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Impact of Pre-Grading / Resubmission of Projects on Test Grades in an Introductory Computer Literacy Course

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Abstract

This research builds on the behavior learning theory that suggests a response from a student, followed by a quick feedback and another response from the student will increase student learning. An experiment was performed that allowed students to submit particular homework projects (response) early. The early submissions were graded promptly and returned to the students with comments for improvement (feedback). The students were then given the opportunity to resubmit the projects prior to the due date (another response) for final grading. Theory indicates that the students who took advantage of such a pre-grading option should do better on subsequent tests which would indicate increased learning as a result of the extra stimulus. The experimental results reported in the current paper provide partial support for the suggested increase in learning by those students who took advantage of the pre-grading option.

Keywords: pedagogy, learning theory, feedback, computer literacy

1. INTRODUCTION

In many computer literacy courses, students are required to complete homework projects, in particular projects teaching how to use office productivity software, such as spreadsheets and databases. However, students often only receive a grade and some minor comments as feedback, and no option is given to correct the errors and actually learn from the mistakes. Learning theory suggests that increased learning will occur with additional stimuli and responses (Gagne, Briggs and Wager, 1992). Even though a number of studies in the research disciplines of pedagogy and psychology have addressed the argument of increased learning through added stimuli, the validity of this theory for the teaching of basic computer skills has not yet been established. In the current paper, we investigate the impact of pre-grading/resubmission of skill teaching projects on student learning.

Over the past two years, we have used an automated grading tool in an introductory computer literacy course that is offered to

business students at a regional university. The use of the automated grading tool has significantly decreased the amount of time an instructor must dedicate to grading.

The current paper emphasizes the capability of automated grading tools to support pre-grading of particular projects. First, a review of behavior learning theory is provided. It follows a review of automated grading tools and a description of the experiment with the statistical results. The paper concludes with a discussion of the results and potential extensions of the research.

2. BACKGROUND: BEHAVIORAL LEARNING THEORY

A student's success is influenced by the ability of the educator to present new information and to evaluate the student's understanding of the information. This process requires the student to learn the material covered by the educator.

Based on the behavioral learning theory, Gagne et al. (1992) proposed several principles for the effective design of instructional courses, including contiguity, repetition, and feedback. Contiguity is the concept that the **feedback** should follow the **response** without delay. The longer the delay of the feedback to a learning stimulus the less is the likelihood of correct answers to future similar questions. The principle of repetition states that practice strengthens learning and improves a learner's retention. By combining the design principles Gagne et al. (1992) developed a conceptual framework of cognitive learning that includes nine "conditions for learning":

- Gaining attention ("reception")
- Informing learners of the objective ("expectancy")
- Stimulating recall of prior learning ("retrieval")
- Presenting the stimulus ("selective perception")
- Providing learning guidance ("semantic encoding")
- Eliciting performance ("responding")
- Providing feedback ("reinforcement")
- Assessing performance ("retrieval")
- Enhancing retention and transfer (generalization")

The results of subsequent research studies suggest that of the nine conditions, eliciting performance and practice from the student ("responding") and providing adequate feedback ("reinforcement") are the conditions most directly connected to student success (Martin, Klein & Sullivan, 2007).

Similarly, Murray (1998) encouraged a teaching style based on drill/rote learning and memorization. Modules should be built with many exercises that are example driven. The principle of feedback requires that instructors inform the learner about whether the answer was correct or incorrect. In the case of an incorrect answer, feedback should include a new path to solve the problem. This new path could be a hint at the correct answer, a restatement of a prior fact, or even a new example that is less complicated (Uden & Beaumont, 2006). For instance, for an incorrect if-statement, a feedback explaining the binary nature of if-statements (true vs. false) would be appropriate. In addition, feedback that indicates that an answer is correct is just as important as feedback on incorrect answers. Confirming the correct answers would remove any doubt students might have on their newly learned skills and thus help retain the knowledge.

Responding is required from learners after they have been given sufficient material to comprehend an objective (Tomei, 2008). A related process called orientation and recall is defined as a process where learning involves the synthesis of prior information that must be recalled to short term memory (Uden & Beaumont, 2006). Similarly, there is a school of thought that learners construct knowledge by making sense of experiences in terms of what is already known (Eugenia, 2010).

When practice is included in a lesson, performance implies an active response by the student to the material provided. For example, in a database lesson, responding might require a student to create a query that counts the number of records in a table in order to demonstrate his/her comprehension of the newly introduced concept.

Responding enables the student to reinforce his/her understanding. Effective practice should parallel the assessments that will be used to test skills and the knowledge reflected in an objective (Reiser & Dick, 1996).

Building on on Gagne et al.'s (1992) results that response and reinforcement are key learning components, the current study investigates whether a focus on these key components can be helpful in teaching hands-on skills more effectively.

3. AUTOMATED GRADING TOOLS

Automated grading systems are provided by a number of textbook publishers, among others. Key advantages of automated grading include:

- Reduced lag time between submission of a project by a student, and response in the form of a grade or other feedback to the student
- Application of a grading rubric for a project that is consistent for all students
- Capability to add assignments as the grading time per project has been reduced.

