1977, 1980; Miller & Housner, 1998) support the position that there are numerous questions associated with the appropriateness of the exercise physiology content that is typically included in the PETE curriculum. Locke (1990) proposed that practicing physical educators fail to use subdisciplinary knowledge because it is basically irrelevant to their work in school settings if taught poorly. It is entirely possible that "the model of the rational teacher who bases instructional decisions on research-based knowledge from the foundational sciences does not describe how most teaching gets done in physical education classes" (Locke, 1990, p. 137). Corbin (1993) also contended that subdisciplinary knowledge is of little practical value if practitioners are unable to effectively apply it to the teaching of physical education. In many respects, research in the subdisciplines of physical education appears to have fragmented and intellectualized the field while neglecting the more practical issue of application (Greendorfer, 1987; Hellison, 1991). McKenzie and Sallis (1996) argued "the trend to require potential physical education specialists to take more theoretical and scientific courses while reducing their exposure to instructional methods, program development and assessment, and physical activities is not necessarily positive" (p. 237). Physical educators who complete a more theoretically oriented plan of study may be "better prepared to teach sedentary, cognitive-focused classes than they are to teach students to be physically active" (McKenzie & Sallis, 1996, p. 237-238).

In addition to course content, the instructional methods associated with exercise physiology courses may also contribute to the problematic gap between theory and practice. Barnett and Merriman (1994) suggested that PETE programs have not provided sufficient integration between the learning of physical fitness concepts in the classroom and their eventual application in a

school-based context. If students are not provided with instructional methodologies that are specifically designed to relate theory to practical problems, they may regard the theory as being irrelevant and educational practice remains largely unaffected by the continually expanding body of subdisciplinary knowledge (Bain & Poindexter, 1981). Of particular interest, Van Donselaar and Leslie (1990) conducted a survey of PETE programs to investigate the current and recommended practices for preparing physical education teachers in exercise physiology. Results demonstrated that a considerable gap exists between the current and recommended instructional strategies for delivering exercise physiology content to prospective physical educators. The findings support the need for "increased attention to physical education teaching applications, reduced reliance on student initiative in making such applications, improved preparation for physical education majors to teach physical fitness concepts, and more collaboration between EP [exercise physiology] and TE [teacher education] personnel" (Van Donselaar & Leslie, 1990, p. 215).

In reference to the related issue of educational environment, Van Donselaar and Leslie (1990) reported that introductory exercise physiology course enrollment traditionally includes students from a variety of majors who have different intentions for the eventual practical application of the involved course content. Course enrollment frequently includes students who are majoring in physical education, athletic training, exercise physiology, athletic coaching, and physical therapy. It is unlikely that the unique instructional needs of each student can be satisfactorily addressed in a course with this type of diverse enrollment (Van Donselaar & Leslie, 1990). Furthermore, the introductory anatomy and physiology courses required in many PETE programs are likely to be (a) taught outside of the PETE program, (b) instructed by non-teacher educators, and/or (c) influenced little by PETE faculty regarding course content and instructional methods (Verner, 1991). While subdisciplinary specialists are likely to maintain a more complete understanding of the involved subject matter, they may lack the knowledge and ability to integrate the essential pedagogical concepts that make the theory to practice transition a workable proposition. Bain and Poindexter (1981), for example, suggested that specialists in the subdisciplines are often unwilling to "dilute" their theoretical course content with issues of practical application. This reluctance to directly address theory and application may be further compounded by "the discipline-based faculty member's inexperience in public school teaching, and in teaching sports as well" (Bain & Poindexter, 1981, p. 40). The diverse nature of the course enrollment, associated time constraints, and instructor characteristics may interact to produce an educational environment that does not readily facilitate the translation of exercise physiology theory into the practice of teaching physical education.

To counter the problems associated with the gap between theory and practice, a variety of solutions have been proposed in the related literature. In order to narrow the gap between theory and practice, it is generally accepted that the course content, instructional methodology, and roles of both the student and instructor must be altered within PETE programs (Collier & O'Sullivan, 1997). It has been suggested that PETE programs must employ instructional methods that foster the development of pedagogical content knowledge that enables students to use subdisciplinary knowledge when resolving practical educational problems (Bain & Poindexter, 1981). The learner must become a more active participant in the teaching-learning process, while the teacher educator must bear the increased responsibility of disseminating current theoretical information in combination with accepted pedagogical practice (Loughery, 1985).

