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Disentangling The Effects Of Student Attitudes and Behaviors On Academic Performance

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Abstract
The interplay among motivation, ability, attitudes, behaviors, homework, and learning is unclear from previous research. We analyze data collected from 687 students enrolled in seven economics courses. A model explaining homework and exam scores is estimated, and separate analyses of ability and motivation groups are conducted. We find that motivation and ability explain variation in both homework and exam scores. Attitudes and behaviors, such as procrastination and working with others directly, affect homework score, but not exam score. These effects are not the same within all motivation and ability groups. Given that homework is the strongest predictor of exam score, we conclude that graded homework is beneficial to learning, and attitudes and behaviors related to homework may have an indirect benefit for exam performance. Suggestions are made as to how homework and course design might be managed to help students at different ability and motivational levels maximize learning.

Keywords
Homework, motivation, study behaviors, academic performance

Instructors assign homework assuming, at least implicitly, that homework enhances student learning, deepens their understanding of the material, and helps them prepare for examinations. Becker (1997) reports that between a quarter and a half of introductory economics instructors assign problem sets. Homework and the practice it provides are viewed as a necessity in courses such as statistics, which focus on developing quantitative problem-solving skills (Williams, 2012). Recently, the development of online homework systems and technology has allowed instructors to use graded homework in large classes, and the market for such systems appears to be growing. But it is important to specify for which students and under what conditions homework helps student learning. The link between homework and student achievement is far from clear. Various studies have reported that the effect of homework on actual achievement may be positive, negative or nonexistent. Further, this effect may be confounded with and/or dependent on psychological factors such as ability and motivation, behaviors such as procrastination or working with others, and demographic characteristics.

In this paper we attempt to clarify the relationships between student characteristics, behaviors, homework, and learning. First, motivation and ability effects on homework and examination scores are examined. Next, factor analysis is used to explore correlations between attitude and behavior measures. Third, a path model predicting homework and examination scores from ability, motivation, attitudes, and behaviors is estimated. Finally, separate analyses of ability and motivation groups are conducted to determine whether these variables may have different effects in different groups.

Previous research on homework effects

Comparing a group of managerial accounting students completing quantitative homework with a group who did not, Rayburn and Rayburn (1999) report consistent improvement on examination performance for the group that was given assigned homework. Arasasingham, Martorell, and McIntire (2011) find that homework score is a significant predictor of final examination score in a 13-section sample of chemistry courses.

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Drelick, Henry, Richards-Babb, and Robertson-Honecker (2011) report that substituting graded homework for quizzes increased the "pass rate" (proportion getting a C or better) in chemistry courses by 4-12%. However, Peters, Kethley and Bullington (2002), report requiring homework in an operations management course did not increase student performance on examinations. In fact they suggest that homework may have a negative effect on overall performance because students in the graded homework group may actually reduce effort toward the end of the semester. The authors suggest that "perhaps students in general allocate a certain amount of their time to studying, and in this course that amount was the result of a 'zero sum' game involving the other courses that the students were taking" (p. 343). In other words, students make conscious decisions about how much effort they need to put into homework in each of their courses in order to maximize returns. Emerson and Mencken (2013) argue that graded homework produces better outcomes than optional or ungraded homework in microeconomics courses. Similarly, Parker and Loudon (2013) report that students who were given extra credit for using an online homework system were more likely to complete the homework. However, Dillard-Eggers, Wooten, Childs, and Coker (2008) find no difference between required and optional homework in accounting courses.

In recent years, there has been a move toward the use of online tools to administer homework assignments. Many schools make use of course management systems such as WebVista or Moodle, and their use has grown dramatically over the past few years. (See Smith, Salaway, & Caruso 2009, for significant evidence of this trend.) Textbook publishers have developed course management systems in a wide variety of disciplines. These systems can reduce the "cost" of grading by reducing instructor time spent, and/or customize assignments according to students' performance on previous assignments or pretests.

The advent of homework management systems spurred research comparing the effectiveness of online homework versus traditional homework. A growing body of literature across disciplines finds online homework to be at least as effective as traditional homework. For some representative studies, see

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Bonham, Beicher, & Deardorff (2003); Drelick et al. (2011); Dufresne, Mastre, & Rath (2002); Emerson & Mencken (2009); Hauk & Segalla (2005); Porter & Riley (1996); and Williams (2012). A recent study by Arasasingham et al. (2011) has also demonstrated that the benefits of online homework are consistent across different sections, instructors, and years of the same course.

Previous research on motivation and study behaviors

Given the generally consistent finding that homework has benefits, researchers suggest the need to move beyond group comparison studies and focus on within group comparisons (Artino, 2007). Underwood (2009) challenges investigators to ask whether some learners gain more from the use of digital technologies than others, noting that "it would be disingenuous to suggest that all learners benefit from a technology supported learning experience" (p. 20). Recent research in postsecondary education has emphasized factors such as motivation, self-regulation, collaboration, and procrastination.

