*Journal of Athletic Training* 1998;33(3):238-243

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# The Effectiveness of an Interactive Computer Program Versus Traditional Lecture in Athletic Training Education

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***Objective***: To evaluate the effectiveness of an interactive athletic training educational curriculum (IATEC) computer program as compared with traditional lecture instruction. Instructions on assessment of the quadriceps angle (Q-angle) were compared. Dependent measures consisted of cognitive knowledge, practical skill assessment, and attitudes toward the 2 methods of instruction.

***Design and Setting***: Sixty-six subjects were selected and then randomly assigned to 3 different groups: traditional lecture, IATEC, and control. The traditional lecture group ($n = 22$) received a 50-minute lecture/demonstration covering the same instructional content as the Q-angle module of the IATEC program. The IATEC group ($n = 20$; 2 subjects were dropped from this group due to scheduling conflicts) worked independently for 50 to 65 minutes using the Q-angle module of the IATEC program. The control group ($n = 22$) received no instruction.

***Subjects***: Subjects were recruited from an undergraduate athletic training education program and were screened for prior knowledge of the Q-angle.

***Measurements***: A 9-point multiple choice examination was used to determine cognitive knowledge of the Q-angle. A 12-point yes-no checklist was used to determine whether or not the subjects were able to correctly measure the Q-angle. The Allen Attitude Toward Computer-Assisted Instruction Semantic Differential Survey was used to assess student attitudes toward the 2 methods of instruction. The survey examined overall attitudes, in addition to 3 subscales: comfort, creativity, and function. The survey was scored from 1 to 7, with 7 being the most favorable and 1 being the least favorable.

***Results***: Results of a 1-way ANOVA on cognitive knowledge of the Q-angle revealed that the traditional lecture and IATEC groups performed significantly better than the control group, and the traditional lecture group performed significantly better than the IATEC group. Results of a 1-way ANOVA on practical skill performance revealed that the traditional lecture and IATEC groups performed significantly better than the control group, but there were no significant differences between the traditional lecture and IATEC groups on practical skill performance. Results of a *t* test indicated significantly more favorable attitudes ($P < .05$) for the traditional lecture group when compared with the IATEC group for comfort, creativity, and function.

***Conclusions***: Our results suggest that use of the IATEC computer module is an effective means of instruction; however, use of the IATEC program alone may not be sufficient for educating students in cognitive knowledge. Further research is needed to determine the effectiveness of the IATEC computer program as a supplement to traditional lecture instruction in athletic training education.

***Key Words***: computers, student attitudes, multimedia

Instructional technology has improved at a rapid rate. While research has supported the use of computers as an educational tool, we found few studies that have examined the effectiveness of advanced forms of instructional technology and its integration into educational curricula. Fincher and Wright[1] defined computer-based instruction as "any form of instruction that uses the computer to present instructional information, with computer-assisted instruction and interactive video being 2 distinct forms of computer-based instruction." Computer-assisted instruction (CAI) generally consists of text only, whereas interactive video programs incorporate multimedia technology. Multimedia technology combines the use of text, audio, video, and graphic images to convey information.

Learning styles and learning approaches are believed to have an influence on student achievement.[2] CAI has been shown to enhance computer literacy, facilitate decision-making skills, and improve student achievement.[3] Studies have compared CAI with textbook reading,[4-6] lecture instruction,[6-15] and other combinations of teaching methods. The effect of CAI on practical components,[4,16] clinical experience,[17] and students' attitudes[3,11,18,19] has also been measured. In comparison with traditional methods of instruction, CAI allows users to progress through a lesson independently and at their own pace. The more advanced multimedia computer programs affect several senses and can meet the needs of a variety of learning styles. Multimedia technology can also be used to create clinical situations, which are of particular value in athletic training education. Clinical situations offer the user the opportunity to simulate real-life situations without risk to the patient. These simulations allow exposure to unusual cases and complex problems, encouraging users to experiment and take risks that might not be appropriate in an actual clinical environment.[20]

