High School Homework Habits and Success in First year Engineering

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High School Homework Habits and Success in Engineering

Introduction

This study is a continuation of a study on homework behaviors in high school and college for a group of engineering students at a large metropolitan research institution. In the first phase of the study we investigated students' attitudes towards homework in high school and in first semester of engineering, self-reported frequency of completing homework in high school and in engineering school, and the reasons students did not complete homework at both levels[1]. The phase of the study documented in this paper investigated the relationship between students' homework completion rates in high school and their academic performance and first year retention in engineering. In this phase we also investigated the relationship between homework completion rates in high school and students' scores on the Brief Self-Control Scale.

According to results from the National Survey of Student Engagement, engineering seniors on average spend more hours preparing for class than seniors in any other discipline. On the 2011 survey, 42% of the senior engineering students who responded to the survey indicated they spent more than 20 hours a week preparing for class[2]. Meanwhile student responses on the Cooperative Institutional Research Program (CIRP) Freshman Survey show high school seniors spent much less time studying or doing homework in their senior year of high school, and over the past twenty years the amount of time students indicated they spent studying or doing homework their senior year has been decreasing[3] (see Figure 1).

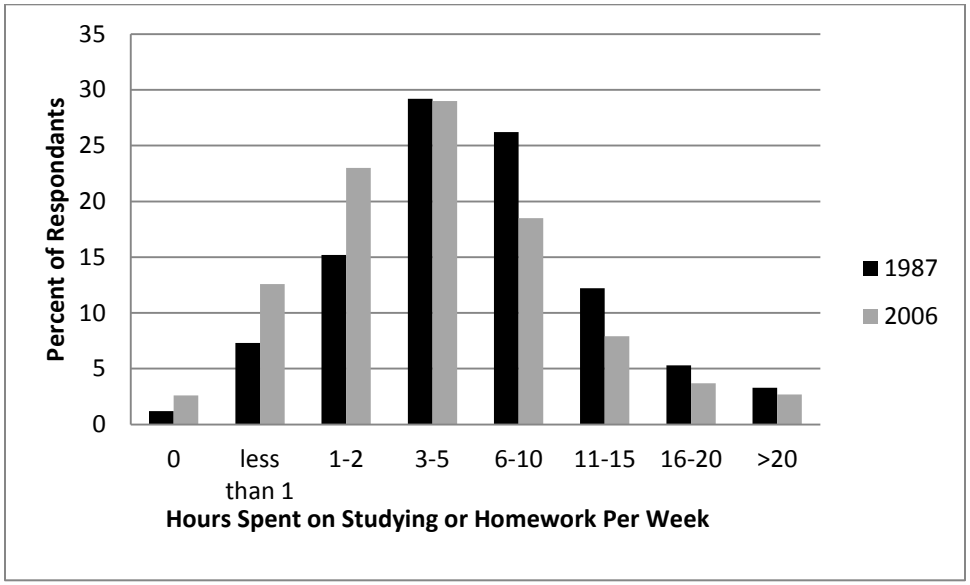

Figure 1. Hours Spent Studying and on Homework in Senior Year in High School in 1987 and 2006 as Reported by College Freshman. Graph constructed with data from Pryor, et al.[4]

Background literature

Value of Homework

The value of homework for students in K-12 has been analyzed from many perspectives. While some have proclaimed that homework is a means to disadvantage the disadvantaged[5] others have found positive benefits to homework[6]. After reviewing the extensive literature on homework in the K-12 system, Cooper summarized the advantages and disadvantages of homework[7]. Of particular interest to this study are the benefits of homework related to learning: better retention of factual knowledge, increased understanding, better critical thinking, better concept formation, and better information processes, and benefits related to increased self-discipline. All of which might result in higher GPAs in college

Studies have also investigated the value of homework at the post-secondary level. For example, homework has been related to developing self-regulation[8], and in one study, homework habits and attitudes were the strongest non-cognitive factors in predicting academic performance in college[9].

Most studies on homework have investigated the relationship between some aspect of homework, such as how much[10], or type of assignment[11], and performance in the current course. What is lacking in the literature are studies investigating the relationship between homework completion in high school and performance in college. The current study set out to answer questions related to long-term benefits of homework completion in high school. Specifically, is there a relationship between homework completion rates in high school and academic performance or self-control in engineering school? Due to the interest in retention in engineering, analysis was also completed to look at the relationship between homework completion in high school and first year retention in engineering.