One strand of this research has focused on the relationship between motivation and the use of self-regulated learning strategies. Zimmerman (2008) views self-regulated learning as "proactive processes that students use to acquire academic skill, such as setting goals, selecting and deploying strategies, and self-monitoring one's effectiveness" (p. 166). Sustained self-regulation of learning is related to students' motivational feelings and beliefs. Self-regulated students are generally more motivated and are higher achievers (Bembenutty & White, 2009; Bempechat, 2004). They establish a productive work environment, use resources effectively, and hold positive motivational beliefs about their capabilities and the value of learning (Schunk & Zimmerman 1994; 1998). Hoskins and van Hoof (2005) describe students who demonstrate an "achieving orientation" as strategic, organized, competitive, able to work effectively, aware of the implication of academic demands, and having high achievement motivation. These students were more likely to use WebCT to access course information and to engage in dialogue with others. The authors conclude that "a strategic student might be inclined to use any tool that might facilitate their achievement" (p. 189).

Using Structural Equation Modeling, Kusukar, Croiset, and Cate (2012) provide evidence that motivation is important in determining academic performance among medical students through good study strategy and high effort. Fraser and Killian (2005) report that students who lack motivation put in less effort, which in turn leads to poor academic performance.

Based on these studies, it is reasonable to conclude that motivation influences performance through its effect on self-regulatory behaviors and study strategies. Another strand of research has focused on the strategies themselves. Which strategies do self-regulated learners use? Which specific behaviors are effective? How do they work to influence performance? Self-regulated students engage in increased effort by completing supplemental problems, managing time effectively, and seeking help in solving problems (Albara & Lokena, 2010; Ramdass & Zimmerman, 2011; Yukseltuk & Bulut, 2009). Using a sample of 257 undergraduate students in an introductory psychology class, Komarraju and Nadler (2013) demonstrate that self-regulation strategies such as effort regulation, completing supplemental problems, and help-seeking are significant predictors of variance in grade point average (GPA). Zimmerman (2008) reports a positive correlation between self-regulatory strategies and measures of course performance.

Parker and Loudon (2013) find that "work ethic" is positively correlated with the use of extra study problems and negatively correlated with collaboration with other students. They report that students with a lower work ethic score are more likely to collaborate, but collaboration is not necessarily associated with better performance. Caplan and Gilbert (2008) investigate the relationship between procrastination and performance on online assignments. Analyzing assignment start times and deadlines, they demonstrate that non-procrastinators obtain higher scores, controlling for GPA. Using a similar methodology and measuring starting and submission times in an online homework system, Wang and Englander (2010) report that both initiation and submission procrastination are predictive of lower grades, but submission procrastination has a stronger effect.

Self-efficacy, the belief in one's ability to complete a task, is also important to performance. Bandura (1993) suggests that "self-regulatory skills will not contribute much if students cannot get themselves to apply them persistently in the face of difficulties, stressors, and competing attractions" (p. 136). Klassen, Krawchuck, and Rajani (2008) argue that *self-efficacy for self-regulation*, the belief that self-regulation is possible and will be successful, is key. They find that self-efficacy for self-regulation is negatively related to procrastination and positively related to higher grades.

The interplay among these various factor is unclear. For instance, Linnenbrink and Pintrich (2002) depict a model in which motivation both affects and is affected by variables such as learning strategies and self-regulation. How do motivation and study strategies influence homework and overall course performance? Is the effect the same for all students? We find few answers to the latter question. Klassen et al. (2008) found that the negative effect of procrastination was greater for those with lower GPAs. Parker and Loudon (2013) found that students who used an online homework system more consistently performed better, gained more benefit from working additional problems in the textbook, and were less affected by collaboration. These findings are not conclusive, but they suggest that the relationship between study behaviors and learning outcomes may not be the same in all ability or motivation groups. This study attempts to address this gap in the literature.

Methods

Sample and data

Data for this analysis come from an earlier study by Doorn, Janssen, and O'Brien (2010). The purpose of that study was to examine student attitudes and approaches to online homework. Students in fourteen sections of seven economics courses were surveyed in the fall semester of 2008. The courses were introductory and intermediate macro- and microeconomics, applied statistics, money and banking, and managerial economics. Graded online homework was a component of each

of these courses. The surveys were administered during the final two weeks of the semester. Survey responses were later linked to homework grades, examination grades, and overall course grades. While combining courses does not allow the examination of differences by topic or level of difficulty, it does increase sample size and generalizability.

Demographics of the sample are presented in Table 1. About two thirds of respondents were male, and about half were sophomores. The majority intended to major in a business discipline or economics.