Other proposed solutions related to the study of exercise physiology include: (a) The formation of professional committees consisting of subdisciplinary experts during curricular revision (Ross, 1981); (b) the use of the *Basic Stuff Series* (Kneer, 1981) in teacher education (Bain & Poindexter, 1981; Loughery, 1985); (c) the design and imple-

mentation of culminating experiences that enhance a student's ability to integrate subdisciplinary knowledge in a variety of contexts (Robertson & Heyden, 1985); (d) the increased focus on developmental rather than adult exercise physiology concepts (Bulger, Mohr, Carson, Robert, & Wiegand, 2000; Karper, 1997; Miller & Housner, 1998); (e) the continued evaluation of instructor qualifications and course content (Bulger et al., 2000; Miller & Housner, 1998; Verner, 1991); and (f) the infusion of a health-related fitness curricular thread or strand within the PETE curriculum (Bulger, Mohr, Carson, & Wiegand, 2001; Feingold, 1994). Furthermore, Van Donselaar and Leslie (1990) recommended the use of separate or team-taught exercise physiology labs for physical education majors. Additionally, Bain and Poindexter (1981) suggested emphasizing the application of pedagogical concepts within subdisciplinary courses, integrating subdisciplinary concepts into professional development courses, and developing new courses that focus specifically on bridging the gap between theory and practice.

Purpose

Although numerous strategies have been proposed in the literature, bridging the gap between subdisciplinary theory and practical application remains a challenging task for PETE students and instructors (Robertson & Heyden, 1985). The course content, instructional methods, and educational environment commonly associated with exercise physiology courses represent three particular areas of concern for physical education teacher educators. In response to these concerns, an alternative exercise physiology course for PETE students was designed and implemented using a number of the previously described instructional strategies for helping students to apply exercise physiology content in a practical setting (Bulger et al., 2000). The purpose of this study was to examine the effectiveness of traditional, theory-based versus alternative, pedagogical content knowledge-based exercise physiology courses in delivering exercise physiology content knowledge to PETE students.

Method

Participants

One hundred and thirty seven undergraduate students attending a large, comprehensive university volunteered to participate in this study. The participants formed the following groups: (a) PETE majors taking exercise physiology taught alternatively—the experimental group (n=37); (b) exercise physiology majors taking exercise physiology taught traditionally—a comparison group (n=33); (c) PETE majors taking exercise physiology taught traditionally—an additional comparison group (n=14); and (d) PETE students taking an introductory course with no exercise physiology emphasis—the control group (n=53).

Instrumentation

Each participant completed an exercise physiology content knowledge test during the first and final weeks of the semester. The test consisted of 40 multiple choice questions which assess knowledge of a variety of theoretical and applied health-related physical fitness concepts that are considered to be particularly relevant to the teaching of school-based physical education (see Figure 1). The test was previously designed, validated, and tested for reliability by Miller and Housner (1998). During the instrument design process, the test was assessed for discriminate validity and was found to effectively differentiate between two groups, graduate students in exercise physiology and undergraduate students in PETE, known to have significantly different educational backgrounds concerning health-related physical fitness. The exercise physiology graduate students participating in the pilot study achieved a mean score of 33.27 (83.20%) on the 40-item test, while the undergraduate PETE students had a mean score of 20 (50.00%). T-tests concerning the total test score and the five sub-component parts of the test (aerobic fitness, muscular strength, muscular endurance, body composition, and flexibility) indicated significant differences between groups (all p-values less than .0001) with the exercise physiology graduate students scoring higher in

every area. Miller and Housner also employed a split-half procedure to measure test reliability. The test was divided according to odd and even numbered test questions. The Pearson-Product correlation coefficient for the odd and even questions was found to be .81 thus indicating an acceptable level of reliability.

Aerobic exercise changes resting physiological parameters. One such parameter is stroke volume. Changes in stroke volume occur for the following reasons:

A. Increased ventricular size
B. Greater amount of blood filling and greater force of contraction
C. Decreased venous return
D. Both A and B
E. All of the above

This type of stretching technique is not recommended because of the possibility of exceeding the extensibility limits of the muscle:

A. Proprioceptive neuromuscular facilitation
B. Ballistic stretching
C. Static stretching
D. Both A and B
E. None of the above

To train the cardiorespiratory system the American College of Sports Medicine recommends that an individual train 2-5 days per week for at least 20-60 continuous minutes, performing activities that require large muscle groups at _____ of maximum heart rate intensity.

