LITERATURE REVIEW

THE EFFECTS OF MANDATORY ERROR CORRECTION ON FUTURE

TEST PERFORMANCE

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Running Head: Error Correction and Test Performance

The Effects of Active Self Correction on Future Test

Performance

The Importance of Active Student Responding In Learning

and Testing

The positive correlation between active student

responding and academic achievement is as well

established in the field of psychology as it is in the

field of education. Barbetta (1993) demonstrated that

when students are responsible for emitting the correct

response (Active Student Responding), a greater recall

of material is demonstrated than when students listen

to the teacher making the correct response and repeat

it. Barbetta's subjects were assigned to one of two

response conditions. The active student response

condition required the students to correctly answer the

missed question themselves whereas the passive response

condition found the students repeating the teacher's

corrected response. The students in the active

response condition demonstrated greater recall on next

day testing than did the students who passively

repeated the correct answer. These findings are very significant in the study of student learning and testing in the classroom.

Although the importance of active student responding during error correction is not a new discovery in the field of psychology, Barbetta (1993) has questioned the methodology that has previously dominated this area of research. Instructional programs that do include the active role of the student during error correction have not exclusively tested this factor to demonstrate its effectiveness over other methods of error correction. From Barbetta's research one concludes that future studies should specifically test the effects of active self correction versus other means of error correction to determine the effect on learning and classroom performance.

Specific Error Correction Research

Plowman and Stroud (1942) demonstrated that high school students who could look over an examination with their errors corrected eliminated about 50% of their errors on a retest a week later. Impressive as these results may appear, they are not surprising at all

since there was only two conditions in this study. One group received their corrected test and the other group received no feedback at all. If the researchers had included a third group, perhaps a group who corrected their own test, then something significant would have been found. The fact that the researchers found that informing students what the correct answers are is better than no feedback at all does not aid the knowledge of what the effects of error correction are. What this early research does do is form the foundation on which future error correction research is built.

Sassenruth and Garverick (1965) attempted to replicate Plowman's (1942) study of improved learning through error correction but failed to demonstrate significant results. While these researchers did attempt to include the active role of the student, many confounding variables were present that does not allow one to specifically test the effects of active self-correction. In this study, instead of telling the students what the correct answers were, the teacher instructed the students to spend twenty-minutes of classroom time correcting wrong test answers. However, no motivation for correcting the test was provided.

The teacher did not indicate that the tests would be collected or that a future test would be given. Many students did not have a textbook with them and either borrowed one from another student, thus reducing the overall time available for correction, or chose not to make the effort to complete the corrections. It is because of the confounds that were present in this study that it is surprising that the researchers attributed the fact that the students who corrected their test did not significantly improve their scores as proof for error correction not being effective.

Knowledge Of Results Research Extended To Error Correction

The use of knowledge of results as a method for feedback is based on the principle that the reinforcement of correct answers enhances learning. To fully understand the research on the topic of knowledge of results one must realize that the term knowledge of results refers to little more than the words correct and incorrect. It in no way addresses the issue of knowledge of the correct response. However, this belief ignores the discovery that providing the student

with the correct answer following an incorrect response
is as reinforcing as the conformation of a correct
answer. Gilman (1969) found that the "reinforcing"
statements such as, "you are correct", are not as
effective in improving student learning than are the
effects of revealing the correct answer. Students who
were informed of the correct response to their missed
questions, achieved higher scores on re-testing than
did students who were only provided with the words
correct or incorrect. Traver, Van Wagenen, Haygood &
McCormick's (1964) work with school children also
demonstrated similar results. Using various feedback
combinations to teach students German vocabulary words,
the researches found that the students who were told
that a response was wrong and who were then corrected
did significantly better than the students who were
given a simple yes or no response. However, Sturges's
(1972) research with delayed and immediate feedback
concluded that it is not only important that students
learn the correct answer but actively go through the
process of learning what the wrong answers were as
well. The results of these studies indicate the
advantages for learning which are available when the

learner is provided with the correct response after making an error.

The vast amount of research on the topic of knowledge of results has demonstrated how this type of feedback can both increase and decrease student academic performance and motivation (Haemmerlie, 1985; Kaess & Zeaman, 1960; Swinnen, Schmidt, Nicholson & Sharpiro, 1990). These studies have demonstrated that knowledge of results feedback is most effective when it is presented as a summary at the end of a test instead of after each item. Swinnen, Schmidt, Nicholson and Sharpiro (1990), demonstrated that the rapid delivery of after-each-item feedback interferes with the mental processes that one goes through when attempting to determine the correct response. It was also concluded that the ability to detect and correct one's own errors is reduced with the constant interference of after each item feedback.