Table 1. Sample Demographic Characteristics

Gender	
Male	437
Female	248
Didn't report	2
Year in School	
Freshman	41
Sophomore	341
Junior	188
Senior	101
Other	14
Didn't report	2
Major	
Business/Economics	524
Liberal Arts	39
Education/Human Services	20
Science/Engineering/Medicine	94
Fine Arts	4
Didn't report	6

Measurement of concepts and variables

Comparison of learning outcomes across courses presents a challenge; courses vary in difficulty, content, number and type of homework assignments, and presentation. Arasasingham et. al. (2011) used normalized examination scores to achieve comparability across multiple courses and sections. Following their example, we use as dependent variables the averages of all homework scores and all examination scores, transformed to Z scores. Using transformed averages has the advantages of being normally distributed (allowing the use of OLS regression),

smoothing out the effect of a single outstanding or disastrous score, and controlling for differences in the number of assignments and examinations. Though it might be argued that overall course grade is a better indicator of learning outcome, it cannot be used in this study, because homework scores are incorporated into the course grade.

Self-reported motivation and cumulative grade point average are treated as exogenous variables in this study. Students rated their own "motivation to do well in this course" on a scale of "very high," "somewhat high," "average," "somewhat low," and "very low." We acknowledge that this measure is subjective and that motivation is in reality much more complex. Since studying motivation was not the original purpose of the survey, this is the only motivation measure we have available. But we believe that a self-report does have face validity; not only is motivation subjective, students are able to compare their own motivation in one course to motivation in other courses. Self-reported cumulative grade point average is the only measure of ability we have available. (See Grove, Wasserman, & Grodner, 2006; Gurung, Weidner, & Jeske, 2010; and Wang & Englander, 2010 for a discussion of the use of GPA as a proxy for academic aptitude.)

Other variables used in this analysis are the following.

1. A series of items measuring attitudes about the online homework system:

Submitting assignments online worked well.
The assignments helped me understand the material.
The assignments helped me prepare for the tests.
I liked being able to work on the assignments at my own pace.
The online system provided helpful feedback.
The instructor provided helpful feedback on the assignments.
I would have done the online assignments even if they had not counted toward my grade.
I would recommend that this system be used in other courses.

Response choices for the above were: Strongly disagree, disagree, no opinion, agree, strongly agree.

2. A series of items measuring how respondents used course materials and approached the homework.

How often and in what ways did you typically approach the practice questions? (before doing the graded assignment, at the same time as the graded assignment, didn't do the practice questions)
How often and in what ways did you typically use the textbook? (read the assigned sections of textbook be before starting to work on an assignment, read only the sections of the textbook that would help with specific questions in the assignment, didn't read the textbook until it was time to study for a test, didn't read the textbook much at all.
When did you typically start working on a homework assignment? (more than two days before it was due, one to two days before it was due, less than a day before it was due).
With whom did you typically work on an assignment? (usually worked alone, usually worked with other students in the class., usually worked with a tutor, usually worked with someone not in the class)

Dummy variables were created from the latter two items above. "Procrastinated" is defined as typically starting assignments less than a day before they were due. "Worked with others" is defined as working with anyone else on homework, including classmates, tutors, and persons not in the class.

3. A series of items measuring respondent's opinions of online versus traditional homework:

What is your overall impression of online homework vs. traditional (paper) homework? (didn't much like, don't mind but don't like a lot, like it)
Compared to traditional (i.e., "pencil and paper" assignments), would you say that online homework *---requires more or less assistance from instructors and/or tutors? (more, about the same, less)*
--- takes more time or less time to complete and submit (more, about the same, less)
--- that you learned more or less using online homework? (more, about the same, less)
I think assigned and graded homework in general is (useful in learning the material, no more useful than ungraded homework, no more useful than studying examples or already-worked-out problems in the lectures or text, useless).

4. Demographics: Gender (dummy variable, 0 = female, 1 = male) and year in school (1= freshman through 4 = senior; 14 cases who selected "other" excluded) are used as control variables in regression models.

Results

Motivation and Ability

In order to examine differences between students in the top, middle, and bottom groups, motivation and GPA were approximately trichotomized as shown in Table 2. Categories were chosen to create the most equal distribution possible into three groups.

Table 2: GPA and Motivation Trichotomized

GPA Category	Frequency	%	Motivation Category	Frequency	%
Under 3.0	284	42.1	Average or below	175	25.6
3.0-3.49	249	36.9	Somewhat high	306	44.8
3.5 or higher	142	21.0	Very high	202	29.6
Valid cases	675	100.0	Valid cases	683	100.0

It should be noted that the most motivated students are not necessarily those with the highest GPA. There are highly motivated students with low GPAs and less motivated students with high GPAs, as Table 3 shows.

