

The Effects of Learn Units on Student Performance in Two College Courses

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Abstract

We report an experiment examining the academic performance of undergraduate students in two special education college courses. The experimenter/professor taught both courses in which he presented curriculum material via written learn units (LUs) (Greer & Hogin, 1999) or in a lecture format across randomly selected weeks in a 12-week semester. There were a total of 20 students (11 in the Emotional Disturbance course, 9 in the ABA course) primarily juniors and seniors majoring in special education ranging in age from 20 to 48.

The independent variable consisted of a series of written LUs presented to students in the form of guided notes that were scripted in logical sequence (based upon textbook material). LUs were defined as a series of meshed or interlocking 3-term contingencies 1 for the student and at least 2 for the professor arranged through scripted curricula. During the LU condition, the professor (1) read a phrase or question from the guided notes (with blank lines) that were distributed to students, (2) discussed the phrase or question, (3) exposed the phrase/question and its corresponding answer on the overhead, (4) provided an opportunity for all students to respond by writing/copying the answer, and (5) then immediately consequence their answers by checking their accurate completion of the blank line. During the lecture condition, the professor lectured (from the material obtained from the textbook chapter) without providing any written LUs. The dependent variable was student grade achievement on weekly short answer essay exams.

Interobserver agreement for independent scoring of the dependent variable for the ABA exams was 97%. Interobserver agreement for independent scoring of the dependent variable for the ED exams was 95%. The mean percentage of procedural integrity for the ABA course was 88% ranging from 83% to 100%. The mean percentage of procedural integrity for the ED course was 100%.

In the ABA course, the mean percentage correct on exams was 83% during the LU class sessions and 68% during the lecture sessions. In the ED course, the mean percentage correct on exams was 84% during LU class sessions and 74% during lecture sessions. Social validity measures indicated high student satisfaction with the learn unit instructional procedure. These results were discussed in terms of the potential utility of the learn unit as a microanalytic measure of both teaching and learning particularly for subject matter in higher education containing specificity in terminology (i.e., factual and scientific content).

Key Words: Learn Units, Instructional time, active student responding, interobserver agreement

The Effects of Learn Units on Student Performance in Two College Courses

It is generally agreed that the goals of science are to understand, predict, and control behavior (Berliner, 1990). Consequently, every respected scientific discipline has its corresponding basic unit of measurement which is ultimately responsible for the profession's advancement and improvement (e.g., biology: the "cell," nutrition: "vitamins and calories," chemistry: "molecules," engineering: the "micron").

Unfortunately, the professions of education and school psychology have lacked an accurate and replicable basic unit of measurement which may well account for decades of student underachievement.

Greer (1994) states that "the identification and use of a primary measure of teaching is essential to the maturation of a science of pedagogy" (p. 161).

The refinement of instructional "time" concepts in relationship to educational outcomes has evolved over decades (Fisher & Berliner, 1985). Recently, "learn units" have been identified within the field of education: "The learn unit consists of the interlocking operants of instruction that incorporate particular student and teacher interactions that predict whether student behavior will be controlled by particular stimuli and setting events" (p. 161) (Greer, 1994). The learn unit measurement has served to produce better research to help children with various needs (Albers & Greer, 1991; Kelly & Greer, 1996; Martinez, 1996; Hogin, 1996; Lindhart-Kelly & Greer, 1997), improve teacher training procedures (Keohane, 1997; Ingham & Greer, 1992), and determine more accurate measures of school-wide effectiveness (Greer, McCorkle, & Williams, 1989; Selinske & Greer, 1991; Lamm & Greer, 1991).

To date there have been no studies investigating the effects of learn units on the performance of undergraduate college students: "Obviously, we are far from hard data on the long-range and even short-range effectiveness of our application of behavioral systems analysis to the college teaching of behavior analysis...We believe that the lecture has been obsolete...We believe that a behavior-analytic view demands or at least suggests something like a learn-unit model of active student responding during classroom instruction" (p. 341) (Malott, Vunovich, Boettcher, & Groeger, 1995).

In an article entitled "The Wastage in Education" (Samuelson, 1998), the author describes the academic and economic failure of American universities and colleges across the country to effectively produce education students who have basic competence in reading, writing and in their subject area.

Research to improve students' achievement is critical given the fact that (1) college degrees have been devalued because many students who obtain degrees lack fundamental literacy skills, (2) many colleges currently offer remedial courses and are closing schools of education, and (3) increasing teacher salaries have never been shown to improve educational outcomes (Samuelson, 1998).

Instructional Time Research

The importance of the instructional "time" concept in the determination of educational outcomes has received much attention both in the general education and behavior analytic literatures (Fisher & Berliner, 1985; Goodman, 1990). Student achievement as a function of instructional time has evolved from the measurement of by-products or inferences to more recently the direct measurement of behavior outcomes (Greer & Hogin, 1999).

Carroll's (1963) major contribution was his redefinition of "aptitude" as a function of time. In other words, aptitude was not regarded as an intellectual ceiling on what a student can learn but, rather, how long it will take that student to master the academic material given sufficient time. Carroll was credited for transforming the mysterious concept of "motivation" into a time-based concept (Ben-Peretz & Bromme, 1990). Bloom (1974) expanded Carroll's theory emphasizing the significance of the student's prior learning and the quality of instruction. Bloom's mastery learning was based on the premise that most students could master required content and, therefore, up to 95% of students in a class have the potential to earn a grade of A if instruction in terms of the degree to which the presentation, explanation, and sequencing of the task corresponds to the optimum rate (i.e., time needed to reach criterion) for a given learner (Fisher & Berliner, 1985).

Allocated time or scheduled time is often defined as the time that the state, district, school, or teacher requires or allocates for instruction in a particular content area for the student (Fisher & Berliner, 1985). Although research has repeatedly shown that an increase in allocated instructional time does not necessarily increase student achievement (Fischer et al., 1980; Heward, 1994), schools across the U.S.

are currently experimenting with "block scheduling" --the 90s terminology for allocated time (Grossman, 1998).

Engaged time or on-task is "that part of allocated time during which the student is paying attention" (Fisher et al., 1980, p. 9). Some research has demonstrated that increasing a student's engaged time or on-task behavior does not necessarily result in a corresponding increase in the number of academic responses the student emits (Heward, 1994; Harris, 1986). Students in classrooms where no achievement gains were made spent 50% of available time in noninteractive on-task activities such as silent reading and seatwork (Stallings, 1980).