A. 60-90%
B. 20-60%
C. 40-85%
D. All of the above
E. None of the above

Exercise contributes to a weight control program by:

A. Increasing expenditure of energy
B. Controlling appetite
C. Increasing Metabolic rate
D. Increasing self-esteem
E. All of the above

The muscle fibers used for muscular endurance are said to be fatigue resistant. That is primarily because of:

A. Greater ability to utilize oxygen
B. Higher concentrations of creatine phosphate
C. Higher capillary supply
D. Both A and C
E. Both A and B

Figure 1. Sample items from the exercise physiology content knowledge test adapted from (Miller & Housner, 1998)

For this study, the test was administered to each group of students independently in a classroom setting. Participants were provided with test questions and answer sheets to record their responses. Prior to data collection, IRB approval was obtained and the participants were informed that their involvement in this study was completely voluntary and the results would have no impact on their course standing or grade. No time limit was imposed for the test.

Treatments

As with any study comparing educational approaches, treatment fidelity remained a potential area of concern. The involved courses were well established and taught across multiple semesters prior to the beginning of this research project. The instructors were asked to deliver the related course material in accordance with the university approved course syllabus and schedule. This decision was made in the interest of maintaining a high degree of ecological validity regarding the employed courses. Given the dynamic nature of the college classroom (e.g., student questions about other topics, infusion of new research developments into courses, differences in teaching style, examples or stories used to illustrate key points), treatment fidelity was difficult to control for and remains a possible limitation of this study.

The involved courses included an introductory exercise physiology course, alternative exercise physiology course for PETE majors, and an introduction to physical education course. The groups receiving traditional exercise physiology instruction took a basic exercise physiology course required of all undergraduate students by both the exercise physiology and PETE programs (see Table 1). Students in these two groups were taught by one of three different instructors who specialize in exercise physiology. Each instructor was made aware of the study's intent as well as the specific nature of the pretest and posttest, and was asked to teach the exercise physiology course as they normally would because the differences in course content, instructional methods, and educational environment between the traditional and alternative course remained a focus of the study. The participating instructors complied, and employed a directive style of teaching emphasizing a lecture/discussion format to deliver the involved course content.

Another group of students was taught exercise physiology using an alternative instructional approach (see Table 1). In contrast to the previously described traditional exercise physiology course, the emphasis of the alternative approach was to assist students in applying the relevant theoretical information acquired to physical education teaching situations. A single instructor, who was a doctoral student in PETE with a specialization in applied exercise science, taught the alternative course. This instructor was also made aware of the intent and assessment procedures to be used. A detailed description of the alternative course has been previously presented in the literature (Bulger et al., 2000). Bulger et al. summarize the purpose of the alternative course in the following passage:

> The major educational goal of the revised course is to develop the student's comprehension of the basic physiological systems, measurement techniques, conditioning concepts, and PCK [pedagogical content knowledge] required for teaching physical conditioning to children in a school-based physical education program. The course provides physical education majors with a unique opportunity to study developmental exercise physiology theory while simultaneously practicing the pedagogical skills that will enable them to facilitate a child's appreciation for physical activity as an essential component of a healthy lifestyle. (p. 174)

The control group received no specific instruction in exercise physiology content. These participants were enrolled in an introduction to physical education course required of all entering PETE students. The course emphasized the philosophical/historical considerations related to the profession of physical education teaching.

Table 1

Traditional and Alternative Models for the Instruction of Exercise Physiology

Variable	Traditional model	Alternative model
Department affiliation	Outside of the PETE program.	Within the PETE program.
Instructor background	Exercise physiologist with little to no background in physical education teaching or pedagogy.	Teacher educator with special preparation in exercise physiology.
Course enrollment	Students with a variety of professional interests.	Students planning to teach school-based physical education.
Educational focus	Subject matter knowledge.	Subject matter knowledge, pedagogical knowledge, and related pedagogical content knowledge.
Course content	Adult-based exercise physiology theory and application.	Developmental exercise physiology theory and application.
Lab experiences	No practical lab experience or a clinical lab including graded exercise testing, measuring body composition, monitoring blood pressure and so forth.	Field-based experiences with children including fitness testing and developmentally appropriate instructional activities.

Students in this group were taught by one of two physical education teacher educators who were aware of the purpose of the study, but had no special training or interest in the area of exercise physiology.

