

# THE NEGATIVE IMPACT OF TOO MUCH EMPOWERMENT: LASTING EFFECTS

**Alka R. Harriger, Purdue University, arharriger@tech.purdue.edu**

**Kyle D. Lutes, Purdue University, kdlutes@tech.purdue.edu**

**Rosemary Ricci, Purdue University, rricci@tech.purdue.edu**

## ABSTRACT

*The Department of Computer Information Systems and Technology at Purdue University performed a study to determine the impact of empowering students to make homework decisions in an introductory programming course. The preliminary results of this study were presented at IACIS 2000 (4), where attendees suggested a follow-up paper that shared the long-term, comparative results of the students in the normal group versus the empowered group. This paper describes the long-term results of the empowering study and provides further evidence that the initial homework recommendations are still valid.*

**Keywords** : empowering students, homework, programming, grading

## INTRODUCTION

During the Spring 1999 semester, two of the authors taught a separate section of the department's introductory programming course. The course format for both sections consisted of two 75-minute, instructor-led lectures and one 50-minute teaching assistant-led practice-study-observe (PSO) meetings each week. Attendance was recorded for each lecture meeting through almost daily quizzes and for PSO meetings through five-point PSO participation grades.

The study's goal was to determine whether there was any difference in student success in the class if weekly homework assignments were optional or required. Both sections used the same textbook (3), covered the same topics, gave the same exams, and made the same assignments, but employed slightly different policies regarding weekly homework exercises. Section one used optional homework assignments, while section two used required homework assignments. Not surprisingly, the students who were empowered to optionally complete homework assignments (section one) had significantly lower scores on exams. Both sections experienced attrition, but section one's drop rate was slightly higher. Section one started with over 100 students and ended with 82 (18% attrition), while section two started with over 50 and ended with 45 (10% attrition). Harriger and Lutes provide additional details on the background and process of the study as well as the end-of-class performance-based results and informal survey results (4).

During the 2000 IACIS presentation, attendees requested the authors to uncover longer-term results that could help solidify the preliminary results of the study. For example, since the course was a prerequisite to another programming course, it would be useful to compare the performance of students in both sections in the second programming course. However, this task required examining individual

student performance in courses outside of the authors' teaching assignments, which is a violation of student privacy. With the assistance of the head academic counselor who could access this data as part of the counseling function, the expected trends were identified and are presented within this follow-up report.

### **OPTIONAL HOMEWORK EXPERIMENT SUMMARY**

An Access Eric parent brochure suggests that homework assignments can help increase opportunities for student learning by increasing the amount of time they have to learn and expanding the amount of content they receive (1). The same brochure describes three types of homework: practice, preparation, and extension. The Purdue introductory programming class employed a variety of assignments that included all three types of homework. One of these, weekly programming homework exercises, gave students regular practice applying newly learned concepts. Unfortunately, it also created a tremendous grading burden for the large enrollment class, requiring the instructors to grade, record, and return 150 student submissions in less than a week for each assignment. There was a nominal grading budget, but it was not large enough to take the necessary time to provide detailed and timely feedback to each student.

Milbourne and Haury provide recommendations regarding the amount of time students in grades K through 12 and college should spend on homework. While they suggest that high school students should spend up to two hours, college-bound students will receive longer and more complex assignments (6). Given differences in learning abilities, some students will take longer while others take less time. In the programming course, each homework assignment was expected to take two to five hours. Since the instructors expected students to make mistakes on their first application of a new concept, the weight of each homework assignment was low -- approximately one percent of the overall grade. Nonetheless, students who spent hours on an assignment expected to earn high grades reflecting the time spent rather than the quality of the result. When low grades were received due to silly errors, students would often quibble over fractions of points instead of understanding what they did wrong. These grade appeals took up too much of the instructor's time that could have been better spent on other, more important tasks.

The two course instructors often discussed ways of better using the instructor's time as well as improving the mood of the programming class. While both agreed on the value of homework, they debated the possibility of not using the homework grade in the overall grade determination. In Spring 1999, the two sections of the same programming class were engaged in an optional homework experiment. Section one students were given the option of completing homework for feedback purposes only, but would receive no grade. "Their grade would be determined by weekly quizzes and exams only. These students were empowered to complete the weekly assignments as they felt was necessary, but an additional homework incentive was offered as well -- borderline students who successfully completed weekly homework were more likely to get the benefit of doubt when final grades were assigned."(4) Section two was required to complete every homework assignment.

## Preliminary Results

The preliminary results of the study reported by Harriger and Lutes showed that the empowered group had no complaints regarding the grading of weekly assignments, and they had similar attendance and overall quiz scores when compared to the required homework group. Unfortunately, and not unexpectedly, the majority of students in the larger section did not complete the weekly assignments. Failure to complete the weekly homework assignments resulted in insufficient exposure to programming. This had a dramatic, negative effect on the exam grades. Section one students earned 10-15% lower scores than their section two counterparts. Informal surveys also confirmed that if assignments have no discernable impact on the final course grade, students would not complete them even when they know they should. Their college-survival skills place non-required tasks at the bottom of their priority list, resulting in option tasks to be ultimately discarded undone (4).