Table 3: GPA by course motivation

	Course Motivation			
GPA	Average/below	Somewhat high	Very high	Total
Under 3.0	100	129	54	283
3.0-3.49	59	115	74	248
3.5 or higher	13	59	70	142
Total	172	303	198	673

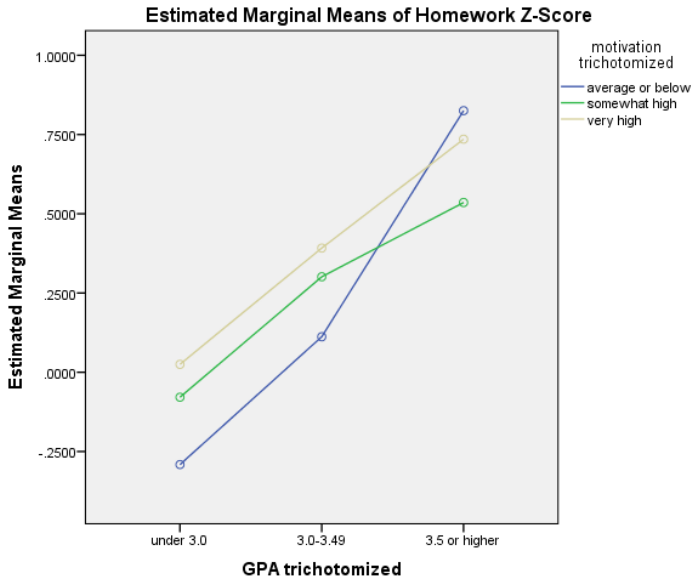
Two-way analyses of variance were performed using GPA and motivation as factors and homework Z score and average examination Z score as dependent variables. The ANOVA results for homework are displayed in Table 4, and a graph of the means is displayed in Figure 1. Only GPA has a significant main effect on homework scores. While it appears that the effect of GPA is stronger for those with the lowest motivation level, the interaction is not statistically significant.

Table 4: ANOVA Summary Table for effects of GPA and Motivation on Homework Z Score

Source	Type III Sum of Squares[b]	df	Mean Square	F	Sig.
Corrected Model	71.840[a]	8	8.980	15.715	.000
Intercept	35.596	1	35.596	62.291	.000
GPA	45.608	2	22.804	39.906	.000
Motivation	2.570	2	1.285	2.249	.106
GPA * Motivation	2.356	4	.589	1.031	.391
Error	379.441	664	.571		
Total	474.915	673			
Corrected Total	451.281	672			

a. R Squared = .159 (Adjusted R Squared = .149)
b. due to correlations between the factors, sums of squares may not add up to the total

Figure 1: Mean Homework Z scores by GPA and Motivation



The ANOVA results for average examination score are displayed in Table 5, and a graph of the means is displayed in Figure 2. Both GPA and motivation have significant main effects on examination scores. These effects appear to be independent of one another. In general, high GPA and high motivation are each associated with higher examination scores, but there is no interaction. While motivation appears to have a smaller effect

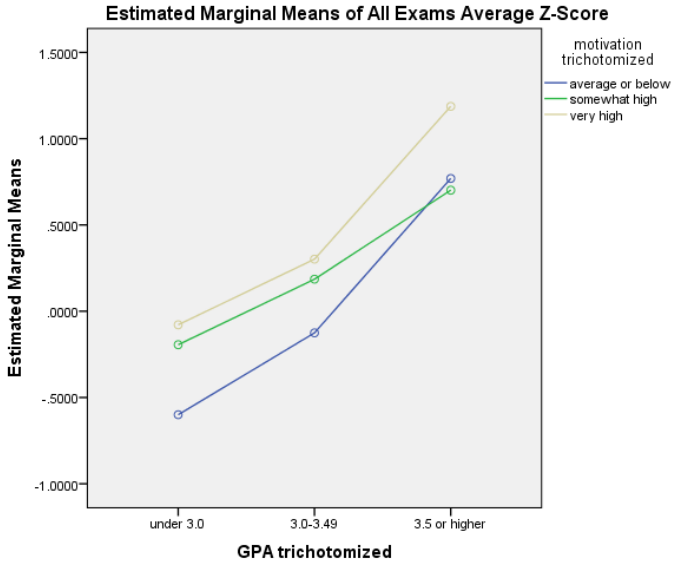
on examination scores among those with the highest GPA, this apparent interaction is not statistically significant.

Table 5: ANOVA Summary Table for the effects of GPA and Motivation on All Examinations Z Score

Source	Type III Sum of Squares[b]	df	Mean Square	F	Sig.
Corrected Model	178.377[a]	8	22.297	35.770	.000
Intercept	25.125	1	25.125	40.306	.000
GPA	88.158	2	44.079	70.714	.000
Motivation	13.772	2	6.886	11.047	.000
GPA * Motivation	4.144	4	1.036	1.662	.157
Error	413.902	664	.623		
Total	602.153	673			
Corrected Total	592.279	672			

a. R squared = .301 (Adjusted R Squared = .293)
b. due to correlations between the factors, sums of squares may not add up to the total

Figure 2: Mean Examination Z scores by GPA and Motivation



To summarize, GPA, which we are using as a proxy for ability, has a positive effect on both homework and examination scores. Motivation has a positive effect on examination scores only. In later sections, we examine the effects of attitudes and behaviors, in conjunction with motivation and ability, on homework and examination scores.