Data Analysis

The nature of the research question prohibited random assignment of participants to experimental and control groups. Intact groups were purposefully sampled because the inherent differences among PETE students and exercise physiology students remained an important characteristic of the study. Consequently, a non-equivalent control-group design was employed (Campbell & Stanley, 1963). Gall, Borg, and Gall (1996) reported that this quasi-experimental design is one of the most widely used in educational research, within which "participants are not randomly assigned to the experimental and control groups, and both groups take a pretest and posttest" (p. 507). The primary threat to internal validity remains the possibility that between group differences on the posttest result from pre-existing group differences rather than an actual treatment effect. From a data analysis perspective, analysis of covariance (ANCOVA) can be used to moderate "the effects of initial group differences by making compensating adjustments to the posttest means of the two [or more] groups" during data analysis (Gall, Borg, & Gall, 1996, p. 508).

Because random assignment of participants to treatment groups was not possible, the interpretive effect of initial group differences was a concern. Accordingly, ANCOVA was determined to be the most appropriate method of statistical analysis. Posttest scores were used as the dependent

variable with pretest scores as the covariate. The independent variable consisted of four levels: (a) PETE majors taking exercise physiology taught alternatively—the experimental group; (b) exercise physiology majors taking exercise physiology taught traditionally—a comparison group; (c) PETE majors taking exercise physiology taught traditionally—an additional comparison group; and (d) PETE students taking an introductory course with no exercise physiology emphasis—the control group. The mean posttest scores of the four groups were compared using a one-way ANCOVA. This same statistical approach was employed to compare the posttest scores of the groups on the five component parts of the exercise physiology content knowledge test. All statistically significant F-ratios received post hoc analysis using Tukey's Honestly Significant Difference.

Results

The mean group posttest scores and standard deviations for the entire test and its component parts are reported in Table 2. The F-ratio generated when comparing the four group mean posttest scores was: $F(4,132) = 85.92$, $p < .01$. Post hoc analysis indicated that the experimental group (PETE majors taking the alternative course) significantly out performed both comparison groups on the content knowledge test, all of which out performed the control group (all p-values less than .01). A similar pattern of results was generated for the sub-component parts of the test. In the areas of body composition, flexibility, and muscular strength the experimental group scored significantly higher than all other groups (all p-values less than .01). The experimental group also outperformed the control group and comparison group of PETE students taking a traditional exercise physiology course on questions related to muscular endurance (all p-values less than .01), but no significant differences were found in relation to the comparison group of exercise physiology students enrolled in a traditional course. On the aerobic fitness questions, the experimental group and both comparison groups scored significantly higher than the control group (all p-values less than .01).

Discussion

As previously discussed, a number of educational scholars have called for the use of alternative instructional and curricular strategies for the purpose of enhancing curricular relevance, increasing student engagement, and facilitating the eventual practical application of subdisciplinary content in applied physical education settings (Bulger et al., 2000; Miller & Housner, 1998; Van Donselaar & Leslie,1990). The results of this study demonstrated that PETE students who received exercise physiology instruction emphasizing concept application outperformed the PETE and exercise physiology students who received their exercise physiology instruction in a more traditional format. In light of these findings, several possible explanations regarding the observed discrepancies in knowledge acquisition merit further discussion: (a) The added focus on pedagogically relevant developmental and applied exercise physiology concepts within the experimental course may have enhanced student performance; (b) The inclusion of an applied laboratory experience within the experimental course may have contributed to improved student knowledge acquisition; and (c) The use of an instructor with expertise in both pedagogy and exercise physiology to deliver the experimental course may have also influenced student learning of generalized exercise physiology concepts as measured by the employed content knowledge test.

While no one should demean the importance of establishing a theoretical foundation in exercise physiology as a basis for the knowledge application that occurs during the teaching of physical education, it appears that in the absence of knowledge application emphasis, knowledge acquisition, in general, may suffer. One would

Table 2

Mean Posttest Scores and Standard Deviations by Group for Test[1] and Test Sub-Components[2]

Group	Entire Test	Test Sub-Components				
		Body composition	Flexibility	Muscular strength	Aerobic fitness	Muscular endurance
	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
PETE experimental group n = 37	27.51 3.95	6.27 1.12	5.62 1.26	4.78 1.77	5.59 1.28	5.16 0.83
Ex. Phys. comparison group n = 33	24.52 3.71	4.97 1.24	4.42 1.60	4.06 1.27	5.88 1.05	5.21 1.17
PETE comparison group n = 14	20.93 3.12	4.21 1.05	4.14 0.95	3.50 1.83	4.79 1.12	4.29 1.44
PETE control group n = 53	15.55 4.62	3.55 1.55	2.68 1.41	2.72 1.38	3.38 1.39	3.23 1.31

[1] The means for the entire test are reported as a raw score out of 40.
[2] The means for the test sub-components are reported as a raw score out of 8.

expect this to be particularly true when the learner is acquiring the knowledge for the primary purpose of application, as is the case with PETE students. Consequently, the perceived significance of a theoretical concept may well be associated with its usefulness in an applied context. Therefore from a curricular perspective, instruction of theoretical concepts must be tempered by that concept's relevance to application.