Self-Control and Academic Performance

Studies have shown a positive relation between self-control and academic performance for the general population of college students[12, 13] as well as for engineering students[14]. In a multiple regression study (n = 201, 78% females, 22% males) to predict college GPA in psychology students, Wolfe and Johnson[15] considered high school GPA, SAT scores, and 32 personality variables assessed using the Jackson Personality Inventory; modifications of the Multidimensional Personality Questionnaire; the Big 5 Inventory; and a few additional variables. After accounting for high school GPA, self-control accounted for the most variability in college GPA (9%); SAT total score was next (5%).

Tangney, Baumeister and Boone[16] conducted two studies investigating the relationship between self-control and multiple factors including college grades. The participants in their studies were undergraduates in a psychology course. In the first study (n = 351, 72% females, 28% male), the age of the participants ranged from 18 to 55 (M = 20.07, SD = 4.99); 49% were white, 20% African American, and 20% other. The sample in the second study (n = 255) was ethnically similar and had an even higher percent of females. Analysis in both studies showed a significant positive relationship between GPA and self-control. Thus, on average, the students with higher reported self-control had higher grades. The authors presumed this phenomenon was due to students with higher self-control being better at "getting tasks done on time, preventing leisure

activities from interfering with work, using study time effectively, choosing appropriate courses and keeping emotional distractions from impairing performance" [17].

Self-Control and Academic Performance of Engineering Students

In previous studies, we investigated the relationship between self-control and academic performance in first year engineering students from two separate perspectives. In one study, we used the self-reported frequency of activities that showed lack of self-control[18] and in another study, we used a validated instrument, the Brief Self-Control Scale, to measure levels of self-control[19]. In both studies there was a significant and positive relationship between self-control and first semester GPA. Meanwhile the relationship between academic ability (measured by scores on the ACT subject tests and on an algebra readiness test) was not significantly related to self-control scores.

Research Questions

If, as some studies have shown[20], completing homework in high school can help develop self-control in students, we would expect students with higher homework completion rates in high school to have higher self-control and perform better in college. The current study investigated if the relationship between self-control and homework completion rate in high school was significant.

The following research questions were addressed:

1. Is there a relationship between homework completion rates in high school and academic performance in engineering students?
2. Is there a relationship between homework completions rates in high school and retention in engineering?
3. Is there a relationship between homework completion rates in high school and self-control scores at the beginning of the first semester of college?

Procedure

During the first week of Fall semester in 2012 and 2013, students enrolled in a required entry level engineering course were sent an email asking them to complete a survey. The survey contained multiple questions related to students' motivations, study habits, high school behaviors and other topics. Students were given class time to complete the survey which took about 10 minutes. No rewards or class credit were given for completing the survey. First semester GPA and retention status were extracted from official university data. As per our IRB protocol, student IDs were replaced with research IDs by employees in the Department of Institutional Effectiveness before the data was given to researchers.

Participants

Participants in the study were first-time fulltime freshman starting in fall of 2012 or 2013 at one ABET accredited engineering school in a large, public, research institution. In both 2012 and 2013 cohorts, 99% of the students were directly out of high school. According to the official university count, the 2012 cohort had 434 students. Three hundred-forty of the students (78%) were male and 94 were female (22%). Eighty -five percent of the cohort was Caucasian and no

other ethnic group represented more than 4% of the cohort. The average ACT composite score was 28.3 (*SD* = 3.15).

The 2013 cohort had 505 students (402 males (80%) and 103 females (20%)). Again this cohort was less ethnically diverse than the national population of engineering students[21] and was 86% Caucasians. The average ACT score was 28.5 (*SD* = 3.17).

RQ1 and RQ2: Students were excluded from analyses for RQ1 and RQ2 if they did not complete the survey question on homework or their first semester GPA was 0. Responses from 864 students (92%) were used for analyses for RQ2 and RQ2. This response rate was above 85%, the recommend level at which the National Center for Educational Statistics requires missing data analysis be reported[22].

RQ3: Students were excluded from analysis for RQ3 if they did not complete all 13 items on the Brief Self-Control Scale or the question on homework completion rate in high school. Students with GPA = 0 were included in this analysis. In total 872 students were included in the analysis for a 93% inclusion rate.