In the field of athletic training, use of CAI and multimedia computer programs has been limited. The few programs that are used consist of text only and have limited multimedia and interactive capabilities. According to a survey of 86 athletic training curriculum directors, 47 respondents used CAI and 9 used multimedia computer programs.[1] As part of an interactive athletic training educational curriculum (IATEC), we created an interactive multimedia computer program designed to develop essential competencies of athletic training through demonstration and skill assessment.[21] One module of this program identified the definition, implications, and measurement of the quadriceps angle (Q-angle). An increased or decreased Q-angle can lead to pathomechanical problems, such as chondromalacia or a subluxing patella, in both males and females. A group of 20 athletic trainers (10 certified athletic trainers, 10 senior student athletic trainers) established content validity of the Q-angle module in the IATEC program. We beta tested the modules and established test-retest reliability from the built-in Q-angle test session ($r = 0.96$ for certified athletic trainers and $r = 0.87$ for senior student athletic trainers).

The Q-angle module in the IATEC program has been used in studies examining practical application, knowledge structures, and cognitive athletic training knowledge.[4,22,23] Buxton et al[4] and Holgen et al[23] compared a combination of instructional methods in determining IATEC effectiveness. Subjects were randomly assigned to 1 of 4 groups: IATEC group, which had 1 hour of interaction with the computer; textbook group, which had 1 hour to study and read Q-angle material; IATEC/textbook group, which had both types of instruction combined in 1 hour; and control group, which had no treatment. All 3 experimental groups performed significantly better than the control group on practical assessment of the Q-angle and attained significantly more cognitive athletic training knowledge. No other significant differences were observed.[4,23] Chen et al[22] examined the use of the IATEC module on knowledge structure. Their findings suggested that the IATEC module had a positive impact on student learning by influencing their knowledge internalization. These studies suggest that the Q-angle module in the IATEC program was equally effective in educating students on both cognitive and practical skill levels when compared with textbook reading.

There are no studies that have determined the effectiveness of the IATEC program versus traditional lecture instruction in attaining cognitive knowledge and practical assessment skills. In addition, no studies have examined student attitudes toward the IATEC program or any other interactive computer program in athletic training education. Therefore, the purpose of our study was to determine the effectiveness of the IATEC program versus traditional lecture instruction in athletic training education by evaluating cognitive knowledge and practical assessment skills of the Q-angle measurement on a human subject, as well as student attitudes toward both methods of instruction.

## METHODS

### Subjects

We recruited sixty-six subjects, 40 males and 26 females, for this study. All subjects were enrolled in an upper-division undergraduate applied anatomy and kinesiology course at a large southwestern university. This was an introductory course, and the prerequisite included human anatomy. Subjects had a background in musculoskeletal anatomy but no formalized education in athletic training. Subjects who volunteered completed a prescreening survey including amount of clinical experience and previous knowledge of the Q-angle, along with a variety of other terms that served as distractors. Those without prior knowledge of the Q-angle were included in the study. The study was exempt from human subjects review because the research involved the use of educational tests and survey procedures that did not directly link subject identification, did not place the subject at risk of criminal or civil liability, and were not damaging to the subject's financial standing, employability, or reputation. Participants signed a willingness-to-participate statement that informed them of the purpose of the study and the importance of enthusiastic participation. All subjects signed a statement of confidentiality to prevent interaction among the subjects regarding the Q-angle topic.

We randomly assigned 66 subjects equally to a traditional lecture group, IATEC group, or control group. Two subjects did not complete the computer program due to scheduling conflicts and were dropped from the study. This left 22 subjects (14 males and 8 females) in the traditional lecture group, 20 subjects (15 males and 5 females) in the IATEC group, and 22 subjects (12 males and 10 females) in the control group.

### Procedure

**Traditional lecture group.** A full-time professor and NATABOC-certified athletic trainer conducted a 50-minute classroom lecture. Subjects were encouraged, but not required, to take lecture notes. The lecture began with an introductory phase that included the definition and importance of the Q-angle. A review of lower leg anatomy and a description of the components of the Q-angle followed. Overhead transparencies were used to review anatomy and the Q-angle and to emphasize knee pathologies. Measurement of the Q-angle was discussed, followed by a demonstration of the procedure using a goniometer. The instructor emphasized step-by-step methods on a human model. Lastly, normative values for Q-angle measurements were given, followed by examples of abnormal cases and resultant pathologies. Immediately after instruction, subjects completed an attitude survey, took the written examination, and scheduled a time to take the practical examination. Subjects were not given the opportunity to practice measuring the Q-angle before the practical examination. All subjects in the lecture group completed the practical examination within 2 weeks of instruction.