Academic learning time (ALT) is defined as "the amount of time a student spends engaged in an academic task that she/he can perform with high success" (Fisher et al., 1980, p. 8). Unfortunately, ALT's definition of student engagement does not enable a clear analysis of specific types of academic student responses (Greenwood et al., 1984). Therefore, as a time-based measure, ALT cannot account for the actual number of learning responses in which a student participated during instruction (Heward, 1994).

Opportunity to Respond and Active Student Responding

By moving away from allocated academic time to engaged or on-task academic time to ALT, educational research gradually recognized the importance of more direct measurement (Greer, 1996; Stallings, 1980). However, "...these measures were still of the appearance of learning (e.g., engagement or on task) and not the measurement of learning outcomes" (p. 140) (Greer, 1996). For example, students could be passively staring at a page of text and still be recorded as being "actively" engaged (Greer & Hogin, 1999).

Vance Hall and his colleagues coined the term opportunity to respond (OTR) in 1977. The term refers to student responding and participation during instruction (Heward, 1994). OTR has been defined as a measure of the "interaction between: (a) teacher-formulated instructional antecedent stimuli (the materials presented, prompts, questions asked, signals to respond) and (b) their success in establishing the academic responding desired or implied by the materials" (Greenwood et al., 1984, p. 64). Although in the literature many authors differentiate the terms OTR and active student responding (ASR), ASR is actually an intertwined component of OTR: "Student response is the second component of opportunity to respond. Tactics that establish high rates of correct academic responding over periods of instruction by the most students are those providing the greater opportunity. Thus, opportunity is confirmed by the academic behavior produced" (Greenwood et al., 1984, p. 65). In other words, ASR involves opportunities for students to practice the academic task (Hall et al., 1982).

Research has consistently shown that teachers and parents who provide higher numbers of opportunities for student responding produce more student learning (Edmonds, 1979; ; Rosenshine & Berliner, 1978; Rotholz et al., 1985; Greenwood et al., 1994, Hart & Risley, 1995). Stanley & Greenwood (1983) found that instruction for fourth graders in Title 1 and non-Title 1 schools provided infrequent amounts of academic responding time. In fact, ASR time was significantly lower among minority students in Title 1 schools. It appears that inner city preschool students raised in low socioeconomic environments may begin school with less educational experience (i.e., language opportunities) at home and fall further behind as a function of low levels of active academic response time (Delquadri & Greenwood, 1981; Hart & Risley, 1995). The implication is that low opportunity instruction (in the form of lecture, media presentations) that requires passive responding produces lower student achievement gains over the course of a school year. As Dewey (1916) once aptly stated, "Students learn by doing." The challenge for educators is to identify and use instructional antecedents and methods that increase students' opportunity to respond and thereby occasion more frequent academic responding. Heward (1994) discusses three "low-tech" strategies for increasing the frequency of active student response during group instruction including response cards, choral responding, and guided notes.

Although the OTR research is considered to be probably the most important contribution of the 1984 conference at Ohio State University (Greer, 1994), even this variable lacked a critical component of instruction--the teacher response or consequence to the student's response (Albers & Greer, 1991; Diamond, 1992).

The Learn Unit

Although research studies have demonstrated the importance of isolated behavioral tactics such as opportunity to respond and active student responding in regards to improving college students' achievement (Saur, 1995; Baker & Mulcahy-Ernt, 1992; Tudor & Bostow, 1991), a more comprehensive measure might account for a combination of several behavioral tactics into one countable unit of measurement. Greer (1994) proposed that the learn unit is the basic unit of instructional measurement for both student and teacher. The learn unit is a comprehensive measurement which includes opportunity to respond, the student's response, the teacher antecedent-consequence, and the student antecedent-consequence in yoked or interlocking three-term contingencies between the teacher and student (Greer, 1996). This interlocking contingency is the least divisible and most effective measurement for both teacher and student thereby serving both as a moment-to-moment student outcome measure as well as a measure of the entire instructional process (Greer, 1996; Hogin, 1996).

Albers and Greer (1991) examined the use of the learn unit in two experiments by examining the effect of increasing the rate of learn unit emissions to three times its baseline rate on student learning. Increases in the presentation rate of learn units were implemented by the researcher prompting the teacher and teaching assistant to increase their presentation rate and assignment of material. Data from the first experiment showed that increasing the rate of learn units resulted in higher rates of correct student responding and lower rates of incorrect responding. Data from the second experiment replicated the results of the first with two other students and further demonstrated that both written and vocal learn unit presentation formats were effective when each was isolated.

Learn units have been found to be the best predictors of student learning. Several studies have demonstrated that higher numbers of learn units consistently result in higher numbers of correct student responses and greater numbers of instructional objectives achieved (Dorow, McCorkle, Williams & Greer, 1989; Greer et al., 1989, Ingham & Greer, 1992; Selinski et al., 1991). Ingham & Greer (1992) analyzed the role of the teacher supervisor in terms of teacher performance via accurate and fluent learn unit presentations. The investigators observed and recorded teacher behavior based on the accuracy of their emission of learn units to students. The findings revealed that when the supervisor delivered flawless verbal and written antecedents, response opportunities, and consequences to the teachers, correct teacher and student responding increased.

The results of Albers & Greer (1991) and Ingham & Greer (1992) demonstrated the value of the consequence in the three term contingency and supported the use of the learn unit as the least divisible component of effective instruction that incorporates both student and teacher interaction.

Hogin (1996) found that when the correction feedback of the learn unit required the students to observe their responses to math problems viewing only their responses and the teacher's consequence (in the absence of the antecedent), they did not learn the math computation operations. Hogin's study demonstrated the importance of the antecedent in the interlocking three term contingencies that form the learn unit. Kelly & Greer (1996) examined the effects of increased rates of curriculum based learn units on the assaultive and self-injurious behavior of three students. The results showed that by increasing the rate of learn units, students remained instructionally engaged thereby increasing their rate of correct responding and opportunities for reinforcement.

The uniqueness of the learn unit is the fact that it incorporates the three term contingency of both the student and the teacher forming an evolving unit of measurement that is continuously shaped by the reciprocal behavioral exchanges of each party. In effect, the teacher's future behavior becomes a function of the moment by moment response of the student -- the teacher learns what to do next based upon student responding.