The experimental course was designed to address the needs of prospective physical educators who planned to pursue careers working in school-based physical education settings that emphasize the teaching of motor skills, games, sports, and physical fitness. In order to meet the specific needs of this target audience, a number of developmental and applied concepts not typically included within introductory exercise physiology courses were integrated into the curriculum of the experimental course. This alternative course focus warranted a reduction in the number of theoretical exercise physiology concepts that were included in the course. Essentially, the course designer was required to make a number of evaluative judgments regarding the most pedagogically relevant and developmentally appropriate theoretical and

applied exercise physiology concepts (Bulger et al., 2000). This critical analysis of the related theoretical and applied exercise physiology concepts may have contributed to the design of a course that made more explicit connections between the subdiscipline of exercise physiology and the practice of teaching physical education for the students, thus positively influencing general knowledge acquisition.

It is worth noting, however, that the designation of these critical concepts may become increasingly difficult as alternative curricular models emphasizing subdisciplinary concepts (e.g., concepts-based fitness courses) continue to become more prevalent in school-based physical education programs. It is quite possible that more advanced theoretical preparation in the subdisciplines of physical education may be necessary if physical educators are going to be teaching in middle or secondary school settings that offer more advanced electives in biomechanics, exercise physiology, sport performance, and so forth.

The experimental course also afforded PETE students the opportunity to engage in an applied laboratory setting where the theoretical and applied principles discussed in class were reviewed and reinforced in the context of a children's fitness education program. Students in the traditional exercise physiology course did not, however, engage in any type of laboratory experience. The inclusion of this two-hour per week laboratory experience, which was added at the expense of one lecture session per week, does not appear to have negatively impacted student knowledge acquisition. Perhaps this indicates that physical education teacher educators must look beyond traditional classroom and laboratory instructional strategies for the purpose of delivering subdisciplinary content in a more student-centered fashion.

The qualifications of the involved course instructors are also likely to have played a considerable role in determining the effectiveness of both the experimental and traditional exercise physiology courses. The experimental course was planned and delivered by a physical education teacher educator with a background in both pedagogy and exercise physiology. Exercise physiology specialists, highly regarded for their disciplinary and instructional expertise, taught the traditional course sections. While no data were collected regarding specific instructional behaviors, it seems reasonable to conclude that the involved instructors may have used different instructional formats and techniques of varying effectiveness based on their individual level of pedagogical expertise and experience. In combination with the previously described differences in the course orientation, structure, and presentation, these individual differences among course instructors are likely to have influenced student learning and test performance to some degree.

Conclusion

In summary, it is our intent that these results may stimulate additional programmatic research concerning the relationship between initial survey courses in exercise physiology and understanding of and practical application in physical education teaching. Given the exponential rate at which the foundational knowledge base continues to expand in the field of physical education, it is unrealistic to expect that pre-service and in-service physical education teachers can develop and maintain expertise in a wide variety of subdisciplinary areas. Accordingly, physical education teacher educators are left with the challenging task of identifying those critical subdisciplinary concepts that will best enable their students to apply this information in a school-based context. Recent publications have addressed this particular issue in the area of exercise physiology and may prove helpful to PETE faculty members engaged in the process of determining curricular content (Bulger & Housner, 2007; National Association for Sport and Physical Education, 2006). A follow-up research question concerns the organization of these critical concepts or competencies into a coherent, conceptual framework that would enable physical educators to use them in the promotion of

children's physical activity and health-related fitness.

In light of the potential problem of knowledge obsolescence in the area of exercise physiology (Kelley & Lindsay, 1977, 1980), further examination of exercise physiology knowledge retention is also needed regarding the knowledge acquired within a course that emphasizes practical application in addition to theoretical concepts. Continued research could help to determine whether or not the exercise physiology concepts learned in an alternative course are retained and applied by practicing teachers in the form of improved fitness education programming within school-based settings. In other words, does the inclusion of a variety of alternative course characteristics (see Table 1) contribute to the pre-service teacher's readiness to (a) develop fitness education unit/lesson plans; (b) teach developmentally appropriate fitness concepts and activities; and (c) assess student performance related to physical activity and fitness.

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