**IATEC group.** The interactive computer program contained the same content as the lecture, yet students received instruction independently outside of class time on a Macintosh 7100X/80 (Apple Computer, Inc, Cupertino, CA) using the IATEC program. This program is designed to provide visual, auditory, and kinesthetic feedback on athletic training educational components. For our study, subjects were directed into the Q-angle lesson. The program began with a brief video segment that demonstrated and explained the essential knowledge and skills of Q-angle assessment. Lower leg anatomy and Q-angle landmarks were reviewed, followed by a test of the information. If an answer was incorrect, immediate feedback was given revealing the correct answer. The Q-angle demonstration on a human model was shown on the computer monitor. Using a mouse and the drag-and-click method, subjects practiced measuring various angles with a goniometer. The subjects then identified Q-angle landmarks on a human model and practiced measuring these angles using the mouse. When the test was completed, the subjects received a score. When a competency level of 70% or higher was achieved, the educational component ended. If 70% was not achieved, the program restarted, beginning with the goniometer practice. The program length varied, but most subjects completed the program within 65 minutes. Immediately after completing the program, subjects took the attitude survey and the written examination. They then scheduled a time to take the practical examination. Subjects were not given the opportunity to review measuring the Q-angle before the practical examination. All subjects in the computer group completed the practical examination within 2 weeks of instruction.

**Control group.** Subjects in this group did not receive either traditional lecture or computer-assisted instruction. We reminded the subjects in this group that they signed a statement of confidentiality vowing not to discuss any information with other involved subjects. Immediately after enrollment, subjects completed the written examination and scheduled a time to take the practical examination. Subjects in this group did not complete the attitude survey because they were not exposed to any type of instruction. All subjects in the control group completed the practical examination within 3 weeks of enrollment.

## Instrumentation

**Written examination.** The written examination consisted of 9 multiple choice questions that measured cognitive knowledge about the Q-angle. Certified athletic trainers ($n$ = 10) in the field established content validity of this instrument before data collection. We calculated the reliability of the examination with an intraclass correlation coefficient obtained from 1-way analysis of variance. Correlations of each question to the total score indicated that each question was moderately related to the total score ($r$ = 0.4 to 0.72). The reliability coefficient was $r$ = 0.70.

**Practical examination.** The practical examination consisted of 12 yes or no questions related to appropriate measurement of the Q-angle. A yes point was given if the subject performed the task correctly, and a no point was given if the subject performed the task incorrectly. This format is based on the national certification examination used by the NATABOC. An expert panel of athletic trainers reviewed, validated, and established points for the NATABOC practical examination.[24] Content validity was assured since it was modeled after the NATABOC practical examination and sampled material presented in the IATEC program and in the lecture instruction. We calculated the reliability of the practical examination with an intraclass correlation coefficient obtained from 1-way analysis of variance. The reliability coefficient was $r$ = 0.93. The subject was asked to measure a human model's Q-angle, and a certified athletic trainer documented the responses. A goniometer, marking pen, and athletic tape were available for the subject's use.

**Attitude assessment survey.** After instruction, the traditional lecture and IATEC groups completed a survey measuring student attitudes toward the 2 different types of instruction. We chose the Allen Attitude Toward CAI Semantic Differential Tool as the attitude assessment tool for this study. It was developed for nursing students and was validated by a small panel (4 experts in computer applications and 1 psychometrician who is considered an expert in semantic differential scales).[25] Of the 26 adjective pairs, 12 were considered to be nonrelevant; thus, the other 14 were retained. The 14 bipolar adjectives could be scored from 1 to 7, with 1 being the least desirable to 7 being the most desirable (Figure). For example, for the adjective pair "rigid:flexible," the nearest space to "rigid" was given 1 and the nearest space to "flexible" was given a 7, with all other spaces in between given respective

