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 quick feedback and another response by the student will increase student learning. An experiment was tracked that gave students the option to submit particular homework projects (response) early; these were graded and returned to students with comments for improvement (feedback). The students were then given the opportunity to resubmit the project prior to its due date (another response) for grading. Theory indicates that the students who took advantage of this pre-grading option should do better on following tests which would indicate increased learning from the extra stimulus. Our experimental results did not indicate a significant 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 office productivity software, such as spreadsheets and databases. However, students often only receive a grade and some minor comments as a 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 there are several studies in pedagogy and psychology discipline addressing this argument, they fail to address validity of this theory in teaching skills. This research investigates the impact of pre-grading/resubmission of projects on student learning.

Over the past two years, the authors have used an automated grading tool in an introductory computer literacy course that is offered to business students of a regional university. The use of these tools has significantly decreased the amount of time an instructor must dedicate to grading.

This paper discusses the implementation of automated grading tools with emphasis on the capability to provide 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 behavioral learning theory, Gagne et al. (1992) proposed several design principles for effective instructional design 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 second principle of repetition states that practice strengthens learning and improves a learner's retention. Gagne et al.'s (1992) conceptual framework of cognitive learning 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 suggested that eliciting performance and practice from the student ("responding") and providing adequate feedback ("reinforcement") are the events most directly connected to student success (Martin, Klein & Sullivan, 2007).

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). In addition, feedback that indicates that the answer is correct is just as important as feedback on incorrect answers.

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).

"Responding" is required from learners after they have been given sufficient material to comprehend an objective (Tomei, 2008). Performance on the student's part is required when practice is included in a lesson. This form of practice implies an active response to the material provided.

For example, in a database lesson, "responding" might require a student to create a query that will count the number of records in a table in order to demonstrate his/her comprehension of this 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).

This study extends the Gagne et al. (1992) study showing response and reinforcement as the key learning components to investigate whether hands-on skills could be taught more effectively focusing on these key components.

The knowledge gained from this study provides valuable insight for instructors, particularly those teaching online web-based courses.

3. AUTOMATED GRADING TOOLS

Automated grading systems are provided by a number of book publishers. Key advantages of implementing automated grading include:

- Reduced lag time between submission of the project and grade / feedback to the student

- Requirement that the instructor develop a grading rubric that is consistently applied to all students for one project
- Capability to add increased 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 facilitate faster and increased feedback, and that all systems may be of advantage to instructors (Tan 2009; Anglin, Anglin, Schumman and Kalinski 2008; and Debuse, Lawley and Shibl 2007). Janicki and Steinberg (2003) also supported 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). CASEGRADER offers twelve cases for the Office 2007 release. If multiple sections of a course use the same limited 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 (AGLS)

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, shared assignment libraries between participating instructors, and plagiarism detection. In addition, the system allows the complexity of exercises to be increased without much additional effort by the instructor. This increase in complexity serves to challenge students and increases the likelihood of their success and learning.

One result of the availability of the AGLS to instructors appears to be an increase in the number of assignments that are given in class. 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, 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.

5. METHODOLOGY, DATA GATHERING AND ANALYSIS

For the current study, 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.

Over one semester, students were given the opportunity to submit three assignments for pre-grading. Students only had to submit the assignment 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.

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, listed in order of due date

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 come in 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 increase student scores

H_1 – Pre-grading will increase 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 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 changed 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 com-

ponent 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 suggests that there is NO difference in learning as a result of pre-grading and learning theory appears not to be supported.e

A closer look at the data, however, provides some additional insights. One explanation for the insignificant t-test in the case of the second assignment/test may be that, while the test was on Excel Scenarios, the pre-grading concentrated actually more on IF statements. 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.

In contrast, the third test was found to be significant and this may interpreted as a positive sign for subsequent research studies. Both, the test and pre-grading assignment focused on Excel Solver.

The first test (Access Hands-On) has a p-value of .114 which also indicates acceptance of the null hypotheses, however this is close to a .10 p value for experimental research.

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 suggest that there might in fact be a gain in learning from pre-grading, as 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 the5%-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

One might question 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 be a sign of learning additional concepts from re-doing projects that then helped in answering questions on the multiple choice portion of the test.

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. Also, pre-grading concepts did not completely overlap with the test concepts; i.e. pre-grading focused mostly on IF statements while test added scenario management skills tested in addition to IF statements. Finally, 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-grading assignments with the hands-on concepts; 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 only partially supported the research hypothesis. The data only 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. In two of the three datasets the research hypothesis was not found to be significant. Rapid feedback was assumed since all projects were graded within 48 hours of submission.

On the positive side, it was encouraging to see how many students took advantage of the pre-grading option. The case in which the test concepts matched closely the hands-on concepts of the pre-grading project showed significance and suggests that learning did occur as a result of the pre-grading option.

Another positive result of the pre-grading was a noticeable reduction in the 'arguments' from students on the 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 the final they might argue that =SUM(B3, B4, B5, B6) was a valid function since they got the correct answers. The pre-grading option permits students to fix formulas that might have yielded the correct result, but were not considered the correct answer according to the learning objectives.

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