Homework, Motivation, and Academic Achievement in a College Genetics Course

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Abstract: We conducted a mixed methods study in an upper-level genetics course exploring the relationships between student motivation, homework completion, and academic achievement at the college level. We used data from an open-ended questionnaire, homework grades and completion reports, and exam scores. We used these data sources to measure self-perceived motivating/demotivating factors and then tested these factors for correlation with homework completion and academic achievement. We found no significance in homework completion when considering credit or extra credit as a motivating factor. According to student reports they completed significantly more homework when considering reinforcement of content as a motivating factor. However, we found discrepancies between students' reported motivation and actual completion rates. Self-reported study style, self-perceived conscientiousness, intelligence, attitude, time commitments, and complexity of assignments had significant impacts on whether or not students completed homework assignments and impacted students' academic achievement. Overall, we found a positive relationship between homework completion and academic achievement within this upper-level college genetics course and provide implications for increasing student motivation.

Keywords: academic achievement; college student performance; genetics education; homework; motivation

INTRODUCTION

Homework is a well-established aspect of academic life. However, students sometimes question its validity and usefulness. As such, homework has often been the focus of academic researchers, who, responding to the concerns of students, parents, and teachers, have investigated the utility of homework at the K-12 level (Cooper et al., 1998; Cooper et al., 2006; Trautwein et al., 2006). Although there are some studies that highlight the benefits of homework completion among college students (Emerson & Mencken, 2011; Grodner & Rupp, 2013; Ramdass & Zimmerman, 2011; Trost & Salehi-Isfahani, 2012), further research into its utility at the college level is needed. This is especially true given the current push toward developing "flipped" classrooms. At the K-12 level, research shows that when students do not complete homework assignments, academic achievement is not beneficially affected (Cooper et al., 1998). Therefore, we think that it is important to understand why students do or do not complete their homework. We define homework as any academic, course-related task assigned by the instructor intended for students to carry out during non-class hours. Furthermore, we define academic achievement as the grade a student receives, either for a course or for a specific assignment. Previous studies performed at the college level suggest that credit and extra credit are strong motivators for homework completion (Carkenord, 1994; Ryan & Hemmes, 2005). Student characteristics may also influence homework completion and academic achievement (Trautwein et al., 2006). Some characteristics that are known to influence academic achievement include intelligence, conscientiousness, attitude, and study style (Busato et al., 2000; Laidra et al., 2007). Knowing why students do homework and how doing homework influences academic achievement can help instructors structure assignments to maximize completion, help students recognize and overcome demotivating factors, and provide evidence for the value of including homework assignments in college level curriculum.

THEORECTICAL FRAMEWORK

Trautwein et al. (2006) proposed a model of academic achievement in which various factors influence homework completion at the 8th grade level. We altered this model by replacing parental influence with social factors to better represent factors facing college students (Figure 1). We justify this change because the role of parents is typically less immediate for college students living away from home (e.g., in dorms). As such, the role that parents played in K-12 education (e.g., providing academic

expectations and assistance with homework) is transferred to students' peers in postsecondary education.

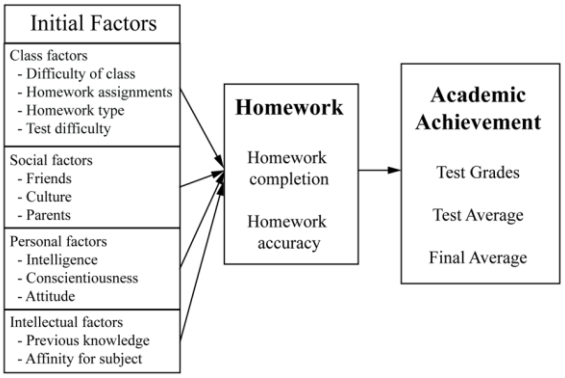


Figure 1. Theoretical framework of academic achievement and homework completion (adapted from Trautwein et al., 2006).