Measures

Homework Completion Rates

On the surveys students were asked to "Select a math or science class in your senior year in which homework was assigned". The largest percentage of students (around 50%) selected calculus and the remaining students selected courses such as physics, chemistry, pre-calculus, college algebra and biology. Students were then asked the following question: "Thinking about the class you selected, what percent of the homework for this class did you complete on time, complete late, or not complete?" The responses were limited to whole numbers between 0 and 100 and all three responses were forced to add up to 100. The responses were divided into five categories as shown in Table 1. There were no significant differences in the average ACT composite score for the students in each category of homework completion.

Table 1

Definition of Homework Completion Category and Average ACT Scores for Each Group

HW Category	Percent of Homework completed	*n*	ACT composite score M	(SD)
1	Less than 80%	124	28.34	(3.22)
2	80 – 84%	60	28.37	(2.85)
3	85 – 89%	52	28.32	(3.00)
4	90 – 94%	134	28.22	(3.34)
5	95 – 100%	493	28.67	(3.09)

Self-Control Instrument

Self-control was measured using the responses to the 13 items that make up the Brief Self-Control Scale[23]. This scale is a subset of the Self-Control Scale that was built on the following concept of self-control:

> Regulating the stream of thought (e.g., forcing oneself to concentrate, altering moods or emotions) restraining undesirable impulses, and achieving optimal performance (e.g., making oneself persist) all constitute important instances of the self-overriding its responses and altering its states or behavior. More generally, breaking bad habits, resisting temptation, and keeping good self-discipline all reflect the ability of the self to control itself, and we sought to build our scale around them[24].

The scale was introduced on the survey with the following question: "With respect to high school, how frequently does each of the following statements apply to you?" A sample item reads "I do certain things that are bad for me, if they are fun." The available responses were (1) *Never*, (2) *Seldom*, (3) *Sometimes*, (4) *Often*, and (5) *Always*. The self-control score was calculated by adding all items on the scale after appropriate responses were reversed. Scores had the potential range of 13 to 65.

The scale has been used in over 50 studies, some of which have been in studies of academic performance[25]. The creators of the scale reported good internal consistency reliability ($\alpha = .83$ and .85 in two different studies), good test retest reliability of .87 ($n = 233$), but did not report convergent validity data.

Using data from this study Cronbach's alpha was in the acceptable range (.84 on the 2012 survey and .85 in 2013). Future analysis on the scale using confirmatory factor analysis showed some concern with convergent validity (factor loadings were less than .7 as recommended by Kline[26)]. This was not entirely surprising as self-control is a complex, multifaceted trait. Based on the widespread use of the Brief Self-Control Scale, it was used, with the slight apprehension of a potential threat to convergent validity. There was no concern for divergent validity; none of the correlations between items were over .9 [27].

Analysis

Analyses were completed in SPSS rev. 21, Amos and MatLab R2014a. The following sections describe in detail the analysis for each research question.

Analysis for RQ1

Based on the Kolmogorov-Smirnov and Shapiro-Wilk tests for normality (see Appendix Table A1), there was a potential issue with assuming normality of the GPA for each category of homework completion. This was most likely due the upper and lower limits of GPA. Further investigation of the histograms and Q-Q plots of GPAs for each category of homework completion confirmed the appropriateness of using a nonparametric test to compare the distributions of GPA between homework completion categories to answer RQ1. For RQ1 the Two -Sample Kolmogorov-Smirnov Test, which is based on the empirical distribution function, was used to test for a difference in the distributions of GPA for the different categories of homework completion. The test was run in MatLab using the *KSTEST2* function. Cliff's delta

was used as a nonparametric measure of effect size. The MatLab program written to calculate Cliff's delta is in the Appendix.

Analysis for RQ2

Logistic regression was used to test whether the level of homework a student completed in high school was related to their retention in engineering status after one year. Specifically, the model tested whether the probability of being retained in engineering after one year was significantly different between students who completed 95-100% of their homework (category 5) and students in the other categories of homework completion. Student status was coded as 1 for students who returned to the same university to study engineering the Fall semester after starting college. Status was coded as 0 for all students who either remained at the same university but switched to an academic unit other than engineering or left the university. In the analysis, homework completion category 5 (completed 95-100% of homework) was used as the reference category.