Exploring Response Structures

It is reasonable to assume that specific behaviors and attitudes about homework may be correlated with each other. Gurung et al. (2010), using a factor analysis of a long list of study behaviors, found that these behaviors reflected underlying cognitive and metacognitive dimensions. Although the online homework survey was not designed for the purpose of creating scales, inspection of correlations (not shown here) suggests that there may be substantively important patterns of relationships among the items; these patterns may loosely fit the concepts of self-regulation and self-efficacy described in the literature.

In order to examine this possibility, an exploratory factor analysis was performed on the attitude and behavior variables. Prinicipal components extraction and orthogonal rotation were used. The advantages of this approach are 1) data reduction allows inclusion of many of the items in the survey and 2) factor scores are produced that are uncorrelated with each other, have substantively important interpretations, and can be used as predictor variables (Johnson & Wichen, 1992).

The results of this analysis, in the form of the rotated components matrix, are displayed in Table 6. Factor loadings of .5 or higher are highlighted in bold. Four factors emerge from the analysis. We call them 1) "Homework attitudes factor" (represents positive attitudes about online homework and its effectiveness); 2) "Study behaviors factor" (represents greater use of textbook and practice problems, and less willingness to do homework unless it is graded); 3) "Perceived effort required factor" (represents perception that online homework requires more assistance and more time than pencil and paper homework); and 4) "Usefulness of homework factor" (opinion that assigned homework is useful). Factors 1 and 2 might very loosely be considered to reflect self-efficacy and self-regulation, respectively. Factor 3 is named "perceived effort required" in the sense that students often equate time spent with effort. Believing that online homework requires more time and assistance may lead to the conclusion that online homework requires more effort. This factor thus reflects perception of required effort, rather than actual effort. Factor scores were saved and used in the regression models.

Table 6: Rotated Component Matrix for Factor Analysis of Attitude and Behavior Items

	Component			
	1	2	3	4
Approach to practice questions	-.068	**.710**	.002	.228
Typical textbook use	.093	**.628**	-.064	-.321
Overall impression of online versus traditional paper homework	**.689**	-.052	.298	.011
Compared to traditional HW, online HW requires more assistance	.175	-.109	**.712**	.188
Compared to traditional HW, online HW requires more time	.058	.163	**.715**	-.239
Compared to traditional HW, learned more with online HW	**.611**	-.251	.136	-.055
Feel assigned HW in general is useful	-.067	.060	-.023	**.862**
Online homework worked well	**.683**	-.108	.222	.027
Online homework helped understand material	**.795**	-.111	.000	-.069
Online homework helped prepare for tests	**.793**	.000	-.152	-.045
Liked flexibility in pace with online homework	**.665**	.046	.172	.048
System provided helpful feedback	**.493**	-.285	.152	-.199
Instructor provided helpful feedback	**.616**	.121	-.247	-.105
Would do homework even if not graded	.391	**-.575**	-.170	-.064
Would recommend online homework	**.853**	-.129	.116	-.067

Specifying the model

How do motivation, effort, and student characteristics work together to influence learning? What is the role of graded homework in this process? With cross-sectional data, we cannot sort out the causal relationships between motivation, behavior, and effort, but we can focus on their independent effects as predictors of performance. In doing so, avenues for improvement in the design and delivery of the course can be discovered. Based on the findings from the literature, we estimate a path model in which "all examinations average Z score" is treated as the dependent variable and overall indicator of learning outcome for the course. "Homework Z score" is an intervening variable through which individual characteristics, attitudes, and behaviors may indirectly affect learning. Year in school, gender, motivation, GPA, and working with others on homework are hypothesized to have a direct effect on average

examination score, as well as an indirect effect through homework. Homework-specific variables, such as procrastination and the factor scores, are hypothesized to affect homework only.

Parameter estimates

Standardized OLS regression coefficients for homework Z score and all examinations average Z score are presented in Table 7. Motivation and GPA have significant positive effects on homework Z score. GPA has the strongest effect among all of the variables in the model, while the effect of motivation on homework is moderate. A positive attitude about homework ("homework attitudes" factor) is the second strongest predictor. Procrastination has a negative effect on homework performance, while working with others has a positive effect. The "study behaviors" factor has a negative effect on homework score. As for the control variables, males score slightly higher on homework than females, and year in school has a negative effect. Altogether, this set of variables explains 28% of the variation in homework score. Clearly there are other variables that cause variation in homework performance that are not included in this model.

The explanation of examination scores is different in several important ways. First, course motivation has a stronger effect on examination score than homework score. Second, attitudes and behaviors such as procrastination, working with others, and the factor scores, directly affect homework score, but not examination score. Finally, homework score is the strongest predictor of examination score. The variables in the model account for almost 46% of the variation in examination scores; much of this appears to come from the homework effect.