LITERATURE REVIEW

Homework is known to bolster student achievement at the K-12 level (Cooper et al., 1998; Cooper et al., 2006; Cooper & Valentine, 2001; Corno, 2000; Gurung, 2003; Keith, 1982; Keith & Cool, 1992; Paschal et al., 1984; Trautwein et al., 2002; Trautwein et al., 2006). Previous research on the benefits of homework completion on college students are linked to significant improvement in their test performance, higher retention rates in enrollment, and improved self-regulatory behaviors like motivation to study, self-efficacy, goal setting, and time management (Grodner & Rupp, 2013; Ramdass & Zimmerman, 2011). However, there have been limited investigations looking at homework and academic achievement in postsecondary settings. Cuadros et al. (2005) found that homework did not increase immediate achievement within an introductory chemistry lab setting. Student performance on homework assignments was not a good predictor for performance on practice tests issued randomly throughout the course. However, they found homework worked as an effective study tool for scheduled exams and that those who did well on assigned homework performed significantly better on those exams. Homework has also been documented as an important learning opportunity for college students (Leinhardt et al., 2007). While we know that the lack of completing homework does not offer any tangible benefit beyond freeing time commitments (Cooper et al., 1998), simply assigning homework does not guarantee either completion or improvements in student success.

Most investigations on student motivation for homework completion at the college level have focused on external incentives, including credit and extra credit (Carkenord, 1994; Ryan & Hemmes, 2005). In psychology, external incentives have been recognized as powerful motivating forces for some time (Chapman & Feder, 1917), and more recent research confirms their powerful role in human psychology (Flaro et al., 2007). As far as external incentives motivating homework completion go, credit has been shown to be one of the most powerful motivating forces. Ryan and Hemmes (2005) compared for-credit and no-credit homework completion across assignments and found that students are more likely to complete an assignment if it bears a credit contingency. Another study, by Tuckman (1998), reported that a required credit incentive of weekly quizzes caused greater improvements in achievement than the introduction of prescribed learning strategies. Michael (1991) argued that credit was the only feasible motivating factor that could be powerful enough to get college students to spend time away from friends, significant others, and unanticipated outings.

Extra credit is another potential motivator, but unlike required credit, its recorded effects vary considerably depending on the conditions in which it is applied (Boniecki & Moore, 2003; Carkenord, 1994; Junn, 1995; Walker et al., 2005). Carkenord (1994) found that by combining extra credit assignments with the ability to use those completed assignments as aids on tests, students completed extra credit assignments nearly 74% of the time. However, Walker et al. (2005) offered extra credit for students to participate in out of class research, yet this only yielded in a 38% participation rate. Although extra credit appears to be not as strong of a motivating factor as required credit, it has many other uses than merely getting students to complete assignments. Junn (1995) used extra credit to improve the achievement of students whose grades were poor, but not beyond the margin of redemption.

There could be many factors beyond credit and extra credit that influence student motivation toward homework completion. For example, Cote and Levine (2000) found a link between attitude and a positive academic experience. In their study, a student who comes to a university with the desire and motivation to learn is more likely to seek out and find positive academic experiences, triggering positive feedback loops between the student and the instructor or institution. In this way, students with a positive attitude are more likely to do well because they are more likely to discover, use, and continue to use the resources required to do so. This mindset could apply to homework as part of a positive feedback loop for students who use it as a study tool. Homework inculcates a mastery of the material, and a student benefits from that mastery, making them more likely to continue doing homework.

Laidra et al. (2007) found that intelligence is correlated with predicting high grades throughout all levels of K-12 education. However, Busato et al.

(2000) found that intelligence is not as strong of a predictor of academic achievement at the postsecondary level. Rather, conscientiousness is a better predictor of academic achievement than intelligence (Busato et al., 2000; Paunonen & Ashton, 2001), and is also positively correlated with effort for K-12 students (Laidra et al., 2007; Trautwein et al., 2006). While there are no studies linking intelligence and conscientiousness with homework completion, we expect that conscientious students will more likely complete homework assignments and perform better in a course.

Students choose to prepare for course exams in numerous ways. Bustato et al., (2000) identified four primary studying styles: a) undirected, a student does not distinguish the important material from the unimportant ones but rather tries to memorize all course content, b) reproduction directed, a student focuses on reproducing the content learned at the examination to obtain a good grade, c) application directed, a student focuses more on applying the content to real-world scenarios while studying, and d) meaning directed, a student focuses on understanding the meaning of the content and employs critical thinking to develop one's own views. Some research has found that choice of study style is positively correlated with academic achievement and positive attitudes about postsecondary schoolwork (Drysdale et al., 2001; Hong et al., 2004). However, Busato et al. (2000), found no positive correlation between any study style and academic achievement. Thus, more needs to be known about the relationships among motivation, intelligence, attitude, conscientiousness, study style, academic achievement, and homework completing at the postsecondary level.