The learn unit proposed by Greer (1994) is the interlocking or yoked operant of both the student and teacher antecedent-behavior-consequence chain which constitutes the basic measure and building block of effective teaching (i.e., teacher productivity) and has been demonstrated to reliably predict student learning outcomes in the fields of education and school psychology (Greer, in press; Greer & Hogin, 1999; Malott, 1999; Heward, 1994; Malott, Vunovich, Boettcher, & Groeger, 1995). The learn unit (in conjunction with the measurement of criterion-referenced instructional objectives) is often inseparable from carefully scripted, logically sequenced, and programmed curricula because such curricula help assure or standardize teacher accuracy, unambiguous antecedents, clear response definitions, and delivery of consequences before the teacher moves to subsequent learn unit presentations (Hogin, 1996). In fact, high rates of learn units in the absence of carefully selected and properly designed instructional materials can be meaningless (Greer, 1994; Engelmann, 1992; Heward, 1994). The use of guided notes (Heward, 1994) satisfies the above criteria and may serve as one way to provide frequent response and consequence opportunities in large groups.

There have been no studies to date testing the efficacy of the learn unit in higher education settings. This research study investigated the relationship of the effects of written learn units (presented by a professor in the form of guided notes) and their impact on student test performance in two undergraduate courses.

METHOD

Participants

The participants were two different intact groups of undergraduate students enrolled in two required courses. The first course was "Techniques of Applied Behavior Analysis" (ABA) and the second was "Teaching Students with Emotional Disturbance" (ED). The courses were taught by the same instructor/experimenter in a special education training program at an urban college. The two courses were comprised of a total of twenty undergraduate students (11 in the ED course, 9 in the ABA course) majoring in special education. There were seven female students and two male students in the ABA course. The class consisted of one Caucasian, three African-American, and six bilingual students of Hispanic background. In the ED course, there were eight female students and three male students. Two of the students in the ED course were also taking the ABA course during the same semester with the experimenter. The ED class was comprised of two Caucasian, four African-American, and five bilingual students of Hispanic origin.

Independent variable

The independent variable was the presentation of written learn units vis a vis guided note (Heward, 1994) handouts with blank lines. The rationale for using guided notes was to provide students with potential curriculum-based written learn units that were scripted, sequenced, and programmed (Greer & Hogin, 1999) and which included all components of the learn unit (i.e., frequent opportunities to respond, active student responding, and an opportunity for consequence). The guided notes were discriminative stimuli thereby setting the occasion for curriculum-based learn units: "When teachers present instruction in scripted sequences based on logical analyses or in scripted instruction based on task analyses, operant units are scripted for the teacher. These scripts specify teacher behavior, student behavior...as well as the sequence of steps and objectives...Teaching scripts can specify learn units with students individually or with groups of students" (p. 19) (Greer, in press).

In other words, guided notes were used because the learn unit is a measure of teaching which (a) engages the use of all components of the three-term contingency (one for the student and at least two for the teacher) as a continuous yoked and interlocking operant response between both the student and instructor and (b) requires logical and flawless programmed sequences (Greer & Hogin, 1999).

The experimenter prepared the guided notes by sequencing and scripting the textbook chapter content resulting in a series of "potential" written learn units (i.e., in the form of sentences or phrases) for all chapters in both textbooks. These were potential LUs because they had to be consequence by (1) the student viewing the answer on the overhead and (2) the professor placing a check mark next to the student's accurate completion of the phrase.

The following is an example of a single learn unit (LU) which is scripted, logically sequenced and programmed providing 1 three-term contingency for the student and 2 three-term contingencies for the professor which was emitted during the first class session in the ABA course:

Student looks at guided note handout	Professor antecedent
Prof. reads: What is meant by "applied"?	Student antecedent
Prof. discusses "applied" in the term ABA and then exposes answer on overhead	Professor behavior
Students write/copy answer: The behavior targeted for change is socially important for the person.	Student behavior
Prof. sees students writing	Professor consequence Professor antecedent
Prof. checks written work on the spot	Professor behavior Student consequence Professor consequence

Next scripted LU sequence: What is included in the term "behavior" in ABA?

Dependent variable

The dependent variable was student performance (i.e., percentage correct) on a weekly basis as measured by in class exams throughout the 12-week semester for ABA and ED courses. The experimenter prepared 22 short answer essay exams (11 for the ABA course, 11 for the ED course) each comprising of eleven questions. The entire content (of all exams for both learn unit and lecture sessions) were always covered during class sessions and the exam content was also available in the textbook chapter. The two textbooks assigned were entitled (1) Applied Behavior Analysis in the Classroom (Schloss & Smith, 1999) and (2) Understanding and Teaching Emotionally Disturbed Children and Adolescents (Newcomer, 1993).

At the end of the semester, the experimenter asked all students in both courses to answer two questions prepared by the professor to assess social validity of student preferences regarding course format. The questions included (1) What did you find to be most useful to help prepare you for your weekly quiz? and (2) Did you prefer the lecture only classes or lecture with written handouts?

Data Collection Procedures

Data were collected each week from the two courses by recording weekly percentage correct/incorrect on exam grades. The experimenter read each exam twice to assure accuracy in the grading and scoring of exams. All student grades were graphed on a weekly basis for both courses.

General Procedures (for Learn Unit and Lecture)

The students in both courses were given a course syllabus on the first day of class. They were informed that they would take an in class short answer essay exam on a weekly basis. All students were made aware of the following instructions: (1) They would have to answer 10 out of 11 questions each week, (2) The experimenter told the students that the exam content would be covered in class a week prior to the exam date, (3) The students were told that the weekly exam content was also covered in the textbook chapter, (4) The students were given the first hour of every 2-hour class session to take their exams, (5) Students were allowed to ask questions as a group regarding clarification of lecture and/or textbook material prior to all exams, (6) Students were advised to purchase and carefully read each textbook chapter in preparation of their weekly exam, (7) Students were encouraged to attend each class session and to take good notes, (8) The chapter exams would be graded by the experimenter and then returned to the student the following week for review by students at the end of the following week's class, (9) Students were encouraged to visit the experimenter during office hours to discuss any questions pertaining to the course, and (10) Students who did not take the exams at the scheduled time were required to take the exam during office hours. These late make-up exams were not included as part of this research data in order to prevent confounding variables such as additional study and practice time, or special knowledge from other students who had already taken the exam. The students were not informed about the research study.