Interestingly, the results confirm Butler's 1987 work on the benefits of homework. Although Butler's findings were written to secondary school teachers, the results of the authors' study support Butler's assertions regarding homework:

- *Schools in which homework is routinely assigned and graded tend to have higher achieving students.*
- *Giving homework on a regular basis may increase achievement and improve attitudes toward learning (2).*

Spalding tells students why they should complete homework – to build a good work ethic for future career success (7). In the case of the CPT study, weekly homework was available for both sections; however, only the second section was required to complete it. If students in the first section completed the homework, they did receive feedback comparable to students in the other section. To encourage students in the first section to do their homework, advice similar to Spalding's was shared on numerous occasions with the students; however, the fact that completing homework regularly had no direct impact on the student's grade was a de-motivator, and most students quickly stopped completing it. Herold explains the obvious reason for this situation is, "Without an incentive, you're asking kids to do something they don't enjoy just for their self-improvement. Most adults can't even do that." (5).

## LONGITUDINAL STUDY RESULTS

During the presentation of the preliminary results of this study at IACIS 2000, attendees requested the authors to uncover longer-term results that could help solidify the preliminary results of the study. For example, since the introductory course is a prerequisite to a second programming course, it would be useful to review students' performance in the second course to determine if failure to complete weekly homework assignments in CPT 250 had any lasting effects on the post-requisite course, CPT 255. Further, two additional demographics, gender and grade point average (GPA), were reviewed for any possible impact to the study. To address these issues, the following questions will be answered:

## 1. Was there a large difference in the academic abilities between the two sections?

To determine whether one section may have randomly received better performing students than the other section, the overall GPAs and major GPAs of all students in both sections were studied. The GPAs prior to enrollment in the first programming course were not available at the time of this writing. However, the current GPAs that included the most recent grades in the first and possibly second programming courses were available and are included here. By reviewing the average and median GPAs, it appears that the homework-required group had a larger percentage of brighter students. Over 50% of the students (24 out of 45) in section two had a B or better average, whereas less than 30% of the students (23 out of 84) in section one had a B or better average. See Table 1 for statistical data on the academic abilities of the two groups.

		High	Average	Standard Deviation	Median	Low
<b>Section One (empowered) GPAs</b>	<b>Overall GPA</b>	3.91	2.73	0.56	2.69	1.66
	<b>Major GPA</b>	3.91	2.64	0.65	2.57	1.33
<b>Section Two (homework required) GPAs</b>	<b>Overall GPA</b>	3.9	2.88	0.62	3.07	1.09
	<b>Major GPA</b>	3.91	2.80	0.54	2.78	1.85

TABLE 1: Academic abilities profile

## 2. Was there a large difference in the gender makeup between the two sections?

As can be expected in technically based fields such as information technology, there was a large majority of male students in both sections (74% male and 26% female); however, the gender difference was greater in the empowered group. The men in the empowered group had an average overall GPA of 2.70 and major GPA of 2.61. The women in the same group had an overall GPA of 2.80 and major GPA of 2.74. In the homework-required, the men had an overall GPA of 2.80 and a major GPA of 2.77, whereas the women had an overall GPA of 3.16 and major GPA of 2.97. Although the female students in the homework-required group appear to have fared better than their empowered counterparts, their significantly higher GPA may better explain their stronger academic performance in the programming class. See Table 2 for more details.

		Percentages within gender group			Percentages within grade range		
		Male	Female	N/a	Male	Female	N/a
<b>Section One (empowered)</b>	TOTAL	59	23	2	70.2%	27.4%	2.4%
	Earned As	9 (15.3%)	0 (0%)		100%	0%	
	Earned Bs	18 (30.5%)	9 (39.1%)		66.7%	33.3%	
	Earned Cs	13 (22.0%)	5 (21.7%)		72.2%	27.8%	
	Earned Ds	15 (25.4%)	4 (17.4%)		78.9%	21.1%	
	Earned Fs	4 (6.8%)	5 (21.7%)	2 (100%)	36.4%	45.4%	18.2%
<b>Section Two (homework required)</b>	TOTAL	34	11	-	77.8%	22.2%	
	Earned As	12 (35.3%)	3 (27.3%)		80%	20%	
	Earned Bs	12 (35.3%)	4 (36.4%)		75%	25%	
	Earned Cs	6 (17.6%)	3 (27.3%)		66.7%	33.3%	
	Earned Ds	2 (5.9%)	0 (0%)		100%	0%	
	Earned Fs	2 (5.9%)	1 (9.1%)		66.7%	33.3%	

**TABLE 2: Gender profile****3. Were there differences in the school dropout rate in either section?**

As with any academic institution, students may leave school for a variety of reasons, including family/personal issues and Purdue-initiated drops. Excluding students who successfully completed graduation, it was determined that 16.7% of the empowered group (14 out of 84) and 15.6% of the homework-required group (7 out of 45) were no longer at Purdue. Given the differences in the academic abilities listed above, the optional homework experiment does not appear to have impacted the long-term dropout rate significantly.