Research Questions

The purpose of this study was to understand the role that homework plays in academic achievement at the college level. The research questions guiding our study were:

- What motivates/demotivates students to complete their homework?
- What is the relationship between homework completion and academic achievement?
- What student-reported characteristics are related to homework completion?

DESIGN

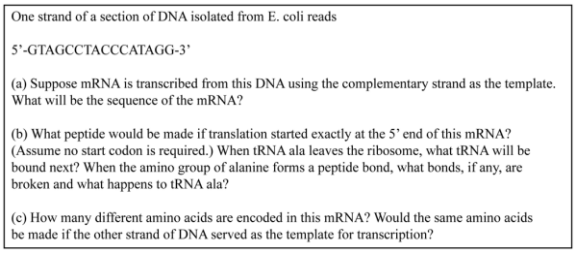
We conducted a mixed methods study with thirty one students from a four credit genetics course designed for upper-level life-science majors at a southern research university. All participants were assigned homework as part of the course and these assignments included graded and extra-credit Problem Packs and non-graded weekly homework. Problem Packs were comprised of problems similar to what students were provided on the exams. For the class, graded and extra-credit homework factored in students' course grades, but for this study we used only exam averages as our measure of academic achievement. We focused on test performance as our measure of academic achievement to correct for any influence homework scores may have had on student grades.

Data Sources

Our data came from student responses on an open-ended questionnaire and student grades on problem packs and five in-class exams.

Problem Packs

The instructor assigned seven problem packs; four were required for credit and three were for extra-credit. He wrote the assignments so the questions aligned with the current chapter assigned (Figures 2 and 3). Students had to complete each problem pack outside of class and sign a pledge stating that they completed the work individually. Problem pack due dates corresponded with exam dates.


One strand of a section of DNA isolated from E. coli reads

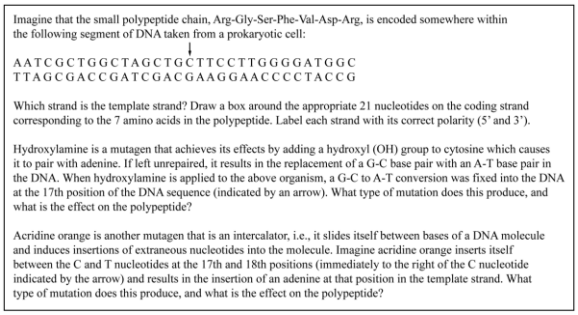
5'-GTAGCCTACCCATAGG-3'

(a) Suppose mRNA is transcribed from this DNA using the complementary strand as the template. What will be the sequence of the mRNA?

(b) What peptide would be made if translation started exactly at the 5' end of this mRNA? (Assume no start codon is required.) When tRNA ala leaves the ribosome, what tRNA will be bound next? When the amino group of alanine forms a peptide bond, what bonds, if any, are broken and what happens to tRNA ala?

(c) How many different amino acids are encoded in this mRNA? Would the same amino acids be made if the other strand of DNA served as the template for transcription?

Figure 2. Sample problem from Polyploidy and Transcription Problem Pack.


Imagine that the small polypeptide chain, Arg-Gly-Ser-Phe-Val-Asp-Arg, is encoded somewhere within the following segment of DNA taken from a prokaryotic cell:

AATCGCTGGCTAGCTGCTTCCTTGGGGATGGC
TTAGCGACCGATCGACGAAGGAACCCCTACCG

Which strand is the template strand? Draw a box around the appropriate 21 nucleotides on the coding strand corresponding to the 7 amino acids in the polypeptide. Label each strand with its correct polarity (5' and 3').

Hydroxylamine is a mutagen that achieves its effects by adding a hydroxyl (OH) group to cytosine which causes it to pair with adenine. If left unrepaired, it results in the replacement of a G-C base pair with an A-T base pair in the DNA. When hydroxylamine is applied to the above organism, a G-C to A-T conversion was fixed into the DNA at the 17th position of the DNA sequence (indicated by an arrow). What type of mutation does this produce, and what is the effect on the polypeptide?

