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ORIGINAL RESEARCH

Immediate Feedback and Learning In Athletic Training Education

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Context: Immediate feedback has been shown to improve student learning more efficiently than delayed feedback in lower-level general education courses. No research exists examining the effects of immediate feedback on learning in higher-level athletic training coursework.

Objective: To determine if using the Immediate Feedback Assessment Technique (IF-AT) improves retention of information taught in upper-level athletic training courses better than traditional multiple choice (TMC) exams. The second purpose of this research was to determine students' perceptions of the IF-AT.

Design: 2 x 2 randomized, crossover experimental design.

Setting: A standard higher education classroom.

Patients or Other Participants: A convenience sample of 23 students enrolled in an upper-level athletic training course.

Interventions: Examination type (IF-AT and TMC) and examination session (initial and follow-up).

Main Outcome Measures: Examination scores of the students on the initial examinations and the follow-up examinations.

Results: The interaction between examination type and examination session was not significant; $F_{(1,44)} = .154$, $P = .696$, $1\text{-}\beta = .067$, $\omega^2 = .015$. Students did prefer the IF-AT over traditional multiple choice as evidenced by the survey.

Conclusions: Using the IF-AT on the initial examination did not significantly improve students' scores on the follow-up examination compared to using the TMC format. However, students gave the IF-AT high scores on the satisfaction survey.

Key Words: Information retention, testing strategies, learning assessment.

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INTRODUCTION

Feedback has been defined as information provided concerning one's level of performance or one's level of understanding.[1] Its purpose is to bridge the gap that exists between the knowledge that is attained by the student and the standards of the educator that have not been fulfilled.[2] The acknowledgement of the positive effects of feedback on student learning dates back to the early twentieth century.[3,4] This initial work found that feedback assisted students in choosing correct responses, and early correction of inaccurate responses led to less incorrect answering in the future. Although there is agreement on the effectiveness of feedback, there is much to debate as to whether delayed or immediate feedback is most effective.[5]

Some literature supports the positive effects of delayed feedback.[6,7] Delayed feedback has been defined as information given at the end of a test[8,9] or up to 7 days after the examination.[5,10] The delay-retention effect (DRE)[6] states that learning requires a period of time, usually 24-48 hours,[11] for students to forget previous inaccurate answers. Once the initial answer is forgotten, feedback is given to the student allowing the correct answers to be remembered. The DRE has been supported[6,7] and refuted[12-14] leaving it controversial.

An opposing theory, the Negative Suggestion Effect (NSE), counters that if students leave the examination session believing that their incorrect answers are correct, they will be susceptible to repeating incorrect answers on subsequent cumulative exams.[15,16] This theory supports the need for providing immediate feedback to students as incorrect answers are believed to facilitate the attainment of correct answers when immediate feedback is provided.[17] Immediate feedback has been defined as feedback given anywhere from seconds after a response[8] to the next meeting of a once a week class.[5] Several studies support the use of immediate feedback to promote student learning.[8,18-21]

Immediate feedback,[19] especially when combined with iterative responding (answering until correct),[8,18,20] has been theorized to assist learning by improving the efficiency of information retention.[21] Immediate feedback combined with iterative responding has the advantage of countering the NSE because students are not given the opportunity to think their incorrect responses are actually correct. Therefore, immediate feedback and iterative responding reduces student susceptibility to repeating incorrect answers. For these reasons, immediate feedback may be influential for those studying with practice tests for professional certification exams,[20] making its impact on athletic training education clear as students prepare for the Board of Certification exam.

One particular tool that has been pivotal in immediate feedback and iterative responding research is the Immediate Feedback Assessment Technique™ (Epstein Educational Enterprises; Cincinnati, OH), also known as IF-AT. The IF-AT allows students to answer multiple choice questions until they identify the correct response. The iterative process allows students to leave a testing session knowing the correct answers to each question. The IF-AT has been shown to improve retention of information[8] for students in lower-level[18] general education[20] courses. However, pharmaceutical students did not score higher when using the IF-AT compared to open-ended questions.[22] To date, no research has been published on the effect of using the IF-AT with students in upper-level athletic training courses. The purpose of this research was twofold: 1) determine if using the IF-AT would improve retention of information taught in upper level athletic training courses better than traditional multiple choice (TMC) exams, and 2) determine the students' perceptions of the IF-AT.

MATERIALS AND METHODS

We used a 2 x 2 randomized design in this study. We chose the independent variables to be examination format (IF-AT and TMC) and examination timing (initial and follow-up). We chose the dependent variables to be the examination scores of the students on the initial examination and the follow-up examination. The Institutional Review Board of the host institution deemed this study exempt from review.