Haemmerlie (1985) and Kaess & Zeaman (1960) demonstrated the same negative effect of after each item knowledge of results and through their research offered additional explanations as to why this negative result occurs. Kaess and Zeaman (1960) concluded that

feedback after each item is only positively reinforcing

if the student is achieving success and in this sense

the rapid delivery of feedback will increase motivation

and may even reduce errors. The opposite of this

effect will be demonstrated with more errors and more

student frustration being recorded if one is constantly

being told that their responses are incorrect.

Haemmerlie's (1985) research demonstrated the same

negative impact of immediate, after-each-item feedback

in a personalized system of instruction learning

environment. Keller (1968) proposed the personalized

system of learning plan that would essentially

eliminate the need for teachers and replace traditional

classroom learning. Keller proposed that giving

students the entire assignment for the course at once,

with the objectives and required level of learning

established, and requiring students to work through the

course on their own, is the classroom for the future.

Since this method of learning has proved to be as

effective as traditional classroom methods it is not

surprising that Haemmerlie (1985) found that the same

negative impact of immediate knowledge of results to

exist in a personalized system of learning environment

as does in other classroom methods.

The existing research that has been conducted on
the topics on knowledge of results and feedback has
established that exposing students to the correct
answer after an error has been made increases their
future test performance of similar concepts. This
increased performance level is greater than the
performance level of students who are not informed of
the correct answer. The research on active student
responding during error correction has been sparse and
has not specifically tested the effects of active
student responding against other methods of error
correction. Barbetta's (1993) error correction
research with only six subjects, coupled with the
knowledge of results and feedback research, has
indicated that active self-correction warrants testing
against other traditional means of feedback. What this
present study addresses is the question, if students
who are informed of the correct answer perform better
than students who are not, would students who are
required to actively emit the correct answer perform
better than the students who are passively informed of
the correct response.   If active self correction

increases student learning and is demonstrated on future test performance, teachers should consider this type of feedback for their classroom. It is predicted that students who are required to correct missed test questions, through the process of active self correction, will demonstrate higher test scores on future tests of similar material than will students who are passively told what the correct answer was.

Annotated Biography

Barbetta, P. (1993). Effects of Active Student Response

During Error Correction On The Acquisition,

Maintenance, And Generalization of Sight Words by

Students With Developmental Disabilities. Journal of

Applied Behavior Analysis, 26 111- 119.

The positive correlation between active student

response and academic achievement is reviewed as is the

belief that active student responding is influenced by

the method in which feedback is provided.   The

question that sparked this study was whether it is

important that whole-word error correction end with the

student or the teacher emitting the right answer.

During active student responding error correction, each

correction trial ended with the student giving the

correct response following a teacher provided model

compared with a no response condition in which the

teacher made the correct response while the student

listened.   Active student response error correction

resulted in more student responses during instruction

than when the student listened to the teacher providing

the desired answer.   This study supports the use of

error-correction strategies such as directed rehearsal,
a remedial strategy that requires students to emit the
correct response several times following an error.
Implications of these results for classroom settings
are discussed.

Gilman, D. (1969). Comparison Of Several Feedback
Methods For Correcting Errors By Computer-Assisted
Instruction. Journal Of Educational Psychology, 60
Number 6. 503-508.

The use of knowledge of results as a method of
feedback is based on the principle that the
reinforcement of correct answers enhances learning. To
fully understand the research on knowledge of results
one must realize that the term knowledge of results
refers to nothing more than the words correct and
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the correct response. However, this belief ignores the
discovery that providing the student with the correct
answer following an incorrect response is as
reinforcing as the conformation of a correct response.
This study indicates that statements such as, "you are

correct", are not as effective as revealing the correct answer.

Haemmerlie, F. (1985). Role Of Immediate Feedback In A Personalized System Of Instruction: Evidence of A Negative Impact. Psychological Reports, 56. 947-954.

The long standing emphasis on immediate feedback in Personalized System of Instruction was reviewed. The development of this type of instruction was explained in terms of the early work of Pressey and Skinner. The results indicated that an after-each item feedback condition more negatively affected performance, preference, and recall than did feedback provided after the examination. However, only 10 subjects were used in this study and because of this one should be cautious about generalizing the results.