Acridine orange is another mutagen that is an intercalator, i.e., it slides itself between bases of a DNA molecule and induces insertions of extraneous nucleotides into the molecule. Imagine acridine orange inserts itself between the C and T nucleotides at the 17th and 18th positions (immediately to the right of the C nucleotide indicated by the arrow) and results in the insertion of an adenine at that position in the template strand. What type of mutation does this produce, and what is the effect on the polypeptide?

Figure 3. Sample Problem from Exam 3.

Weekly Homework

The course instructor also assigned weekly homework to reinforce content covered in each chapter and prepare students for the problem packs and course exams. The questions came from the required textbook for the course (Klug et al., 2008). The instructor did not collect or grade these assignments; however, he often reminded and encouraged students to complete the homework each week. He also discussed and reviewed these questions in detail during weekly recitation sessions.

Questionnaire

We administered a questionnaire prior to the final exam on the last day of the course. The questionnaire consisted of 17 questions, eight multiple response and nine open-ended questions. We used this to identify student reported motivation for taking the course, their feelings about the course, homework and problem pack completion, how students viewed themselves compared to their peers in terms of motivation, intelligence, studiousness, responsibility, interest in school, value placed on school, and effort put into school, preferred study strategies, perceptions about the purpose of homework assignments, and personal motivating/demotivating factors for completing homework.

Data Analysis

We determined motivating and demotivating factors for homework completion by analyzing the questionnaire. We categorized students' top three motivating and demotivating factors for completing assignments in this course. Then, we ranked each categories based on the frequency of responses.

We compared student reported motivation with actual performance in terms of Problem Pack and homework completion, using a *t*-test to determine if there was a significant relationship between credit, extra credit, or reinforcement motivating factor and completion of the related assignment type. To determine this, we obtained the overall frequencies for credit and extra credit assignment completion by students from the instructor. When quantifying non-graded homework completion, we used student-reported completion rates provided on the questionnaire. We created a numerical scale that ranged from 0 (never) to 3 (always) based on student responses regarding how often they completed the weekly homework. We averaged student responses and divided by the maximum value, 3, reporting the result as a percentage.

Next, to address whether student homework completion related to academic achievement in this course, we ran a Pearson correlation comparing students' exam average against their completion of problem packs. We omitted student reported non-graded homework in order to minimize error.

We also ran a Pearson correlation measuring completion of problem packs as related to student reported intelligence, conscientiousness, and attitude. Conscientiousness and attitude were aggregate factors, comprising the mean student response across three composite characteristics. Conscientiousness included student reported studiousness, responsibility, and effort put forth in school. Attitude included student reported motivation, interest, and value for school. Intelligence was measured from students' response as an individual factor.

Finally, to measure the value of study style in promoting homework completion we first categorized student responses about how they studied for course exams into two study styles: whether students used homework as a study tool when preparing for exams or not. We tested each study style against completion of credit and extra credit problem packs using a *t*-test, omitting non-graded assignments.

RESULTS

Homework Completion

Student responses fell into a broad range of 12 categories for motivating factors and 13 categories for demotivating factors. Overall, students were most likely to complete homework assignments given for required course credit.

Motivating Factors

Students reported motivating factors that fell into 12 categories (Table 1). Out of all student responses, the top three motivating factors were reinforcement (28.75% of total responses), credit (18.75%), and extra-credit (11.25%). Responses placed into the "reinforcement" category were those that indicated that simply having to learn the material or wanting to master the material was a motivating factor, those placed into the "credit" category indicated that a credit contingency was a motivating factor, and similarly, those placed into the "extra credit" category indicated that extra credit was a motivating factor. Altogether, the top three factors composed 58.75% of all student responses.

Demotivating Factors

Students reported demotivating factors that fell into 13 categories (Table 2). The most common demotivating factors were "other commitments" (27.85%) and "unable to understand" (20.25%). Together, these two categories compose 48.1% of total student responses. They are followed up by both "too difficult" and "too long" (8.86%). This indicates that students' primary problems are not being able to find the time to complete their homework and being unable to understand the level of complexity required. And, while some students seemed to be easily distracted from homework, such as the student who listed "Good movie on HBO" as a demotivating factor, other students are very dedicated to completing their homework assignments, such as the student who listed "The only thing that would stop me is if there was some kind of emergency in my life . . ."