**4. Did a large group of the empowered students retake the first programming course?**

It would be logical to expect students who do poorly in a prerequisite course to repeat it before moving on to the post-requisite course. After reviewing the enrollment data, it was discovered that none of the homework-required students retook the first class, whereas eleven of the students in the empowered group repeated the first class. When reviewing the original grade data from the empowered group, two of the repeaters earned a C in the first course, four earned a D and five earned an F. The new grades earned were not available; however, two of the repeaters who initially earned an F eventually withdrew from the repeated class. This data suggests that at least a few of the empowered students learned the value of homework and felt that they needed to retake the first class.

**5. Did a large group of the empowered students retake the post-requisite programming course?**

Since a majority of the empowered group did not retake the first programming class, it was expected that they would experience a larger struggle in the post-requisite class, resulting in more students repeating of the first class. As of the writing of this paper, 23 students from the empowered group (27.4%) and 16 students from the homework-required group (35.6%) had not taken the post-requisite class. After comparing the second course data for the students who did enroll from both sections, it appears that the optional homework experiment had little impact on the performance in the subsequent class. Six students from section one and two students from section two repeated the post-requisite course. Interestingly, the only two repeaters from the homework-required group had earned Bs in the first course, while the repeaters in the empowered group consisted of six students, two earning Bs, three earning Cs, and one earning a D. More in-depth study will be necessary to determine the reason for this unexpected result. See Table 3 for more details.

Original grade in first programming course	Repeated second programming course	
	Section One (empowered)	Section Two (homework required)
Earned As	N/a	N/a
Earned Bs	2	2
Earned Cs	3	N/a
Earned Ds	1	N/a
Earned Fs	N/a	N/a

**TABLE 3: Repeated second programming course**

## 6. Did the students with required homework assignments continue to earn better grades in the second programming course?

To assess the long-term effects of the optional homework experiment, it was important to track student performance in subsequent programming courses. First, the overall grade distributions in the first and second programming courses were evaluated. When considering the entire group, the empowered group's performance in the second course was more closely matched their performance in the first course than that of the homework-required group. However, a large number of students in both courses had not enrolled in the second course at the time of this writing. After considering only those who enrolled in the second course, there was little difference in performances between the two groups. See Table 4 below.

Grade Earned	Grade distribution in first programming course		Grade distribution in second programming course					
	Section One (empowered)	Section Two (homework required)	Section One (empowered)			Section Two (homework required)		
			Raw numbers and percentages for the original 84 students	Percentages for only the 61 who enrolled in the second course		Raw numbers and percentages for the original 45 students	Percentages for only the 29 who enrolled in the second course	
As	9 (10.7%)	15 (33.3%)	8	9.5%	13.1%	6	13.3%	20.7%
Bs	27 (32.1%)	16 (35.6%)	13	15.5%	21.3%	10	22.2%	34.5%
Cs	18 (21.4%)	9 (20%)	26	31.0%	42.6%	10	22.2%	34.5%
Ds	19 (22.6%)	2 (2.4%)	9	10.7%	14.8%	3	6.7%	10.3%
Fs	11 (13.1%)	3 (3.6%)	5	6.0%	8.2%	-	0%	0%
N/a			23	27.4%	--	16	35.6%	--

TABLE 4: Grade distribution in both programming courses

An alternate approach for evaluating performance was to track each student's performance from the first course to the second course. Students in the empowered group appeared to be more successful in maintaining or improving their grades than those in the homework-required group (Table 5). Further study will be needed to determine why.

	First course grade totals	Second course grade							
		A	B	C	D	F	% earning same grade or higher	N/a	
Section One (empowered)	Earned As	9	6	1	1	-	-	75%	1
	Earned Bs	27	2	10	9	1	-	54.5%	5
	Earned Cs	18	-	1	8	4	2	60%	3
	Earned Ds	19	-	1	6	4	2	84.6	6
	Earned Fs	11	-	-	2	-	1	100%	8
Section Two (homework required)	Earned As	15	6	5	-	-	-	54.5%	4
	Earned Bs	16	-	2	9	-	-	18.2%	5
	Earned Cs	9	-	3	1	3	-	57.1%	2
	Earned Ds	2	-	-	-	-	-	--	2

	Earned Fs	3	-	-	-	-	-	--	3
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**TABLE 5: Second course grades as a function of first course grades**

## RECOMMENDATIONS

The preliminary results of the study confirmed what the research has shown -- homework is an important part of the learning process and failure to provide motivation for homework (by making it optional) results in the loss of an important learning opportunity for students. In the first course, this translated into lower test scores and lower course grades. The longitudinal study results, however, do not necessarily support the conclusions from the preliminary study results. Students in both groups were equally successful. Further study will be needed to explain why there appears to be no long-lasting effects. However, given the direct outcomes from the preliminary study, the original recommendation still holds: "Instructors who are teaching practiced skills like programming owe it to their students to assign regular, required homework, and find other ways to manage the grading burden and deal with quibbling over points. After all, practice makes perfect (or at least adequate) programmers." (4)

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