Lecture Procedure

The instructional sequence during the lecture only condition was as follows: (1) The experimenter lectured by following a scripted sequence of lecture notes but did not provide any written learn units to the students (i.e., there were no student guided note handouts and no overhead transparencies), (2) Students took their own notes based on the lecture material they had heard, (3) The experimenter responded to student questions and comments as in the learn unit condition, (4) The experimenter wrote key terms and clarified concepts on the blackboard, and (5) All exam questions were based on both lecture and textbook material as in the learn unit condition.

Learn Unit Procedure

The instructional sequence during the learn unit condition was as follows: (1) The experimenter distributed "potential" (because they were not yet consequence by the professor) written learn units in the form of guided notes with blanks for all students in the ABA and ED courses, (2) The experimenter then placed these notes with their completed answers on overhead transparencies, (3) The experimenter sequentially exposed only the potential learn unit sentence or phrase (i.e., guided note with the answer) on the overhead projector which was relevant to the topic after he finished discussing it (all other potential learn unit sentences were covered), (4) The experimenter then provided the students an opportunity to "actively" respond by copying the information from the overhead onto handouts which consisted of fill-in blank spaces, (5) The experimenter provided immediate written feedback to students by placing check marks as they completed their own notes on these handouts, (6) The experimenter gave students an opportunity to ask questions or make comments, (7) The experimenter then presented the next LU (steps #3 to #6 above) and (8) All exams were based on both material covered in class and the textbook chapter.

Experimental Design

An alternating treatment design across randomly selected weeks throughout the 12-week semester for both courses was used to compare the utility of programmed, sequenced, and scripted LUs in contrast to the lecture format which does not typically provide LUs to students. Greer (in press) states that "the presentation is typically improvised in the lecture format (i.e., antecedent presentations with infrequent response opportunities)" (p. 20).

Interobserver Agreement (IOA)

Independent grading of the weekly exams in both courses were evaluated by the experimenter and a graduate student in the Department of Special Education using sample key or model answers to short answer essay questions to assure grading accuracy. The interobserver agreement for independent grading of the dependent variable for Applied Behavior Analysis exams was 97%. The interobserver agreement for independent grading of the dependent variable for ED exams was 95%.

Interobserver agreement for the independent variable was assessed by seven graduate students from the same department. They served as observers during LU class sessions to check for procedural reliability in both ABA and ED courses. The mean percentage of procedural integrity for the ABA course was 88% ranging from 100% to 83%. The mean percentage of procedural integrity for the ED course was 100%.

Results

In the ABA course, the total mean percentage correct on exams was 83% during the LU class sessions and 68% during the lecture sessions. In the ED course, the total mean percentage correct on exams was 84% during LU class sessions and 74% during lecture sessions.

The mean percentage correct on ABA exams for Student A was 81% during LU classes and 52% during lecture only classes (equivalent to a letter grade of B as opposed to F), Student B was 73% during LU classes and 47% during lecture only classes (equivalent to a letter grade of C versus F), Student C was 95% during LU classes and 77% during lecture only classes (equivalent to a grade of A versus C), Student D was 63% during LU classes and 45% during lecture only classes (equivalent to a grade of D versus F), Student E was 90% during LU classes and 73% during lecture only classes (equivalent to a grade of A versus C), Student F was 87% during LU classes and 70% during lecture only classes (equivalent to a grade of B versus C), Student G was 98% during LU classes and 83% during lecture only classes (equivalent to a grade of A versus B), Student H was 90% during LU classes and 81% during lecture only classes (equivalent to a grade of A versus B), and Student I was 81% during LU classes and 76% during lecture only classes (equivalent grade of B versus C.)

The mean percentage correct on ED exams for Student A was 95% during LU classes and 75% during lecture only classes (equivalent to a grade of A versus C), Student B was 87% during LU classes and 68% during lecture only classes (equivalent to a grade of B versus D), Student C was 78% during LU classes and 60% during lecture only classes (equivalent to a grade of C versus D), Student D was 96% during LU classes and 81% during lecture only classes (equivalent to a grade of A versus B), Student E was 90% during LU classes and 80% during lecture only classes (equivalent to a grade of A versus B), Student F was 87% during LU classes and 78% during lecture only classes (equivalent to a grade of B versus C), Student G was 95% during LU classes and 89% during lecture only classes (equivalent to a grade of A versus B), Student H was 73% during LU classes and 68% during lecture only classes (equivalent to a grade of C versus D), Student I was 79% during LU classes and 75% during lecture only classes (a grade of C regardless of instructional format), Student J was 71% during LU classes and 70% during lecture only classes (a grade of C regardless of instructional format), and Student K was 67% during LU classes and 69% during lecture only classes (a grade of D regardless of instructional format).