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Rigid | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Flexible |
| Useful | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Useless |
| Stimulating | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Boring |
| Meaningless | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Meaningful |
| Pleasant | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Unpleasant |
| Valuable | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Worthless |
| Creative | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Unimaginative |
| Impersonal | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Personal |
| Efficient | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Inefficient |
| Inappropriate | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Appropriate |
| Comfortable | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Uncomfortable |
| Nonthreatening | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Threatening |
| Overpowering | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Easy to control |
| Time-saving | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Time-consuming |

**Allen Attitude Toward CAI Semantic Differential Tool, with scoring key.**

numbers in order. Subjects placed a check where they felt the instruction should be rated on the basis of the adjective pair. The 14 bipolar scales were then grouped into 3 subscales labeled comfort, creativity, and function. Comfort and creativity each contained 4 bipolar adjective scales, while function contained the remaining 6. We calculated the scores for both types of instruction based on the 3 subscales, as well as a total overall score. Total scores could range from 0 to 98, while score ranges for the 3 subscales were as follows: 0 to 28 for comfort; 0 to 28 for creativity; and 0 to 42 for function.

### Data Analysis

We computed means and standard deviations for traditional lecture, IATEC, and control groups for the written and traditional lecture practical examination scores. We used a 1-way analysis of variance to examine the differences among the 3 groups for both the written and practical examinations. A post hoc analysis ($P < .01$) using the Scheffe procedure was used to determine significant differences among groups on cognitive assessment and practical assessment of the Q-angle.

We calculated means and standard deviations for the total score and the 3 subscales of the attitude survey for the traditional lecture and IATEC groups. An independent $t$ test was used to determine whether significant differences ($P < .05$) existed among the groups. We calculated the reliability of the entire survey and each subscale with an intraclass correlation coefficient obtained from a 1-way analysis of variance.

## RESULTS

Group means and standard deviations for the written and practical examination scores are listed in Table 1. Results of a 1-way analysis of variance indicated a significant difference among the 3 groups on the written examination ($F_{2,61} = 57.61$; $P < .001$). Post hoc analysis using the Scheffe procedure indicated that the traditional lecture group performed significantly better than both the control and IATEC groups, and the IATEC group performed significantly better than the control group.

Results from the practical examination also indicated a significant difference among the 3 groups ($F_{2,61} = 55.86$, $P < .01$). Post hoc analysis using the Scheffe procedure indicated that the traditional lecture and IATEC groups performed significantly better than the control group, but there was no significant difference between the traditional lecture and IATEC groups.

The means and standard deviations for the total score and the 3 subscales of the attitude survey are shown in Table 2. Because the attitude survey relies on a 7-point scale (1 being the lowest, 7 being the highest), Table 3 illustrates the means and standard deviations on a 7-point scale. For our study, favorable attitudes toward type of instruction were considered to be any score above 4.0.

The reliability for the entire attitude inventory was $r = 0.90$, while the reliability for the subscales of comfort, creativity, and function was $r = 0.84$, 0.56, and 0.84, respectively.

We performed a $t$ test to determine whether significant differences in attitudes existed between the 2 groups as measured by total score and for each of the 3 subscales. For the total score, the traditional instruction group had significantly more favorable attitudes toward instruction ($t_{41} = 7.81$, $P < .05$) than the IATEC group. The 3 subscales showed similar findings. The traditional lecture group had significantly more favorable attitudes on comfort ($t_{41} = 4.86$, $P < .05$), creativity ($t_{41} = 4.92$, $P < .05$), and function ($t_{41} = 3.08$, $P < .05$).

## DISCUSSION

Both methods of instruction proved to be effective learning tools for subjects when obtaining cognitive knowledge to perform practical skills in athletic training, as indicated by the significantly higher scores over a control group. The results of the written examination, however, indicated that the traditional lecture group gained significantly more cognitive knowledge about the Q-angle than the IATEC group. Our results suggest that, while the IATEC module is effective, it may not be able to stand alone as a means of instruction for this particular topic in athletic training subject matter. In addition, our results suggest that students preferred lecture instruction over the IATEC instruction, as measured by attitude scores for the overall score and for each of the 3 subscales.