Table 7: Standardized regression coefficients for homework Z score and all examinations average Z score

Independent variable	Homework Z score	All exams average Z score
Year in school	-.099**	-.029
Male	.096**	.155**
Course motivation	.077*	.143**
Cumulative GPA	.311**	.317**
Procrastinated (1 if yes)	-.100**	.040
Worked with others (1 if yes)	.098**	-.105**
HW attitudes factor	.237**	.048
Study behaviors factor	-.105**	.041
Perceived HW effort required factor	.083*	-.049
Assigned HW worthwhile factor	-.045	-.002
Homework Z-Score		.402**
R^2	.281	.458
F-ratio	24.214**	47.486**
N	631	631

*p< .05, **p < .01

Differences by GPA and motivation

To examine the possibility that homework and study behaviors might produce different effects for students in the top, middle, and bottom ability and motivation groups, the model above was run separately for each group. While separate regressions allow comparison of the effects of variables in each group, differences cannot be tested for significance.

Results for the GPA groups are presented in Tables 8 and 9. For homework Z score, motivation and study behaviors have stronger effects within the lowest GPA group, while perceived homework effort required has a substantially stronger effect for the highest group. Procrastination negatively impacts the lowest GPA group the most, while working with others is most beneficial to the lower group. A positive opinion of online homework has a positive effect in all three groups. The proportion of variation explained by the model is slightly higher among the highest GPA group.

In the model for examination scores, homework score stands out as the strongest predictor. This effect of homework is strongest among the highest GPA group. A positive attitude

about homework is significant in the highest GPA group. Motivation has a positive effect in all three groups, and collaboration has a negative effect. The model explains more variation in examination scores among the highest GPA group.

Table 8: Standardized regression coefficients for homework Z score, by GPA group

	GPA Group		
Independent variable	< 3.0	3.0-3.49	3.5 – 4.0
Year in school	-.037	-.148*	-.144
Male	.145*	-.002	.255**
course motivation	.114*	.077	.072
Procrastinated (1 if yes)	-.145*	-.097	-.100
Worked with others (1 if yes)	.197**	-.012	.030
HW attitudes factor	.263**	.219**	.201*
Study behaviors factor	-.129*	-.131*	-.046
Perceived HW effort required factor	.069	-.060	.326**
Assigned HW worthwhile factor	.043	.164**	.111
R^2	.221	.148	.285
F-ratio	8.047**	4.291**	5.439**
N	265	233	133

*p< .05, **p < .01

Table 9: Standardized regression coefficients for all examinations average Z score, by GPA group

	GPA Group		
Independent variable	< 3.0	3.0-3.49	3.5 – 4.0
Year in school	-.105	.082	.054
Male	.175**	186**	.110
course motivation	.184**	.106	.177**
Procrastinated (1 if yes)	.003	.050	.072
Worked with others (1 if yes)	-.131*	-.092	-.142*
HW attitudes factor	.002	.016	.211**
Study behaviors factor	.072	.065	-.057
Perceived HW effort required factor	.004	-.103	-.017
Assigned HW worthwhile factor	-.027	.041	-.053
Homework Z-Score	.396**	.457**	.591**
R^2	.272	.265	.564
F-ratio	9.502**	7.999**	15.798**
N	265	233	133

*p< .05, **p < .01

Results for the motivation groups are presented in Tables 10 and 11. GPA has a strong effect on homework score for all levels of motivation, but the relationship is not as strong for the "somewhat high" group. The homework attitudes factor has a strong positive effect in the "average or below" group, and a moderate positive effect in the "somewhat high" group. Procrastination has a slightly more detrimental effect on homework among those who say their course motivation is "very high." Working with others is most beneficial to the "somewhat high" group. The effect of perceived homework effort required becomes stronger as motivation increases.

In predicting examination scores, homework and GPA stand out as the strongest predictors. Working with others on homework has a stronger negative impact on examination scores for those who are less motivated, as does perceived effort required for homework.

Overall in the within group analyses, there is a slight tendency for males to score higher on both variables than females, and for those who are farther along in school to score lower.

Table 10: Standardized regression coefficients for homework Z score, by motivation group

Independent variable	Motivation Group		
	Average or below	Somewhat High	Very High
Year in school	-.167*	-.117*	.004
Male	.123	.055	.143*
GPA	.359**	.232**	.389**
Procrastinated (1 if yes)	-.116	-.062	-.202**
Worked with others (1 if yes)	.036	.123*	.086
HW attitudes factor	.382**	.215**	.102
Study behaviors factor	-.063	-.120*	-.159*
Perceived HW effort required factor	-.003	.116*	.136*
Assigned HW worthwhile factor	-.041	-.073	-.033
R^2	.371	.194	.296
F-ratio	9.839**	7.396**	8.145**
N	160	287	184

*p< .05, **p < .01

Table 11: Standardized regression coefficients for all examinations average Z score, by motivation group

Independent variable	Motivation Group		
	Average or below	Somewhat High	Very High
Year in school	-.104	-.017	.006
Male	.262**	.177**	.082
GPA	.200**	.330**	.400**
Procrastinated (1 if yes)	.037	.125	-.040
Worked with others (1 if yes)	-.143*	-.140*	- 065
HW attitudes factor	.003	.083	.028
Study behaviors factor	.078	.040	.004
Perceived HW effort required factor	-.189**	-.020	.032
Assigned HW worthwhile factor	.057	.012	-.097
Homework Z-Score	.433**	.458**	.343**
R^2	.431	.439	.417
F-ratio	11.288**	21.561**	12.391**
N	160	287	184

*p< .05, **p < .01

Discussion

Several important conclusions can be drawn from these analyses.