Analysis for RQ3

The results of the Kolmogorov-Smirnov and Shapiro-Wilk tests for normality (see Appendix Table A2) showed potential concern of normality of self-control scores for only the responses in homework completion category 5. Further investigation of the histograms and Q-Q plots reduced this concern and thus t-tests for normally distributed data were used in the analysis. Hedge's *g* was used to measure effect size (calculated using an effect size calculator[28]).

Results

RQ1: Students who had completed 95 to 100% of their homework in high school had the highest average GPA followed by students who had competed 90-95% of their homework in high school (see Table 2). Based on the results of the Two-Sample Kolmogorov-Smirnov Tests, the GPAs for groups 1 through 4 had significantly different distributions than group 5. The effect sizes as measured by Cliff's delta ranged from .26 to .42.

Table 2

Average and Standard Deviation of GPA for Each Group of Homework Completion and Results of the Two-Sample Kolmogorov-Smirnov Test for all Groups Compared to Group 5 with Effect Size

HW Group	Percent of Homework Completed	*M*	*SD*	*K-S test statistic*	Significance	Cliff's delta
1	Less than 80%	2.53	.87	.34	<.001	.38
2	80 – 84%	2.50	.80	.37	<.001	.42
3	85 – 89%	2.63	.85	.28	<.001	.32
4	90 – 94%	2.80	.69	.24	<.001	.26
5	95 – 100%	3.08	.74			

RQ2: Among the participants, the first year retention in engineering was 74%. Students who had completed 95-100% of their homework in high school had the highest retention rate (77.3%) followed very closely by the retention rate (76.7%) of the group who completed between 80 to

84% of their high school homework assignments. Students who completed less than 80% had the lowest retention rate (66%). The remaining retention rates are in Table 3.

Logistic regression results using category 5 as a reference category (n = 496 in category 5) are in Table 3. The results show overall that homework completion rate in high school was not a significant factor in predicting the likelihood a student was retained in engineering after one year (p=.111). The $R_{Cox\ \&\ Snell}^2$ was low (.013), which indicates that very little of the variability in retention rates is explained by the student's homework completion category. The analysis showed a significant difference in the likelihood of retention between students who completed 95-100% of their homework and students who completed less than 80% of their homework. Based on the odds ratio, students in category 5 were twice as likely to be retained for one year as students in category 1. The odds ratio was not significant for any other category.

Table 3.

Logistic Regression Results for Retention after One Year, with Category 5 as Reference Category.

HW Category	% Retained	*B*	*S.E.*	*Wald*	*df*	Sig.	Odds ratio	95% C.I. for Odds ratio	
								Lower	Upper
Overall				7.508	4	.111			
1	66%	-.555	.218	6.483	1	.011	.574	.374	.880
2	77%	-.035	.324	.012	1	.915	.966	.512	1.821
3	69%	-.413	.319	1.678	1	.195	.661	.354	1.236
4	73%	-.213	.222	.915	1	.339	.808	.523	1.250
Constant		1.224	.107	129.739	1	.000	3.402		

RQ3: Self-control scores ranged from 27 to 65. Table 4 shows the average and standard deviation of the self-control scores for each homework completion category. The group of students who indicated they completed 95-100% of their homework had the highest average self-control score, followed by the group who had completed 90-95% of their homework. The group who completed less than 80% of their homework had the lowest self-control score. The average self-control scores for groups 1-4 were all significantly different compared to group 5. The effect size was largest for the group who had completed the least amount of homework (see Table 4).

Table 4

t-test Results of Self-Control Scores Category 5 Compared to Other Categories

HW Group	*n*	*M*	*SD*	*t*	*df*	Significance	Hedge's *g*
1	127	42.45	6.61	8.37[a]	196	<.001	.83
2	61	44.74	4.86	4.66[a]	90	<.001	.55
3	53	44.47	7.06	3.39	539	<.001	.51
4	136	45.32	6.39	4.08	622	<.001	.41
5	488	47.95	6.59				

[a] t-test for unequal variance, all others were t-test for equal variance

Note: Sample size is slightly different than in GPA analysis due to survey questions completed and inclusion of 0.0 GPA students in this analysis.

Conclusions

The results of this study must be viewed along with its limitations. As with all self-reported survey data, it is unknown how accurately a given student's responses represent actual behavior. Before generalizing the results to another group of students, one must consider the participants in this study were all from one university which was less ethnically diverse than the national population of engineering students.