Several researchers have reported CAI to be as effective as traditional lecture instruction for attaining cognitive knowl-

**Table 1. Means (Standard Deviations) for Written and Practical Examinations**

| Variable | Lecture ($n$ = 22) | IATEC ($n$ = 20) | Control ($n$ = 22) |
|---|---|---|---|
| Written* | 7.73 (1.03) | 5.75 (1.68) | 3.36 (1.29) |
| Practical† | 8.38 (3.11) | 6.65 (3.70) | 0.00 (0.00) |

* Range of scores is 0 to 9.
† Range of scores is 0 to 12.

**Table 2. Means (Standard Deviations) for Attitude Scores Toward Traditional Lecture and IATEC Instruction**

| | Lecture ($n$ = 22) | IATEC ($n$ = 20) |
|---|---|---|
| Total (max = 98) | 82.59 (12.17) | 74.15 (12.29) |
| Comfort (max = 28) | 24.55 (4.72) | 21.30 (4.61) |
| Creativity (max = 28) | 21.50 (3.36) | 18.55 (4.12) |
| Function (max = 42) | 36.55 (6.07) | 34.30 (5.11) |

**Table 3. Means (Standard Deviations) for Attitude Scores Toward Traditional Lecture and IATEC Instruction on a 7-Point Scale**

| | Lecture ($n$ = 22) | IATEC ($n$ = 20) |
|---|---|---|
| Total | 5.90 (1.32) | 5.30 (1.68) |
| Comfort | 6.14 (1.31) | 5.34 (1.31) |
| Creativity | 5.38 (1.31) | 4.64 (2.0) |
| Function | 6.09 (1.25) | 5.72 (1.36) |

edge.[7,8,11] Other researchers,[6,14] however, have shown CAI to be significantly better than traditional lecture instruction in imparting knowledge and enhancing instructional efficiency. Billings and Cobb[26] found that the strongest predictor of achievement was attitude toward CAI. Gaston[11] reported no significant difference in students' attitudes toward lecture instruction and CAI. Research by Day and Payne[8] and Porter[14] showed CAI to be effective; however, they reported that students preferred the traditional lecture method of instruction over CAI.

Research examining the effectiveness of CAI in teaching practical skills has been shown to be as effective as,[16,27] or better than,[4] other methods of instruction. The results of our study indicate no significant differences between the traditional lecture and IATEC groups for practical skill performance of Q-angle assessment; however, examination of the mean scores yields important implications from a clinical perspective. A score of 6.65/12, which was the IATEC mean score, would not be clinically acceptable as a demonstration of practical skill competence of Q-angle assessment. Consequently, our results underscore the importance of examining both statistical and clinical significance when interpreting results. One problem we faced was that subjects had to schedule an appointment to take the practical examination. Due to time constraints, some subjects did not complete the practical examination until 2 weeks after instruction. This delay may have affected the subject's retention of the subject matter.

The inconsistency in the literature can be partially explained by examining the advantages and disadvantages of CAI versus traditional lecture instruction. The subjects in our traditional lecture group were not only familiar with the instructor, but were also accustomed to the lecture/demonstration format of instruction. Traditional lecture instruction is thought to be more familiar and less threatening,[14] which may enhance learning. Lack of computer experience can lead to computer anxiety; hence, subjects may feel frustrated and carry negative attitudes toward the program. Familiarity and experience usually lead to a more positive attitude toward CAI, as indicated by Porter.[14] His research indicated that, although attitudes toward traditional lecture instruction were better, attitudes toward CAI showed continued improvement in scores after 60 days of use.

Another possible explanation for the inconsistency in the literature is the quality and validity of different software programs. While the authors of IATEC established content validity, they did not report construct or predictive validity. Other interactive multimedia computer programs may produce different results depending on the validity and quality of the programs. Programs that are user friendly and run efficiently are highly recommended for ensuring a positive learning environment.