Kaess, W. and Zeaman, D. Positive and Negative Knowledge of Results on a Pressey-Type Punchboard. (1960) Journal of Experimental Psychology, 60 12-17.

In the early 1930's Pressey used several devices which provided human subjects with immediate knowledge

of results. In the 1960's researchers were interested

in applying his work in the development of teaching

machines. In this study, the two kinds of knowledge of

results, positive and negative, were presented. It was

found that the knowledge that an item choice is correct

reduces errors and that information that the answer is

wrong leads to an increase in errors. These results

lead to the assumption that negative information

interferes with he learning of the correct answer.

Keller, F. (1968). "Good-bye teacher..." Journal of

Applied Behavior Analysis, 1 79-89.

In this essay Keller reviews his development of a

personalized system of instruction that in a sense

eliminates the need for a teacher. In this type of

classroom setting,students are given an outline of the

work expected for the year. They must demonstrate

knowledge of each unit of work before they are

permitted to move on. This is determined by an

assistant who grades each unit work on a pass or fail

basis. Each student then takes the final exam on a

date that is predetermined at the beginning of the

year. His method proved to be as effective as traditional classroom methods and forms the basis of educational software programs that are being developed today.

Plowman, L. and Stroud, J.B. (1942). Effects of Informing Pupils of the Consequences of Their Responses to Objective Test Questions. Journal of Educational Research, 36, 16-20.

One of the earliest and few examples of improving learning through correction feedback. It was demonstrated that high school students who could look over an examination with their errors corrected eliminated about 50% of their errors on a retest a week later. In one group students received their test with all the corrections made while the other group received no feedback. The fact that 50% of errors were eliminated on the future test by the group that received the feedback may be explained because not many errors were made to begin with. The fact that one group did not receive any feedback at all is an important potential confound. While this study did

prove that error correction improved learning, the fact that it was done without the active role of the student adds to the questionable methodology of the study.

Sassenruth, J and Garverick, C. (1965). Effects of Differential Feedback From Examinations on Retention and Transfer. Journal of Educational Psychology, 56 259-263.

This study attempted to replicate previous findings involving feedback in the classroom. Of interest to this study was that attempt to replicate Plowman's study which found that error correction improved future test scores. This finding was not evident in this present study where students were returned their test and given 20 minutes to correct it before handing it in. For many reasons, the results were not replicated. Several students did not have their textbooks and either borrowed from other students, thus reducing the time that each student had to correct their test, or did not choose to correct. There was also no penalty for not correcting the test and as a result no motivation to do so. The one

relevant comment that arose from this research is that when making corrections students should focus on both correct and incorrect responses.

Sturges, P. (1972). Information Delay and Retention: Effect of Information In Feedback and Tests. Journal of Educational Psychology, 63 Number 1, 32-43.

The researcher raised the question of what are subjects actually learning with delayed and immediate feedback when he investigated the belief that improved retention would result with 24 hour feedback compared to immediate feedback. It was found that it is not only important that students learn the right answer but go through the process of learning what the wrong answers are as well. What is important is the knowledge that the process of obtaining the right answer is just as important as learning what is wrong and why.

Swinnen, S., Schmidt, R., Nicholson, D. and Sharpiro, D. (1990). Information Feedback for Skill Acquisition: Instantaneous Knowledge of Results Degrades Learning.

Journal of Experimental Psychology: Learning, Memory,

and Cognition, 16 Number 4. 706-716.

In this study the researchers discovered that the

rapid delivery of feedback may interfere with the

mental processes that one goes through in selecting the

correct response. They felt that individual error

correction skills are crucial for learning. If one has

the skill to determine their own errors then improved

performance would result. They found that with

immediate feedback (after each item) the process of

correcting responses in one's own mind is absent.

Travers, R., Van Wagenen, R., Haygood, D & McCormick,

M. (1964). Learning As A Consequence Of The Learner's

Task Involvement Under Different Conditions Of

Feedback. Journal of Educational Psychology, 55. 167-

173.

In this student feedback research, the authors

used various techniques to teach children German

Vocabulary words. The students who were told that a

response was wrong and who were corrected did far

better than children who received a simple yes or no

response following each answer. Implications for

knowledge or results and feedback research are

discussed.