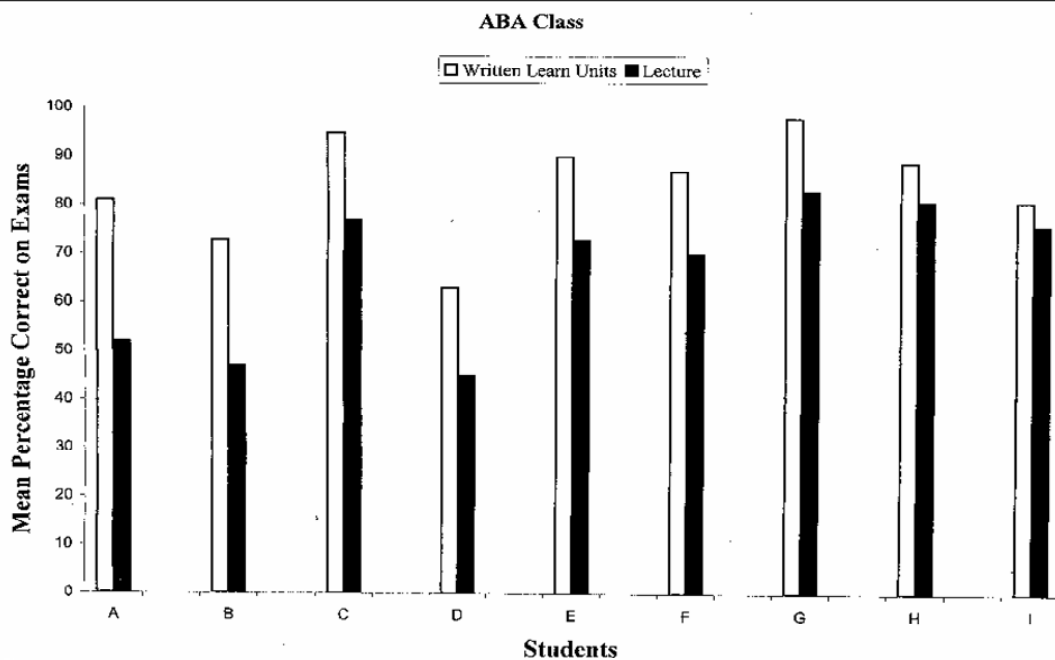


Figure 1. The mean percentage of correct on examinations

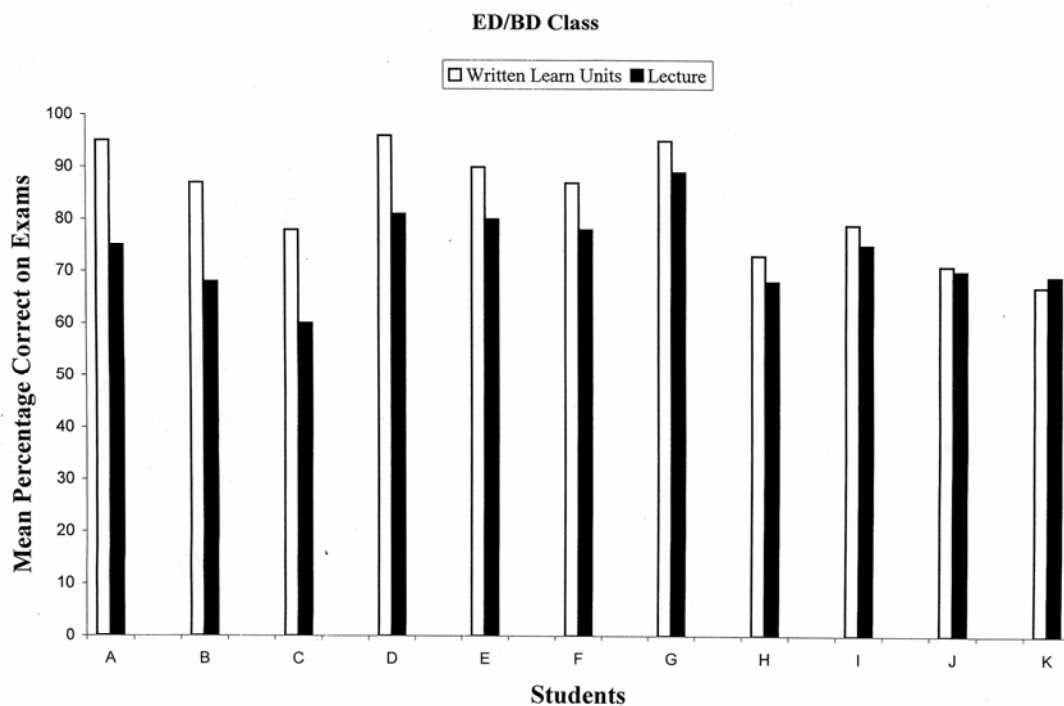


Figure 2. The mean percentage correct on examinations

In the ABA course, the mean percentage correct for all students taking exam #1 was 79.8 (learn unit-based exam) (exam percentages ranged from 70 to 100), exam #2 was 60.7 (lecture-based) (exam percentages ranged from 45 to 80), exam #3 was 75.8 (lecture-based) (exam percentages ranged from 53 to 96), exam #4 was 83.8 (learn unit-based) (exam percentages ranged from 43 to 100), exam #5 was

84.3 (learn unit-based) (exam percentages ranged from 70 to 100), exam #6 was 70.1 (lecture-based) (exam percentages ranged from 24 to 87), exam #7 was 87.1 (learn unit-based) (exam percentages ranged from 70 to 95), exam #8 was 82.1 (learn unit-based) (exam percentages ranged from 70 to 95), exam #9 was 71.3 (lecture-based) (exam percentages ranged from 30 to 95), exam #10 was 63.1 (lecture-based) (exam percentages ranged from 0 to 100), and exam #11 was 83.3 (learn unit-based) (exam percentages ranged from 60 to 100).

In the ED course, the mean percentage correct for all students taking exam #1 was 86.4 (learn unit-based exam) (exam percentages ranged from 40 to 100), exam #2 was 85.5 (learn unit-based) (exam percentages ranged from 52 to 100), exam #3 was 79.9 (learn unit-based) (exam percentages ranged from 55 to 98), exam #4 was 73.1 (lecture-based) (exam percentages ranged from 43 to 95), exam #5 was 77.6 (learn unit-based) (exam percentages ranged from 46 to 95), exam #6 was 77.6 (lecture-based) (exam percentages ranged from 48 to 98), exam #7 was 68.9 (lecture-based) (exam percentages ranged from 47 to 91), exam #8 was 84.0 (learn unit-based) (exam percentages ranged from 65 to 95), exam #9 was 80.0 (lecture-based) (exam percentages ranged from 60 to 95), exam #10 was 89.5 (learn unit-based) (exam percentages ranged from 75 to 100) and exam #11 was 70.0 (lecture-based) (exam percentages ranged from 40 to 100) (see Figure 4).

The results showed that all nine students in the ABA course earned mean test grades that were approximately at least one letter grade higher during class sessions in which written LUs were presented (see Figure 1). Eight out of the eleven students in the ED course also achieved mean test grades that were approximately at least one letter grade higher during class sessions in which they had received written LUs (see Figure 2). Overall, a 15-point performance difference was found between mean LU and lecture test grades in the ABA course (Figure 3) whereas only a 10-point performance difference was noted between mean LU and lecture test grades in the ED course.