Although the traditional lecture group significantly outscored the IATEC group in total score and in the 3 subscales of the attitude survey, the IATEC group still showed favorable attitudes toward the IATEC module. Recall that any score above 4.0 indicates favorable attitudes (Table 3). These findings are consistent with the work of Gaston,[11] Lowdermilk and Fishel,[3] and Xakellis and Gjerde,[19] who also found favorable attitudes toward CAI. However, the practical importance of these differences should also be taken into consideration. Although the differences among groups in this study were statistically significant, all the mean scores were favorable and the mean differences were less than 1 point (0.27–0.80). Thus, the high statistical power in this study, given the sample sizes of 22 and 20 per group, yielded statistical differences that in a practical setting are quite small.

Finally, while the reliability for total score (0.90), comfort (0.84), and function (0.84) were high, the reliability for creativity (0.56) was quite low. Allen[25] reported similar reliability measures, with the subscale for creativity being lower than the other scales ($r = 0.66$). Additional work examining the factor structure with a large independent sample in athletic training is warranted to determine the suitability of the subscales for this population.

Day and Payne[8] reported that negative aspects of CAI were lack of feedback, lack of student control, lack of interaction between the student and instructor, and a biased orientation against computer instruction. While the IATEC module used in our study does provide positive feedback in the form of a correct answer, there is no discussion or student:student or student:professor interaction. In our study, students received only a single exposure to the IATEC module, which may have contributed to less favorable attitudes. In addition, students in the lecture group received instruction during a regular class period, whereas students in the IATEC group were required to seek instruction outside class time. These factors may have affected their attitudes and ability to attain cognitive knowledge and may partially explain the significantly more favorable attitudes and higher written examination scores for the traditional lecture group as opposed to the CAI group.

A disadvantage for the IATEC group was the use of a 2-dimensional tool and measurement on a computerized human model, while the lecture group visualized the procedure as the instructor demonstrated the steps on a human model. Identifying an anatomic landmark on a live human model usually entails palpation as well as visual information. Palpation is absent when using the IATEC module, and therefore this task is more difficult. Consequently, the IATEC group may have had difficulty in the transition from the computer simulation to the human model on the practical examination. Students who prefer traditional lecture instruction may also benefit from real-life demonstrations.

Some students may need to experience both methods of instruction to maximize learning. One advantage of the IATEC module was that subjects were able to work independently and control their own pace. Immediate feedback was given, and corrections had to be made in order to advance in the program. Moreover, subjects could voluntarily repeat the sessions as needed in order to gain sufficient understanding of the material. Similar support for CAI was also reported by Porter.[14]

Additional research employing a combination of lecture and IATEC instruction merits investigation to fully explore these issues. Incorporating the entire IATEC program, as opposed to 1 module, would also allow examination of the program's full potential. A combination IATEC/lecture group was not included in this study because subjects in the lecture group were exposed to the Q-angle lesson as part of a university course. The lecture for this topic was 50 minutes, and, had a fourth group of students been allowed to then use the IATEC program in addition to the 50-minute lecture, they would have had more exposure to the topic than the other groups. This would have skewed the results of our study, giving the fourth group a clear advantage over the other groups.

Further research is needed to investigate retention of material, since transferring learned knowledge to a clinical situation is the true measure of success in athletic training. Using interactive multimedia programs for a longer period of time, such as for an entire semester, may determine long-term effects. Lastly, implementing interactive multimedia computer programs at different institutions, in other athletic training curriculum programs, may increase the generality of the results.

In conclusion, the IATEC module has been shown to be an effective educational tool in athletic training; however, it may not be able to stand alone. Attitudes toward both types of instruction were favorable, but attitudes toward lecture instruction were significantly more favorable than toward IATEC instruction. Given the continually changing face of instructional technology, traditional lecture should not be dismissed as a form of instruction. The implementation of interactive multimedia computer programs into athletic training curricula must remain a primary focus for future research. The advantages of all types of instruction need to be maximized, while the disadvantages are minimized. Through continued research and development of instructional technology in athletic training, the most effective means of integrating computers into curricula can be determined.

## ACKNOWLEDGMENTS

This study was supported by the National Athletic Trainers' Association District 8 Research Award, 1996. The interactive computer program module used in this study (IATEC) was developed by Barton P. Buxton, EdD, ATC, and Thomas Speitel, PhD, at the University of Hawaii.

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