The Effects of Mandatory Error Correction on Future

Test Performance

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Running head: ERROR CORRECTION AND TEST PERFORMANCE

Abstract

Research has demonstrated that students who are
informed of the correct answer to their wrong test
responses perform better when similar questions are
repeated than do the students who receive alternative
methods of feedback. The present study investigated
the difference in the performance of students who were
passively informed of the correct answer from those who
were required to actively correct their wrong test
answers. Student achievement on future tests of
similar material was monitored for 27 subjects on three
subsequent occasions over a six week period. The
active correction students consistently performed
higher than those in the passive correction condition,
although a statistically significant difference was not
found. The meaningful implications for classroom
learning and feedback, from the perspectives of both
the teacher and student, are discussed.

The Effects Of Mandatory Error Correction On Future

Test Performance

Although the positive correlation between active

student responding and academic achievement is well

established in the discipline of educational psychology

(Barbetta 1993), there is a gap in specific research

which explicitly tests the effects of students actively

emitting the correct response during error correction.

Research on active student responding has shown that

students who are required to actively participate in

the lesson as it is being taught, perform better than

students who learn in more traditional passive

environments (Barbetta, 1993). Feedback research has

established that informing students of the correct

answer following an error increases later recall

(Gilman, 1969; Plowman & Stroud, 1942; Sassenruth &

Garverick, 1965; Travers, Van Wagenen, Haygood &

McCormick, 1964). This increased performance level is

greater than the performance level of students who are

not informed of the correct answer.

Barbetta's (1993) error correction research with

learning disabled children has indicated that active

student responding warrants testing against other

traditional means of feedback. This research

demonstrates that students who repeat an answer out
loud, after being corrected by their teacher, recall
more concepts than students who are told but don't
repeat the correct response. Even Sturges' (1972) who
researched delayed and immediate feedback concluded
that it is not only important that students learn the
correct answer but actively go through the process of
learning what the wrong answers were as well.

Combining active student responding with
knowledge of the correct response, this study proposes
an alternative method of error correction. By requiring
students to actively correct their own missed test
questions, it is predicted that student learning can be
increased. More specifically, it is hypothesized that
the students who are required to actively correct their
missed test questions will demonstrate higher scores on
later tests of similar material than will the students
who are only passively informed of the correct answer.

Method

Subjects

Twenty-seven students from an introductory
statistics class at Algoma University were involved in
this research. Although the students were not
initially aware that they were subjects in an

experiment, when all testing was complete they were given course credit for their participation. The subjects were randomly assigned to one of two error correction conditions based on the time they selected to complete the computer aided tutorial.

Apparatus

I-stats, an interactive computer program designed by the psychology department at Algoma University, was the apparatus used in this study.

Procedure

On the first day of classes, students from the introductory statistics course were informed by their instructor that they were required to attend a computerized statistical tutorial during the next two weeks. The students were told the computer program was designed to help students learn statistics. The researcher who conducted this experiment, was introduced with the regular teaching assistants and proceeded to sign the students up for a tutorial time of their choice. An in-class test, based on the statistics tutorial was scheduled.

As the students arrived for their appointments, the researcher, whom the students believed was a teaching assistant, briefly introduced the program as a teaching tool and informed the students that a twenty-

five question multiple choice test followed the
tutorial. The researcher was available for any
questions the students had and was seated at a desk in
the back of the room. Upon completion of the tutorial,
the students were permitted to review any portion of
the material before taking the test. It was only after
the students completed both the tutorial and the test
that there was any difference in the instructions the
students in the two error correction conditions
received. In the "active correct condition", the
students were informed of their score after completing
the test and were then required to correct all
incorrect answers before leaving. If the students were
unable to correct the missed question on this second
attempt, the computer provided students with the text
they needed to re-learn the correct answer. The
tutorial did not end until their test was perfect.
When students in the "passive correct condition"
completed their test, they were also informed of their
score but were provided with the correct answer for all
of their incorrect responses.

The scheduled quiz, labelled as Test 1, based on
the tutorial was administered approximately 48 hours
after all students had completed this computer test, as
scheduled on the original course outline. The students

did not expect to be re-tested on this material at any time in the future. However, two weeks after the in-class test, the students were given a unit test, labelled as Test 2, where a sub-set of 12 questions were based on the statistical tutorial. Four weeks after this second test, another unit test was given, labelled as Test 3, where a sub-set of 13 questions were based on the tutorial. The mean scores of the two groups were compared on these three subsequent tutorial based tests.

<div align="center">Results</div>

Although statistically the results were not significant, as demonstrated by the ANCOVA (See TABLE 1), one can not ignore the fact that the active correction students consistently performed better than those students in the passive correction condition. In addition, the students in the active correction group always performed the same or better than they did in the initial tutorial whereas those in the passive correction condition always scored lower than the mean score they had originally achieved.