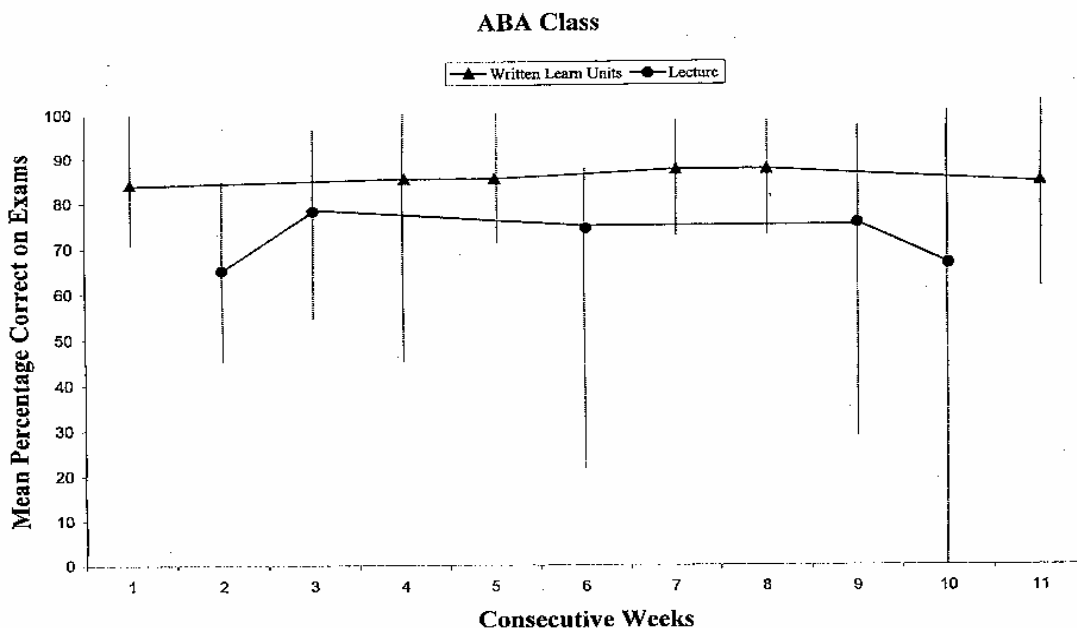


Figure 3. The mean percentage of correct on examinations in ABA class. Solid triangle (\blacktriangle) and solid circle (\bullet) represent the mean percentage correct and the dotted lines represent the range (----).

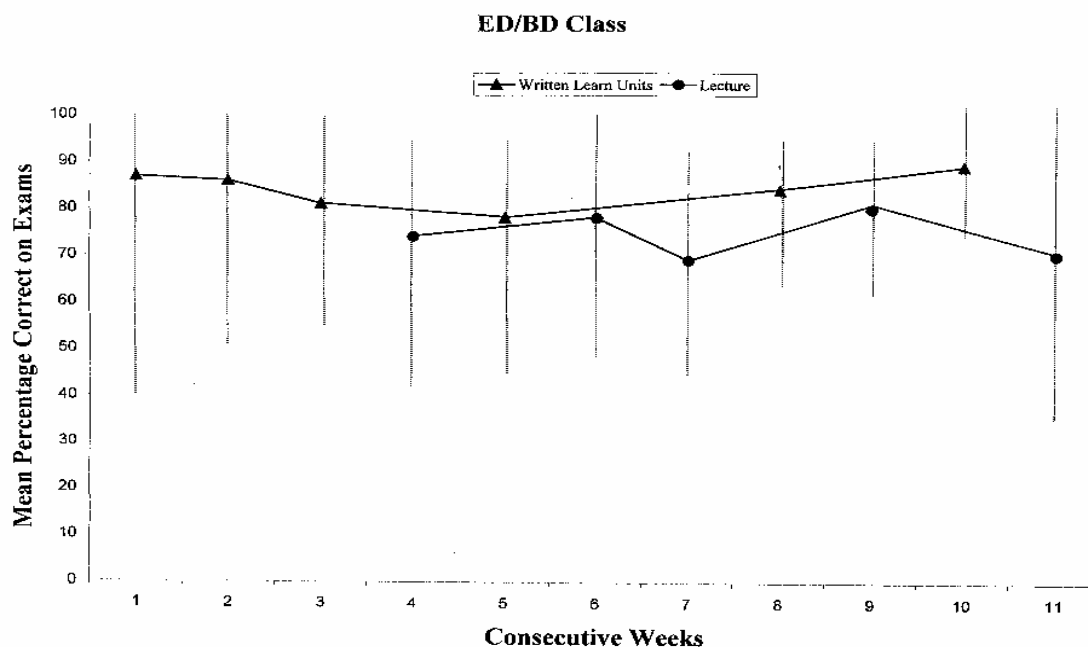


Figure 4. The mean percentage of correct on examinations in ED/BD class.

DISCUSSION

The purpose of this study was to examine the effects of written learn units on the academic achievement of undergraduate students. The measurement of the learn unit includes the interlocking behaviors of student and teacher three-term contingencies. Greer (1994) stated that the three term contingency trial for the student was yoked with the three term contingency trial for the teacher. Consequently, the behavior of the student was contingent upon the behavior of the teacher--i.e., each party "learns" from the other. The three term contingency trial for both student and teacher evolved to reduce the teaching and learning process into its fundamental elements--the smallest measurable unit of teaching and learning: "Because it predicts students' learning, the learn unit is a basic measure of effective teaching and can be used to discriminate between effective and ineffective teaching practices" (p. 30) (Greer, in press).

The learn unit measurement has been reported in the literature to improve a wide range of academic and social behaviors of certified students receiving special education services (Kelly & Greer, 1996; Martinez, 1996; Lindhart-Kelly & Greer, 1997; Polirstok & Greer, 1982; Donley & Greer, 1993; Lodhi & Greer, 1989; Keohane, 1997; Hogin, 1996). However, there have been no studies investigating the effects of learn units on the academic performance of students in higher education nor with non-certified students in regular education settings. This study examined the effects of learn units on the test performance of undergraduate students enrolled in a special education university program.

The results demonstrated that for the ABA course, the mean percentage correct on exams was 83% during the LU class sessions and 68% during the lecture sessions. In the ED course, the mean percentage correct on exams was 84% during LU classes and 74% during lecture classes. In other words, there was a 15-point performance difference between LU- and lecture- based tests for the students in the ABA course whereas only a 10-point performance difference was found in the ED course between LU- and lecture-based tests.