Participants

A convenience sample of 23 students (6 male, 17 female; age = 20.41±0.80 years, 20 athletic training majors, 3 health promotion majors) enrolled in a junior level undergraduate athletic training upper extremity assessment course participated in this study. None of the students had any prior experience with the IF-AT. We collected data during two separate sections of the same course, both taught by the lead investigator.

Testing Procedures

Approximately 3 weeks into the fall semester, the lead investigator randomly divided the students into two groups. We assessed the content knowledge of group A students (N = 11) using a 10-question, 4-answer option traditional multiple choice (TMC) test. When using the TMC, students circled the letter of the answer they thought was correct, receiving no immediate feedback on whether their answer was correct or incorrect. We assessed the content knowledge of group B students (N =12) using a 10-question, 4-answer option IF-AT (Figure 1).[20,23,24] We gave the students in group B a brief overview of the IF-AT and an explanation of how to use the instrument. The IF-AT allowed students to answer multiple choice questions until they were correct by having them scrape off an opaque coating over their answer selection. A star was revealed in a box if the answer was correct, whereas an empty box was revealed if the answer was incorrect (see Figure 1). Students had the opportunity to self-correct by choosing another answer if their initial answer was incorrect until they came to the correct answer. The iterative responding allowed students to leave the test knowing the correct answer to each question.

At the subsequent class meeting, at least 48 hours following the initial examination, the lead instructor reviewed the examination with all students regardless of their initial examination format and then proceeded to teach new material. The new material

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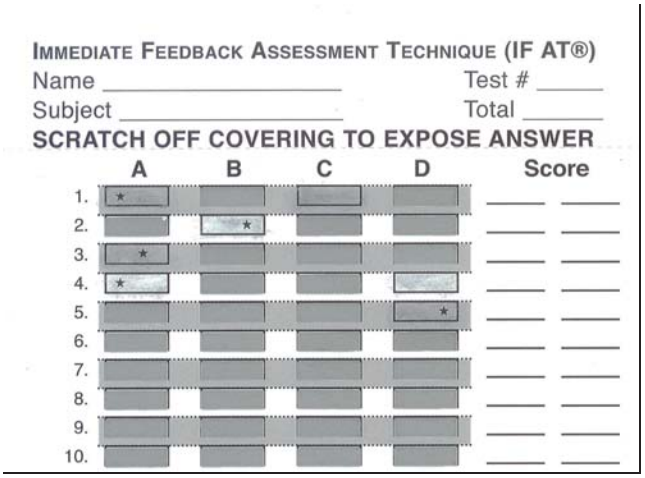
Figure 1. The Immediate Feedback Assessment Technique Answer Form (trademark and patent are held by Epstein Educational Enterprises. Used with permission.)



was not directly part of the experiment. It was covered simply to provide material to the class and provide the normal information distraction that would typically occur between information acquisition and testing. This new material was not part of the follow-up examination. Approximately one week (7 days) following the initial examination (TMC and IF-AT), we gave the students a follow-up examination covering the same content as the initial examination. The follow-up examination was a 10-question, 4-answer option TMC exam that covered the same material as the initial test; however questions and answers were reordered to minimize the effect of memorization.[20]

Seven weeks into the semester we repeated the testing procedure while rotating the groups to allow Group A to receive the IF-AT during the initial exam and Group B to receive the TMC during the initial exam. Both groups received a reordered 10-question TMC follow-up exam approximately 1 week later.

Students in both groups received 2 points for a correct answer and zero points for an incorrect answer on the initial and follow-up tests. We did not award partial credit if students chose the correct answer on the second or third try using the IF-AT. We compared scores on the initial and follow-up tests for both groups.

Twelve weeks into the semester we gave all students an additional test using only the IF-AT and offered partial credit if students chose the correct answer on their second attempt. We did this to help facilitate the students' completion of the IF-AT Satisfaction Survey (Figure 2) at the end of the semester. The 12 week IF-AT scores were not counted in the initial or follow-up test data in any way. The survey questions, taken from previous work,[25] asked the students questions about the IF-AT compared to other testing procedures. The students rated their answer on a 7 point scale (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree). The 14-question survey has three sections: overall satisfaction, elements of satisfaction, and miscellaneous. The survey assessed the students' testing preference, their satisfaction with the IF-AT, and the ease of each testing type (IF-AT and TMC). The survey also included space for the students to provide any comments regarding the IF-AT.

Table 1. Means and Standard Deviations for the Examination Scores (score out of 20 points possible)

		Mean ± SD	95% CI
Initial	IF-AT	15.17 ± 4.21	13.20, 16.72
	TMC	14.96 ± 4.16	13.42, 16.93
	Total	15.07 ± 4.14	13.84, 16.29
Follow-up	IF-AT for initial	16.43 ± 4.63	14.11, 17.63
	TMC for initial	15.87 ± 3.71	14.67, 18.20
	Total	16.15 ± 4.16	14.92, 17.39

Statistacal Analysis

We used a split-plot repeated method ANOVA to identify the interaction between examination type, examination session and the main effects for examination type and examination session. We used SPSS version 17.0 (SPSS Inc., Chicago, IL) for the test score analysis and Microsoft Excel 2007 (Microsoft Corporation, Seattle WA) for descriptive statistics of the participant survey. The *a priori* alpha level was set at $P \leq .05$.