1. Motivation and ability matter, but in different ways. The ANOVA indicates that while each of these variables affects homework and examination scores in the expected way, these effects are independent of each other. Vansteenkiste, Sierens, Soenens, Luyckx, and Leno (2009) argue that a high level of motivation does not necessarily yield a more desirable outcome if the motivation is of poor quality. Examination of means suggests that high ability might compensate to some extent for low motivation and vice versa. In addition, the separate analyses of GPA and motivation groups suggest that different variables explain achievement when groupings are based on GPA than when they are based on motivation.

2. Ability (as measured by GPA) is a strong predictor of both homework and examination scores. Even in the presence of controls for motivation, attitudes, and behaviors, GPA explains considerable variation in the dependent variables. Since it is difficult or impossible to influence the ability of students who

enroll in a course, it is important to determine which strategies and approaches are successful with which students.

3. Graded homework matters. Homework score is a strong predictor of examination score, even with motivation, ability, attitudes, and behavior controlled. This holds across all models and is consistent with the literature previously described that finds significant homework effects. Our models explain more variation in examination scores than homework scores. This may be due to the strong relationship between homework and examination performance – in short, homework score predicts examination score.

4. The approach to homework matters. How and when a student approaches homework influences homework performance, even in the presence of controls for ability and motivation. A positive attitude about homework has a positive effect on homework score. (It is possible, however, that students who do well on homework receive positive reinforcement from good grades, thus influencing their opinion of the homework). Procrastination results in lower homework scores, while working with other students may improve scores. Procrastination may deprive a student of the necessary time and resources required to do well. Collaboration offers a student the opportunity to check his/her work against others, to learn from others, and perhaps to get answers from others.

The perception that online homework requires more effort is weakly predictive of a higher score. The "study behaviors" factor has a negative effect on homework. This may seem contradictory, but it is possible that students who find the homework more difficult also find it necessary to put more effort into reading the textbook or using practice problems. These may be the students who struggle the most. It is also possible that these students are studying less strategically (Gurung et. al. 2010; Hoskins and van Hoof, 2005). The "assigned homework is worthwhile" factor is the only factor that is not significant in this model. Perhaps it matters less that students approve of homework than that they have some incentive to do it.

5. Homework-related attitudes and behaviors affect examinations indirectly through their effect on homework. This finding may be related to self-regulation and self-efficacy.

Ramdass and Zimmerman (2011) identify 3 components of self-regulation: motivational, cognitive and metacognitive. Our research suggests that all of these components may be important. Motivation is more strongly related to examination score than it is to homework score. Homework may be more within the student's control than an examination. Seeking help, using books and other resources, and sharing answers are not typically available on examinations; often it is simply studying and preparation that explain examination scores. The homework factors are not directly predictive of examination score, but to the extent that homework prepares a student for examinations, the effect of these variables on examination scores could be substantial but indirect. Working with others positively affects homework score but negatively affects examination score. Students may be able to benefit from others' work on the homework, but if they allow others to do homework for them, they may be less prepared for examinations. In this sense, collaboration may be a "dangerous distraction" (Gurung et al., 2010). Students with high ability and/or motivation may be less negatively affected by such distractions. Similarly, Parker and Loudon (2013) report that collaboration is more common among those who are less motivated, and that it does not seem to have a beneficial effect.

6. The effects of attitudes, behaviors, and homework are not equal for all students. Among those whose GPA is in the middle and high groups (3.0 or higher), perceived homework effort required and positive attitudes about homework have the strongest effects on homework score. But among those whose GPA is below 3.0, other variables also have significant effects. Motivation in this group has a positive effect on homework. This group is also more negatively affected by procrastination and more positively affected by working with others. It may be that those of lower ability are more influenced by external factors and decisions (Klassen et al. 2008; Gurung et al. 2010).

The positive effect of homework on examination scores is strongest for the high ability group. The model also explains the most variation in examination scores in this group (R^2 = .526). It may be that the highest achievers use homework more effectively in preparing for examinations. As Klassen et al.

(2008) suggest, those with a higher GPA may also have a higher self-efficacy for self-regulation; that is, they are more confident that the use of self-regulatory behaviors will work for them. Interestingly, working with others on homework is slightly more detrimental to examination scores in this group, though it has a negative effect in all groups. Perhaps higher ability students work more efficiently alone. Parker and Loudon (2013) report that students who were most "engaged" with homework tended to work alone. As with homework, procrastination is most detrimental to examination scores in the lowest GPA group. Klassen et al. (2008) also report this interaction between GPA and procrastination.