Indeed, the results of previous research studies suggest that the use of automated rubrics can result in faster and increased feedback, and that systems may be of advantage to instructors (Tan 2009; Anglin, Anglin, Schumman and Kalinski 2008; and Debuse, Lawley and Shibl 2007). Similarly, Janicki and Steinberg (2003) suggested the need for increased computerized support for learning. Heinrich, Milne, Ramsay and Morrison (2009) demonstrated how e-tools can be used to increase the efficiency and quality of assignment making.

Examples of automated grading systems include case-based auto graders and procedural-based graders.

Case-based Auto Graders

An example of a case-based auto grader is CASEGRADER by Thomson Course Technology (Crews and Murphy 2008). Instructors are provided with a set of cases that can be instantly graded. This type of system offers challenging, multi-step, realistic problems that students may submit to be automatically graded. Feedback is instantaneous and based on incorrect responses. Students are informed of their grade and provided feedback immediately following their submission of an assignment. One major limitation of this system includes the inability of instructors to create their own cases (Crews & Murphy, 2008). For example, for the Office 2007 release, CASEGRADER offers a total of twelve different cases. If multiple sections of a course use the same limited set of cases, an increase in student plagiarism could occur.

Procedural-based Graders

Procedural-based graders include systems such as SAMS2007 (2007) by Thomson Course Technology and SNAP by EMC Paradigm Publishing (2007). These alternative systems are applications that grade student responses based on the procedure used to reach the answer. The application may either be a web system or a software application that simulates the environment of Microsoft Office programs in order to provide a hands-on experience for the students. These systems usually incorporate smaller problems that attempt to reinforce a procedure to be remembered. Few complex problems exist in the database of questions for these graders.

4. PRE-GRADING WITH A CUSTOM-BUILT AUTOMATED GRADER

Adaptive Grading and Learning System

In order to meet the specific needs of students and instructors at a regional public university, a customized grader was developed and implemented in the fall of 2008. Known, as the Adaptive Grading/Learning System (AGLS), the system consists of modules that provide automated grading of Microsoft Excel 2007 and Access 2007 assignments with personalized and rapid feedback, assignment libraries that can be shared among participating instructors, and plagiarism detection. In addition, the system allows increasing the complexity of exercises without much additional effort by the instructor. This increase in complexity serves to challenge students and increases the likelihood of learning success.

One result of the availability of the AGLS to instructors was a notable increase in the number of assignments that are given in class due to a significant decrease in grading time. For example, the instructor of one section of the computer literacy course now requires twelve different assignments, versus five projects that were required prior to the implementation of the AGLS four semesters ago. According to behavior learning theory, more responses from students should be associated with more learning.

Pre-grading

Following the introduction of the AGLS, some instructors gave students the opportunity to submit their projects in advance of the due date for one (or even several) round(s) of pre-grading. After a project was graded and specific comments were posted to the student's grade book on the web, the student could resubmit the project for final grading.

It should be noted that the comments provided to the students did not give them the solution

but rather pointed to what needed to be corrected. Examples include:

- Excel: Incorrect formula in B17
- Excel: Missing IF in C24
- Excel: Absolute reference in D22
- Excel: Incorrect use of the SUM function
- Access: Primary key incorrect in table 'Customers'
- Access: Field type incorrect for zip code
- Access: Query Invoices, criteria for past due invalid

The practice avoided students turning in a project basically blank and the automated system giving them the correct formulas or criteria.

Methodology, Data Gathering and Analysis

For the current study, experimental data was gathered from one section of eighty-seven students in an introductory information systems course. By selecting only one section taught by the same instructor the experiment avoided differences due to different instructor content, teaching styles and assignments.

Assignment	Number of student who submitted early
Access (basic table and query design)	76 out of 87
Excel (basic IF's)	66 out of 87
Excel (Solver)	61 out of 87

Table 1: Pre-grading submissions

Over one semester, students were given the opportunity to submit three assignments for pre-grading. Students only had to submit the assignment a reasonable time prior to the due date to get feedback and an opportunity to resubmit. Table 1 details the number of students who took advantage of the pre-grading opportunity. The order of the assignments in Table 1 is the order in which they were assigned during the semester.

Two observations may be derived from Table 1. First, the number of students who submitted projects early was rather high. It was a very favorable observation that 85% of students submitted the first project early; and even at the end of the semester 70% of students submitted for pre-grading. The instructor expected the pre-grading rate to be lower.

The second observation is less surprising: the number of students who submitted early decreased over the semester. The decrease can be interpreted such that as more work in other courses became due, students tended to complete their assignments closer to the due date.

To test if additional learning occurred for those students who took advantage of the pre-grading opportunity, the following hypothesis was developed:

H_0 – Pre-grading will not be associated with higher student scores

H_1 – Pre-grading will be associated with higher student scores

In addition to the homework projects in Access and Excel (Table 1), four tests were administered during the semester. Each of the tests had two components: a multiple choice/short answer component and a hands-on component that tested the literacy skills covered in the previous weeks (i.e., Access and Excel). Pre-grading opportunities were available prior to three out of the four tests.