RESULTS

The means and standard deviations for the examination scores according to examination type and examination session are presented in Table 1. The interaction between examination type and examination session was not significant ($F_{1,44} = .154$, P = .696, $1\text{-}\beta = .067$, $\omega^2 = .015$). The main effect for examination format was not significant ($F_{1,44} = .115$, P = .736, $1\text{-}\beta = .063$, $\omega^2 = .052$). The main effect for examination timing was significant ($F_{1,44} = 6.035$, P = .018, $1\text{-}\beta = .671$, $\omega^2 = .092$), as the follow-up exam scores (mean = 16.15±4.16) were significantly higher than the initial examination scores (mean = 15.07±4.14). The descriptive statistics of the survey results can be seen in Figure 2. Students particularly liked the fact that the IF-AT exam let them know the correct answer for every question (mean = 6.30±0.88), and let them calculate their score (mean = 5.87±1.14). They also expressed satisfaction in knowing they got the correct answer (mean = 6.26±0.86).

DISCUSSION

The results of the current study do not support the NSE phenomenon as students without immediate feedback performed similarly to those who did receive the immediate feedback. Although, the power of our analysis ($1\text{-}\beta = .067$) was below the typically accepted level of .80,[26] the P value (P = .696) for the interaction was very large and the effect size ($\omega^2 = .015$) was very small. Based on the P value and the effect size,[27,28] we have confidence that the IF-AT did not improve the students' ability to retain more information compared to the TMC. Our results conflict earlier studies that show improved information retention for students in lower-level, general education courses when using the IF-AT.[8,18,20] The improved information retention was due to the active discovery process of finding the correct answer. One previous study did find that upper-level pharmacy students using the IF-AT scored similarly to a comparable group of students taking open-ended question examinations covering the same course content.[22] Our results show no improvement in scores

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Figure 2. Means and Standard Deviations for the Survey Questions (1 = strongly disagree, 4 = neither agree nor disagree, 7 = agree strongly)

Overall Satisfaction	**Mean ± SD**
I like using a word processed form more than the IF-AT form for multiple-choice questions.	3.74±1.36
I would like it if I could use the IF-AT form in all of my courses that have multiple-choice tests.	4.39±1.64
I did not like using the IF-AT form and would prefer never to use it again.	2.74±1.63
Elements of Satisfaction	
I like the fact that the IF-AT form allows me to get partial marks on multiple-choice questions.	5.27±1.28
I like the fact that the IF-AT form lets me know the right answer to every question.	6.30±0.88
I like the fact that the IF-AT form lets me figure out my score on the multiple-choice portion of the test.	5.87±1.14
Miscellaneous	
The IF-AT form is confusing and difficult to use.	2.00±1.31
I think that the IF-AT is fairer than the word processed form for multiple-choice tests.	4.17±1.85
The IF-AT form allowed me to learn from my mistakes.	5.61±1.20
I learn more using the IF-AT than using the word processed form for multiple-choice tests.	4.74±1.39
I had a real feeling of satisfaction whenever I got the correct answer on my first try.	6.26±0.86
I had a real feeling of disappointment whenever I got the wrong answer on my first try.	5.35±1.75
The IF-AT form made the multiple-choice portion of the test feel a bit like a game.	4.95±1.40
It takes longer to answer multiple-choice items with the IF-AT than it does with a word processed form	3.65±1.67

for students using the IF-AT over those who used TMC. Perhaps the differences in results are attributed to the differences in the populations being studied and not the method of assessment. We speculate that the lower-level general education student has little knowledge and experience with the course content being studied and students in upper-level athletic training and pharmacy classes[22] have significant background knowledge and experience with the course content. In our study, this experience could account for the lack of difference in scores on the follow-up examination between the 2 examination formats. In other words, upper-level students may not be as dependent as lower-level general education students on immediate feedback as a pedagogical tool to improve information retention. A second potential explanation for our results could be that upper-level students may be more motivated to seek information on their own. In this situation, students do not rely on immediate feedback because they have the tools and motivation to self-correct.

It is important to note that confusion may exist because the definitions of delayed and immediate feedback overlap in the literature. Feedback given at the end of a test[8,9] or 7 days after an examination[5,10] has been cited as delayed feedback. Feedback given seconds after a response[8] and during the next meeting of a once a week class[5] has been described as immediate. The overlap between the definitions of immediate and delayed feedback make interpreting the literature and comparing research results difficult. Also, deciding which form of feedback is most appropriate to improve retention of didactic information is complicated due to the variability in definitions.