Separate analyses by motivation show that the homework attitudes factor has a positive effect in the two less motivated groups. This might indicate that liking online homework contributes to higher scores where motivation is lower. Parker and Loudon (2013) suggest that the immediate feedback from online homework may be rewarding, even for those who are less engaged with it. These findings are also consistent with the "self-efficacy for self-regulation" (Klassen et al., 2008) or "achieving orientation" (Hoskins and van Hoof, 2005) explanations.

Working with others seems most beneficial to homework for the middle motivation group. Procrastination has a slightly worse effect on homework among the most motivated. We find no explanation for these findings in the literature, but speculate that the most motivated students may produce higher quality homework in general, and procrastination deprives them of the necessary time to achieve that high quality. The motivation of those in the middle may be increased by the social effect of working with others. The least motivated students will neither benefit as much from collaboration nor lose as much from procrastination as those in the middle.

GPA, which we use as a proxy for ability, has a very strong effect on examination score in all three motivation groups, but it is strongest for the most highly motivated group. Homework has a stronger effect on examination scores for those who are *less* motivated. It appears that the experience of homework enhances learning even when students care less about the outcome. Those who are less motivated may still do well if they

are able to effectively connect homework content with examinations. Working with others on homework has a stronger negative impact on examination scores for those who are less motivated, as does perceived effort required by homework. It may be that these "dangerous distractions" (Gurung et al., 2010) are more detrimental for the less motivated.

With respect to the control variables of gender and year in school, there are slightly significant findings. Inconsistently across our models, males perform better than females, and those in higher years of school perform slightly worse than younger students. The literature is inconsistent on these variables as well, with some studies finding differences and others finding none. Further investigation of these differences is beyond the scope of this study.

Implications for instructors and course designers

It is important to consider how components of course design, especially online homework, might be managed to help students at different ability and motivational levels maximize learning.

1. Graded homework is useful and beneficial. These results are consistent with those of many other studies in suggesting that students learn and benefit from graded homework.

2. Online homework should work well, fit the course material, and provide feedback. The "homework attitudes factor" reflects a positive impression of the online homework system and this is consistently related to good performance. This factor covers both the technical aspects ("worked well," "let me work at my own pace") and perceived learning outcomes (feedback, understanding material, preparing for examinations) of online homework. The "effort required" factor suggests that the realization that online homework will require effort is also positively related to performance. The stronger effect of positive homework attitudes among those with lower motivation supports the value of individualized feedback for this group in particular. Instructors should make sure that accessing and using the system is easy and free of technical problems. Homework content should be explicitly related to the course content and to

examinations. This connection might be made by presenting homework questions in a similar way to examination questions, covering the same content, discussing homework in class, and suggesting that students review homework as part of their preparation for examinations. Instructors should demonstrate and discuss the link between graded homework and examination scores.

3. Students should be advised of the costs and benefits of specific approaches to homework. Instructors should discuss the relationship between procrastination and grades. Simple reminders of upcoming deadlines and the amount of time required to complete an assignment might help students avoid procrastination. Resources to which students can turn for assistance should be explicitly noted. Instructors should advise students that group work can be beneficial, but only if group members teach and learn from each other. Effective group work might be discussed and demonstrated.

4. Particular attention should be paid to students having difficulty with homework. This study has demonstrated that performance on homework may be an early indicator of a student's success in a course. If a student is earning low homework grades, the instructor could discuss the student's study strategies with him/her and identify potential areas for improvement. Procrastination and effort seem to have the strongest effects on homework among the lowest GPA group; these might be areas that the instructor could address with the student. To the extent that the instructor can assess motivation and ability, these factors should be considered in customizing recommendations. Opportunities to ask questions or do homework in class should be provided.

Implications for future research

This study has several weaknesses which might be addressed in future research.

1. *Design*. The original purpose of the study was to measure student opinions and experiences with online homework systems. Though learning outcomes were included in the data collection, the cross-sectional design makes it difficult to sort out the causal relationships between motivation, attitudes,

behaviors, and outcomes. Future studies may benefit from a longitudinal design, in which the time ordering of these variables could be determined and the direction of effects clarified.

2. Measurement of concepts. This study indicates that motivation is one important factor affecting students' success with homework and examinations, but we do not have a very detailed measure of motivation. Future studies might include the various dimensions or orientations related to motivation and determine which dimensions relate most strongly to the use of online homework and its outcomes. With respect to behaviors, we asked students to report their own study behaviors; however the use of online systems potentially allows some of these variables, such as the time when homework is started, the time spent on homework, the use of practice questions, etc., to be measured more precisely.

3. Sample and population represented. The participants in this study were enrolled in economics and statistics courses. On the one hand, the courses were diverse in terms of content and level, which makes comparability a problem, and combining them also produces a risk of hiding important differences. On the other hand, drawing all courses from the same department and group of majors might be considered too narrow. Future research could include a cross section of many more disciplines and subject areas, but it could also examine specific courses or types of courses. It would be important to determine whether the same approaches to homework work in different kinds of courses and with different populations of students.

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