For each test, student data was divided into two groups based on whether a student had taken advantage of the pre-grading option or not:

- Experiment Group: took advantage of pre-grading prior to the test
- Control Group: no pre-grading prior to the test

For each test the population of the groups differed, based on who had taken advantage of the related pre-grading opportunity. Reflected in the numbers is, thus, the decreasing number of students who took advantage of pre-grading over the semester (Table 1).

To eliminate any bias due to the differences of a student's prior knowledge or motivation, relative instead of absolute test scores were used. This measure also eliminates the potential that those students who submitted projects early were more motivated or more intelligent. Specifically, the difference between the scores of the multiple choice component and the hands-on component of the test for each student was used as the data-basis. For example:

Experiment Group Student 1:
Multiple Choice Test Score: 85
Hands on Test Score 91
Difference: 6

Control Group Student 1:
Multiple Choice Test Score: 85
Hands on Test Score 87
Difference: 2

Thus, in this example the experiment student scored 6 points higher on the hands-on component of the test while the control student scored 2 points higher. An analysis of the means was performed to determine whether the differences between the two groups were statistically significant.

Results and Discussion

For all cases a two tailed t-test was run assuming normality of the data. For two of the cases the variances test yielded unequal variances and thus a modified t-test was run (Table 2).

Cases	p-value	Variance
Access Hands On	.114	Unequal
Excel IF's	.524	Unequal
Excel Solver	.012	Equal

Table 2: p values from t-tests

As is summarized in Table 2, the results of the t-test analysis suggest that for two out of three assignments, the difference in learning as a result of pre-grading is NOT significant at the 5%-level. For the third assignment (Excel Solver), however, a difference is found that is highly significant at 1.2%. In all, the support for learning theory as a result of our experiment appears to be mixed.

A closer look at the data provides some additional insights and support for our hypothesis H_1. The first test (Access Hands-On) has a p-value of .114 which indicates acceptance of the null hypothesis; however, this result is close to a .10 p-value that can in fact be accepted for experimental research. One explanation for the highly insignificant t-test in the case of the second assignment/test may be that, while pre-grading concentrated on IF-statements, the test was actually on Excel Scenarios. IF-statements can be used in Scenarios, but are not necessarily included in the building of scenario cases that students often find difficult. Thus this hands-on test did not fully match the pre-grading assignment.

Table 3 compares the average results of the control and experiment groups and computes the difference between the multiple choice and hands-on components for the entire section. The results support our H_1, as they suggest that there might in fact be a gain in learning from pre-grading: For the experiment group, the difference between the multiple-choice and the hands-on components of the test is larger (5.72) than for the control group (4.22). Students who took advantage of pre-grading performed particularly well in the hands-on component of the test when compared with the multiple-choice component. However, the difference was, again, not statistically significant the 5%-level.

	Control	Experiment
Avg Multiple Choice	82.04	86.06
Avg Hands On	86.27	91.8
Difference	4.22	5.72

Table 3: Test score means and differences, both groups, all assignments combined

An unanswered question is whether the scores on the multiple choice tests (which are higher for the experimental group) are not just a sign of more motivated students, but also a sign of learning of additional concepts from re-doing projects that then helped in answering questions on the multiple choice portion of the test. The effects of concept learning may thus have had an additional impact on the relative differences between the results of projects and tests and the levels of significance (or lack thereof).

6. LIMITATIONS AND FUTURE RESEARCH

One limitation of the current research setup resulted from the fact that the hands-on portion of the second test did not exactly match the concepts that were included in the pre-grading assignment. More specifically, pre-grading focused primarily on IF-statements while the test included scenario management skills in addition to IF-statements. In addition, there may have been an impact of concept learning from re-doing assignments.

To overcome these limitations, the following research is currently in progress:

A) Matching the concepts on the pre-graded assignments with the hands-on portions of the multiple choice tests; and

B) A re-examination of the multiple choice tests to eliminate the impact of concept questions about Excel or Access on the final scores. This will permit a less biased analysis of the data.

7. SUMMARY AND CONCLUSIONS

In summary, the results of the experiments partially supported the research hypothesis, and, thus provided limited support for the behavior learning theory that a response solicited from a student, followed by rapid feedback and then another response would increase student learning. Rapid feedback was assumed since all projects were graded within 48 hours of submission. In particular in the case in which the test concepts matched closely the hands-on concepts of the pre-grading project (Excel Solver), the results were highly significant, suggesting that learning did occur as a result of the pre-grading option.

As a side-effect of the experiment, it was encouraging to see how many students took advantage of the pre-grading option, thus increasing their chance for learning. Another positive result of the pre-grading experiment was a noticeable reduction in the 'arguments' from students on grading. Since students were given the option to re-submit their projects, they did not argue over small grading questions. Whereas if the first grading had been final they might argue that =SUM(B3, B4, B5, B6) was a valid answer since it resulted in the correct value on the spreadsheet. The pre-grading option permits students to fix formulas that might have yielded the correct value, but were not considered the correct answer according to the learning objectives.

The knowledge gained from this study provides valuable insights for instructors, particularly those teaching online web-based courses as such environment lacks the direct observation of learning during physical lab meetings.

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