This study was correlational and thus no cause and effect can be determined, but the data does support a positive relationship between homework completion rates in high school and first semester performance of engineering students. The results also showed a relationship between homework completion rates in high school and self-control scores during the first week of the student's first semester in engineering school. On average students who completed 95 to 100% of their homework in high school performed better than students who completed a lower percentage of their homework in high school. The students who completed 95 to 100% of their homework also had higher average self-control scores than students who had completed their homework less frequently. The results are supported by research showing positive effects of homework related to learning, self-discipline and organizational skills[29].

Since analysis showed no significant difference in the likelihood of being retained after one year between students who completed 95-100% of their homework versus students who completed less than 95% but more than 80%, no conclusion can be made as to whether students who complete more homework in high school are more likely to be retained in engineering after one year. But since students who completed all or almost all (95-100%) of their homework in high school were twice as likely to be retained in engineering after one year as students who completed less than 80% of their homework, it seems wise to inform students who are considering engineering as a major, that being in the habit of not completing homework in high school might have a negative impact on their ability to remain in engineering.

It is unknown whether students with better self-control completed more of their assigned homework in high school or if completing assigned homework in high school helped students develop stronger self-control. As with performance, it is unknown why the increased homework completion rate in high school was related to higher average GPA in college. It could be by

completing more of the assigned homework the students gained a better understanding of the subject matter which later helped them perform better in their engineering courses. This conclusion must be taken with slight caution since this analysis did not take into account the amount of homework assigned, but instead looked at the percentage of the assigned homework that was completed. To us it seems more likely that consistently doing homework in high school helped students develop the discipline or time management skills to help them be successful in engineering school. Both time management[30] and self-control[31] have been shown to be related to performance in engineering.

Future research should seek to determine exactly how homework behaviors in high school affect performance in engineering. For example, investigating whether completing a higher percentage of assigned homework helps develop time management skills and self-control, or if students with better time management skills and higher self-control just do more homework in high school. Since there are mixed results as to the success of time management interventions in college students, adults and high school students[32], it would be valuable to understand if completing homework in high school leads to better time management skills.

In conclusion, these results taken together with the first part of this study[33], help us understand the homework behaviors of a group of engineering students and the relationship of these behaviors to first semester performance and first year retention in engineering. Performance and retention of engineering students is a complex issue with many interrelated factors affecting outcomes. These results point to the value of assigning homework in high school math and science courses and placing a high value (percentage of grade) on homework.

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Appendix

Table A1

SPSS Results of the Tests for Normality of GPA for Each Level of Homework Completion.

Homework completion category	Skew	Kurtosis	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
1.00	-.721	.461	.077	124	.068	.956	124	<.001
2.00	-.655	.481	.094	60	.200	.966	60	.088
3.00	-1.034	.609	.152	52	.004	.914	52	.001
4.00	-.891	1.842	.081	135	<.001	.951	135	<.001
5.00	-.962	.847	.106	497	<.001	.929	497	<.001

a. Lilliefors Significance Correction

Table A2

Results from Normality Tests on Self-Control

Homework completion category	Skew	Kurtosis	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
1.00	-.062	.171	.066	121	.200	.991	121	.574
2.00	-.037	-.979	.078	59	.200	.964	59	.078
3.00	-.001	.083	.092	52	.200	.985	52	.766
4.00	-.138	-.055	.076	132	.061	.984	132	.115
5.00	-.121	-.192	.052	483	.007	.995	483	.115

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

MatLab program to calculate Cliff's delta

```
% read in data from two samples D1 and D2

D1=xlsread('filename', range of first data set);
D2=xlsread('file name', range of second data set);

% count number of observations in each data set

N1=numel(D1);
N2=numel(D2);
```

```
% transpose file from data set 1 and create matrix which
% is each element in data set 1 subtracted from each
% element in data set 2

TD1=D1';
z=bsxfun(@minus,TD1,D2);

% count the number of elements in the new matrix that are negative, positive
% and zero

ctpos= numel(z(z(:)>0));
ctneg=numel(z(z(:)<0));
ctzero=numel(z(z(:)==0));

%calculate the Cliff's Delta effect size

esize=(ctpos-ctneg)/(N1*N2);

%display Cliff's delta

disp(esize)
```