In contrast to the overall 15-point performance difference between learn unit-based and lecture-based exams in the ABA course, students in the ED course whose grades were not higher on learn unit based exams may be explained by the fact that the textbook content did not specify operational definitions of vocabulary terms (e.g., "educational therapy," "therapeutic process"). Therefore, the grading of ED examinations may have been more subjective, discretionary, and liberal because of this lack of specificity in vocabulary. The implication is that subject matter containing specificity in vocabulary allows for more objective scoring of exams (i.e., assessing only chapter-specific content).

All nine students in the ABA course achieved a mean percentage correct on LU-based tests that was equivalent to at least 1 letter grade higher than they would have received on their performance on lecture-based tests. Eight students out of eleven in the ED course earned a mean percentage correct on LU-based tests that was also equivalent to at least 1 letter grade higher than their lecture-based performance.

College student's academic improvement in this study and their personal satisfaction with written learn unit class sessions (as opposed to lecture sessions) will be discussed in relation to the literature and research in instructional time, opportunity to respond/active student responding, and learn units.

Instructional Time

According to both educational research (Brophy & Good, 1986) and behavior analysis literature (Greenwood, Hart, Walker, & Risley, 1994), the critical component of effective schooling is that of maximizing class time in order to expedite student learning. Throughout the ages, researchers in the fields of education and psychology have recognized the obvious relationship between amount of time and learning (Currie, 1884; Carroll, 1963; Bloom, 1968). In fact, Skinner (1968; 1984) stated that most of the problems facing education could be solved if student time in school was utilized more efficiently. The goal is to identify a reliable and valid measure (i.e., an independent variable) which will increase the number of correct student responses in less time. Unfortunately, the historical evolution of time measures such as allocated (scheduled) time, engaged time (time on-task), and academic learning time (ALT) have failed to (1) identify specific teacher behaviors and (2) provide a clear analysis of specific types and numbers of academic student responses (Greenwood et al., 1984; Heward, 1994). Today's popular version of allocated time is known as "block scheduling" whereby states across the country are requiring schools to increase class periods from 40 to 66 minutes. More than half of American high schools have currently adopted a schedule that offers longer class blocks: "With rising expectations for student achievement, heightened social and academic needs, and overcrowding, many schools have had to fundamentally rethink how they teach" (Grossman, 1998). Unfortunately, studies of correlations between amount of allocated time and academic achievement have consistently produced non-significant results (Heward, 1994).

The undergraduate students in this study attended weekly classes each for two and a half hour "block" lengths of time during the LU and lecture conditions. Yet the students in both courses learned significantly more (i.e., as measured by their weekly test performance) during the class sessions in which the professor emitted complete and accurate learn units. The number and rate of learn unit presentations by the professor is a specific teacher behavior which can be counted and functionally related to student learning outcomes than merely increasing the time of class periods. The research indicates that unless teachers are trained, they do not automatically emit complete learn units: "In some lectures or lessons, the teacher presents an extensive set of antecedents; at some point a student or students will be questioned" (p. 20) (Greer, in press).

Opportunity to Respond and Active Student Responding

Although Heward (1994) distinguishes active student responding (ASR) from opportunity to respond (OTR) stating that OTR does not provide an account of discrete learning trials, both ASR and OTR are interdependent measures because opportunity is confirmed by the academic behavior produced by the student (Greenwood et al., 1984, Hall et al., 1982). As part of their definition of OTR, Greenwood et al. (1984) clearly state that the ultimate result in presenting antecedent stimuli (i.e., the materials presented, questions asked, prompts) is their success in establishing the academic responding desired by the curriculum materials. These researchers point out that the importance of OTR is its focus on active (e.g., writing, oral reading) rather than passive responding (e.g., watching the teacher lecture, viewing an overhead transparency presentation). Their study reported that students in the inner-city Title 1 sample engaged in less academic responding during a typical day than did the suburban, high socioeconomic school group. They concluded that teachers who exposed students to "low opportunity to respond instruction" (e.g., lectures) should expect to result in significantly lower achievement gains in their students over the course of a school year. In a major longitudinal study, Hart and Risley (1995) discovered that young children reared in poverty experienced far fewer verbal opportunities to respond resulting in striking disparities in their future vocabulary growth rate and IQ test scores. It is quite likely that the informal instruction received in the home by children from their parents is more effective when the interactions are complete and accurate learn units (Greer, 1996, personal communication).

In relation to ASR research, Heward (1994) concluded that increasing the frequency with which each student makes academic responses has (1) consistently produced better performance on same-day, next-day, and follow-up tests of the material taught, (2) resulted in higher levels of on-task behavior (i.e., reduced levels of off-task, disruptive, and "looking bored" behavior), and (3) been preferred by the great majority of students over traditional instructional formats.

The written learn units in the form of guided notes in this study provided the students with continuous and multiple opportunities to respond and, therefore, to receive immediate consequences for their writing and attending behaviors (i.e., professor's verbal and written corrective feedback, student's viewing correctly written answer on overhead).

The Learn Unit

The learn unit consists of two or more interlocked three-term contingencies of the teacher and student. The sequence is described by Greer and Hugin (1999) as follows: (1) the attending student serves as the teacher's antecedent, (2) the teacher responds by presenting the student antecedent, (3) the student behaves by responding to the stimulus either correctly or incorrectly which in turn, (4) consequences and serves as an antecedent for the teacher to (5) consequence the student for his or her response. The completion of this single learn unit functions as a consequence for the teacher to present the next learn unit. This type of microanalytic analysis is easily overlooked when instructors deliver lectures.

Greer (1994) suggests that learn units must be considered together with the measurement of criterion-referenced instructional objectives and presented via scripted sequences based on logical analyses or based upon task analyses. The accuracy, number, and rate of learn units have predicted student learning in programmatic research conducted by behavioral investigators at Teachers College Columbia University. Albers and Greer (1991) studied the effect of increasing learn units presentations to three times their baseline rates with seventh-grade classified students in a remedial math class. Results demonstrated the utility of both written and vocal learn units in producing higher rates of correct academic responding and an increase in the achievement of instructional objectives. These findings were consistent with results obtained by Ingham & Greer (1992), Selinske et al. (1991), Greer et al. (1989), and Lamm & Greer (1991). Based on these studies, it was found that increasing the number of learn units that were sequenced carefully and that were accurately consequence by teacher and supervisor behaviors led to (1) an increase in correct academic responses, (2) higher numbers of achieved objectives and (3) fewer incorrect responses.