The exams given to the students in the current study were comprised of 10 questions. Perhaps these exams were not long enough to facilitate the NSE phenomenon, although previous work has shown the IF-AT to be successful at improving student performance with only 14 questions.[20] Students could have remembered the questions and looked up the answers after the exam or after class to see which questions they answered correctly and incorrectly, especially if they were motivated to do so. If the exam had a larger number of questions, this would have increased the difficulty of remembering the correct answers until the follow-up examination, perhaps stimulating the NSE phenomenon.

Also, the timing of the follow-up exam may have affected the results. The follow-up examinations were given approximately one week after the initial examinations. Increasing the amount

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of time between the two sessions may have changed the results of this study, although significant differences were found as soon as one day after the initial exam in previous work.[20] It would be interesting to see if the results remain the same if the follow-up exam was not given until several weeks later or at the end of the semester. Increasing the time between the two sessions may increase the chance of the NSE phenomenon for those who used the TMC format for the initial examination leaving students susceptible to repeating incorrect answers on the subsequent follow-up exam.[15,16] Also, short term assessment of information retention may not capture the improved capacity of the students to solve difficult problems.[22]

Although the examination scores did not improve more for the students taking the initial examination with the IF-AT, the students appeared to prefer the IF-AT over the TMC based on the survey results. However, although our students were satisfied with the IF-AT, they did not rate their satisfaction as high as students in previous studies.[23, 25] In one of the previous studies,[25] we speculate the reason satisfaction scores were higher for the IF-AT is due to the fact that students received partial credit when they found the correct answer on their second try. We believe students may have rated the IF-AT higher because they had the opportunity to receive partial credit, whereas they did not have the option of receiving partial credit on the TMC. The satisfaction results show that students valued the IF-AT, even if using the IF-AT did not improve student learning as measured by the follow-up examination scores. Furthermore, using the IF-AT may help students assess their learning, help them identify areas where more academic attention is warranted, facilitate critical thinking to solve problems,[22] and potentially lead to deeper learning.[23] The IF-AT, by providing immediate feedback, is a tool which not only assesses knowledge but also reinforces knowledge, qualifying it as a teaching tool. We believe the TMC format is only an assessment tool, not a teaching tool. Therefore, the IF-AT and the TMC formats ultimately have different purposes.

In our study as well as in a previous study,[29] some students had trouble scratching off their preferred choice on the IF-AT form because of the close proximity of the selections. This problem could easily be resolved by changing the layout. To try to counteract this problem, we advised the students in the current study to select their answers on the test itself before scratching off their selections on the IF-AT form.

Some educators may have some reservations about using immediate feedback especially with students who have test anxiety. Several studies have found the majority of students prefer using the IF-AT over other testing methods and would like to use it for all of their classes that use multiple choice tests.[22,23,25,29] DiBattista and Gosse[29] found that student preference for the IF-AT was not correlated to test anxiety or test performance.[29] Furthermore, using the IF-AT actually reduced test anxiety especially when students answered a question correctly on the first try as was common.[29] However, other students listed an increase in their anxiety as something they did not like about the IF-AT.[22] Providing students with an introduction to the IF-AT form and a practice test may reduce student apprehension as nervousness is often higher when people are put in unfamiliar situations.[30]

Limitations & Future Directions

The current study had several limitations. We had a small sample size leading to low statistical power. We also only included one upper-level athletic training course for our data collection. Future research could use larger samples of students in various levels of classes to potentially provide a more robust understanding of how the IF-AT can help improve student learning. Because upper-level students may not be adversely affected if feedback is not immediate, follow-up studies should look at providing immediate feedback to students just entering the athletic training education program. Educators need to teach and assess in ways which match student knowledge and backgrounds. Perhaps the IF-AT provides a better way to assist first-year students who are just beginning to acquire athletic training knowledge and skill, making its use in introductory courses appropriate. Further research should also explore student satisfaction across multiple levels to determine if broad audiences of students favor the IF-AT.

Continued work using the IF-AT or other feedback mechanisms could also use much larger examinations with numerous questions and provide a longer amount of time between the exam sessions. Although limited work has been completed on computerized methods of immediate feedback,[20, 31, 32] future work should evaluate how technology can be used to provide immediate feedback during examinations and the effectiveness of such technology on improving student learning.

CONCLUSIONS

The results of this study do not support the use of the Immediate Feedback Assessment Technique to improve scores on a follow-up examination compared to using a traditional multiple choice format. Although scores did not improve for those using the IF-AT, the students did give the IF-AT high ratings on a satisfaction survey. Further research is warranted to more fully understand the effects of immediate feedback on student learning in athletic training education programs.

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