Insert Table 1 about here

The two groups were academically equivalent after the initial lab with a mean score of 75.5%, as shown by an ANCOVA (See TABLE 2). Following Test 1, the active correction group showed virtually no change in performance with a mean score of 76% while the passive correction group dropped to 73.8%. Similarly, on Test 2 the active correction group showed no change with a score of mean score of 75.5%. The passive correction group once again demonstrated a decrease in overall performance with a mean score of 70.4%. Both groups improved on Test 3, with the active correction students reaching a mean score of 79.5% while those in the passive correction group increased to a mean score of 74.9%. It should be noted that the students in the active correction condition only spent an average of 15 minutes making the mandatory corrections.

Insert Table 2 about here

Discussion

The fact that the students who actively corrected their missed test questions consistently performed better than the students who were passively informed of the correct answer is very meaningful from the

perspective of both teachers and students. Even though the consistent difference in mean scores was not enough to be considered statistically significant, one must realize that an increase in student achievement was demonstrated. Even if this method of feedback only produces a small effect, the increase in performance that students can achieve is worth the minimal time and effort that it takes to complete. Especially as competition and pressure for students to achieve high grades increases, techniques for improving student learning, such as mandatory error correction, should be investigated.

By combining active student responding with knowledge of the correct answer, an alternative method of feedback, which requires students to be actively involved in error correction, was developed. Recall that research has shown that passively informing students of the correct response increases their later achievement (Gilman, 1969; Plowman & Stroud, 1942; Sassenruth & Garverick, 1965; Travers, Van Wagenen, Haygood & McCormick, 1964). The results of this study indicate that requiring students to actively correct their own missed test questions may provide for an even greater increase in later academic achievement than presently exists.

In developing any type of educational testing program, one must be certain that the test feedback is delivered at the conclusion of all questions and not after-each-item. Research has demonstrated that after-each-item feedback is only positively reinforcing when the student is achieving success and detrimental to performance and motivation if one is constantly receiving negative feedback (Haemmerlie, 1985; Kaess & Zeaman, 1960; Swinnen, Schmidt, Nicholson & Sharpiro, 1990). It is important to note that this study adhered to this principle in the design of the test feedback.

Since the error correction was mandatory, it is believed to have had a greater effect than if students are given the option as to whether or not they want to correct their test. This is evident in the behaviour of the passive correct group when they were given the option to review their corrected test for as long as they wanted. No student reviewed for longer than 5 minutes and many reviewed for less than a minute. Requiring students to correct their test will ensure that they do take the few minutes that are necessary to perhaps increase their learning and later performance.

Future research which requires active student

responding during error correction should be conducted
on a larger sample size and with more test questions,
if one is searching for a significant difference.
However, because of the potential of this technique to
improve student learning, I encourage teachers to test
this method of feedback in their classrooms. Since
teachers often become teachers because they want to
enhance student learning, the discipline of educational
psychology should be very interested in the results of
research in this area. Classroom time that is
dedicated to active error correction is definitely time
well spent.

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Sturges, P. (1972). Information Delay and Retention:
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    Number 4. 706-716.

Travers, R., Van Wagenen, R., Haygood, D & McCormick,
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    Learner's Task Involvement Under Different
    Conditions Of Feedback. <u>Journal of Educational</u>
    <u>Psychology</u>, <u>55</u>. 167-173.

Author Notes

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TABLE 1

ANCOVA SUMMARY TABLE : DIFFERENCE BETWEEN GROUPS

	DF	SEQ SS	ADJ SS	ADJ MS	F	P
TEST 1	1	34.3	34.3	34.3	.33	0.571
TEST 2	1	162.5	162.5	162.5	.88	0.357
TEST 3	1	131.6	131.6	131.6	.96	0.337

TABLE 2

MEAN TEST SCORES IN PERCENT

	ACTIVE	PASSIVE
TUTORIAL	75.5	75.5
TEST 1	76.0	73.8
TEST 2	75.5	70.4
TEST 3	79.5	74.9

Test Scores in %
(Adjusted)

	ACTIVE	PASSIVE
I-Stats Only	75.5	75.5
In-Class Quiz	76.0	73.8
2 Weeks Later	75.5	70.4
4 Weeks Later	79.5	74.9
11 Weeks Later(F)	88.3	76.9