The microanalytic (i.e., decision tree) analyses of written learn units in this study was presented in a group setting by the professor following sequenced scripts available to students both on their desks and viewed on overhead transparencies. The professor monitored the delivery of complete and accurate learn units by (1) providing clear and flawless antecedent curricular stimuli in the form of guided notes, (2) observing students' behavior of notetaking, and (3) consequating students' notetaking after the completion of each phrase (i.e., a single learn unit). The professor did not move on to the next learn unit until each student mastered the specific phrase or sentence as evidenced by their correct answers on their guided notes. During lecture sessions, the professor read a scripted sequence of lecture notes but had no evidence of moment-to-moment mastery of academic content. The initial antecedent for the professor to present curricular stimuli to the student is the student's attentive looking behavior at the professor. Presentation of an antecedent by the professor to the student (e.g., professor points to overhead and reads "The behaviors characteristic of mental illness are caused by organic malfunctions due to _____") is the professor's response and serves as the antecedent for the student's response. The behavior of writing notes by the student (e.g., copying the answer from the overhead transparency) functions as a consequence for the professor as well as an antecedent for the professor's next response to the student (e.g., reinforcement of the correct response by checking the answer or correction feedback of an incorrect answer). The professor's latter response is the consequence for the student as well as a consequence for the professor (i.e., the student's correct response) to emit the next sequenced learn unit.

In short, the learn unit procedure provided the professor with a micro analytic (i.e., decision tree) analyses and standardized measure for efficiently and continuously assessing and improving student progress throughout two and a half hours of instruction by checking (consequating) each students' written response.

Conclusion

The data from several sources converge on the finding that a "decision tree" analyses by teachers of the interlocking student/teacher operants is critical to the maturation of a science of pedagogy (Malott et al., 1995; Heward, 1994; Greenwood et al., 1991; Greer & Hogen, 1999). The research demonstrates that teachers who were effective (i.e., produced high rates of mastery of student objectives and an increase in test performance) presented more student behavior opportunities and consequated student behaviors more than did teachers who were less effective (Albers & Greer, 1991; Greenwood et al., 1991). Based on the research to date, the learn unit serves the following functions according to Greer (in press): "(1) it is a measure that predicts students' learning for the academic and social behaviors tested in the existing research, (2) because it predicts student learning, the learn unit is a basic measure of effective teaching and can be analyzed to discriminate between effective and ineffective teacher/professor behaviors, (3) the learn unit provides a data base for what teachers/professors need to learn in order to be effective--a scientifically based curriculum for teacher graduate training, and (4) the learn unit with its establishing operations and the students' instructional history provides rule governed operations for solving instructional problems through contingency analyses of student and teacher/professor interlocking behaviors." For example, the only two students (J, K) in this study who did not improve their test scores on LU-based tests may be explained by instructional histories of significant deficiencies in essay writing skills, motivational variables, and/or competing setting events. In fact, Student K was experiencing personal health problems along with the deteriorating health and death of his father during the semester whereas Student J indicated that she had a history of "learning disabilities."

The conclusion of the most comprehensive and rigorous international comparison ever conducted of academic achievement was reported in February of 1998 by the U.S. Department of Education concluding that the longer students stay in American schools, the farther they academically fall behind their age-mates in most industrialized nations of the world. Throughout the decades, specific as well as vague suggestions for American school reform have been proposed to improve student learning outcomes

including (1) increasing academic standards and making a commitment to excellence, (2) increasing the length of class periods (i.e., block scheduling) or the length of the school day, (3) requiring summer school, (4) increasing funding for higher teacher salaries, (5) improving quality of textbooks and computers, (6) empowering teachers and parents, (7) requiring teachers to have undergraduate majors in the subjects they will teach, (8) decentralizing administration, (9) decreasing classroom size, (10) developing professional partnerships between public schools and colleges of education (i.e., consultants), (11) improving the format and quality of tests for children, (12) developing more rigorous tests for teacher certification, (13) increasing the amount or difficulty level of homework, (14) introducing "new and improved" curricula, and (15) providing teachers with experienced mentors and additional preparation periods (Skinner, 1984; Greer, 1996; National Commission on Excellence in Education, 1983). Although all of these suggestions for improving education are important considerations, unfortunately, none of these changes deals with the critical issue of identifying (1) an absolute measure of teaching which can reliably and validly predict learning and (2) specific teacher behaviors functionally related to the measurable improvement of student learning.

The findings reported in this study expand the database of the utility of the learn unit both as a microanalytic measure of teaching and learning as well as an effective independent (intervention) variable not only for students with disabilities (Kelly & Greer, 1996; Martinez, 1996; Lindhart-Kelly & Greer, 1997; Keohane, 1997; Hogin, 1996; Albers & Greer, 1991; Selinske et al. 1991; Lamm & Greer, 1991) but also for non-classified students in higher education settings. If the utilization of the learn unit measurement is further documented in future studies to improve student outcomes, there will be more accumulated data to substantiate the preliminary finding that the learn unit is the fundamental measure and building block of teaching and learning from pre-K to college (Greer & Hogin, 1999).

Future investigations of the learn unit in higher education should (1) incorporate end of semester cumulative exams to compare the weekly mean percentage correct on exams to performance maintenance over time on a final exam consisting of both LU- and lecture-based content, (2) distribute guided notes in both LU and lecture conditions but not consequating students' written answers during the lecture condition, (3) collect and analyze the quality and potential improvement of students' notes based on lecture sessions (Peverly, Brobst, Graham, & Shaw, in press), and (4) test the generalization of the findings of this study by using larger samples of students taking various types of college courses with and without having precise operational definitions of technical terms (e.g., statistics, critical analysis of literature) at other universities consisting of students representing broader ethnic backgrounds.

Future studies may help identify the optimal number, rates, and quality of written and/or vocal learn units in college courses (as opposed to merely increasing block time scheduling) to prevent (1) academic failure and dismissal, (2) drop out, and (3) remedial coursework.

Ultimately, the learn unit has the potential to serve as a universal unit to reliably and validly measure and thereby enhance the teaching, learning, and school satisfaction of classified and non-classified American students from preschool to college classrooms.

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