Responses placed into the "other commitments" category indicated that having other things to do was a demotivating factor. Those that were placed into the "unable to understand" category showed that the student literally could not comprehend the nature of the questions and that this was a demotivating factor, while responses placed in the "too difficult" category were those in which students indicated that they understood the nature of the questions, but the difficulty of the work was a demotivating factor. The "too long" category was for responses that showed

Table 1. Student reported motivating factors.

Motivating Factor	Percent n=80	Illustrative Responses
Reinforcement	28.75%	"To better educate myself and understand the material," "Information might be on exam"
Credit	18.75%	"If it's for a grade," "Required"
Extra Credit	11.25%	"Extra credit," "Extra credit for attempting problems"
Able to Understand	8.75%	"Can understand homework," "If I understood the material"
Free Time	7.50%	"Easy schedule," "Having free time"
Interest in Material	6.25%	"I like the material," "Can capture interest"
Concern for Grade	5.00%	"I need to maintain a high GPA and this is a 4 hour course," "Wanting to do well in the course"
Material Covered	3.75%	"We go over the material before it's due," "Going over more examples in class like those in the PP and homework"
Self-Assessment	3.75%	"To test my knowledge," "Determine what I know and don't know"
Not Too Long	1.25%	"Less problems"
No Distraction	1.25%	"No good movies on"
Other	3.75%	"We get ample time to do it and the teacher is willing to help," "It's against my work ethic to turn in an incomplete assignment"

students' feelings about excessive length of assignments or the time that it took to complete assignments was a demotivating factor.

Completion

Overall, students completed 79.03% of all credit assignments, 64.56% of all extra-credit assignments, and 56.99% of all non-graded assignments. This contrasts with student-reported motivation, which listed "Reinforcement" as the top motivator, "Credit" as the second, and "Extra-credit" as the third. Non-graded assignment completion was derived from student-reported data, and as such may be less accurate than completion levels for credit and extra-credit assignments, which were derived from student grades.

A *t*-test revealed the relationship between listing credit and completing problem packs as not significant ($t(29) = -.497$, $p = .623$). Within the same sample, we found no significant relationship between listing extra credit as a motivating factor and the actual completion of extra credit problem packs ($t(29) = -2.13$, $p = .83$). Students who listed reinforcement as a motivating factor tended to report that they completed more non-graded homework assignments than those who did not ($t(29) = -2.64$, $p < .05$).

Table 2. Student reported demotivating factors.

Demotivating Factor	Percent	Illustrative Responses
Other Commitments	27.85%	"Other class work," "Not having enough time"
Unable to Understand	20.25%	"I did not quite understand the material when given the problems," "Not understanding questions"
Too Difficult	8.86%	"Too hard; don't know how to do it," "Difficulty of subject matter"
Too Long	8.86%	"Length of problems," "Time it takes to work them"
Not for Credit	7.59%	"Not for a grade," "Counts little"
Boring or Redundant	3.80%	"Just not interesting," "Lots of very similar, repetitive problems"
Distraction or Procrastination	3.80%	"Good movie on HBO," "Procrastination/Avoidance"
Personal Feelings	3.80%	"Frustration after not understanding it," "Don't feel like it"
Extra Credit	3.80%	"It's extra credit," "Extra credit"
Material Not Covered	2.53%	"Material not focused on as much during lecture," "We don't go over the material in class before it's due"
No Outside Aid	2.53%	"Don't know who could help," "Not enough help from outside sources"
Extenuating Circumstances	2.53%	"The only thing that would stop me is if there was some kind of emergency in my life. I can't think of anything else that would stop me," "Severe illness"
Other	3.80%	"Redundant/Too difficult," "The lectures are not interesting"

Homework Completion and Academic Achievement

A Pearson correlation seeking 2-tailed significance revealed a strong correlation between homework completion to academic achievement, $r(29) = .633$, $p < .001$. Students who completed more homework did better on their exams than students who did not (Figure 4).

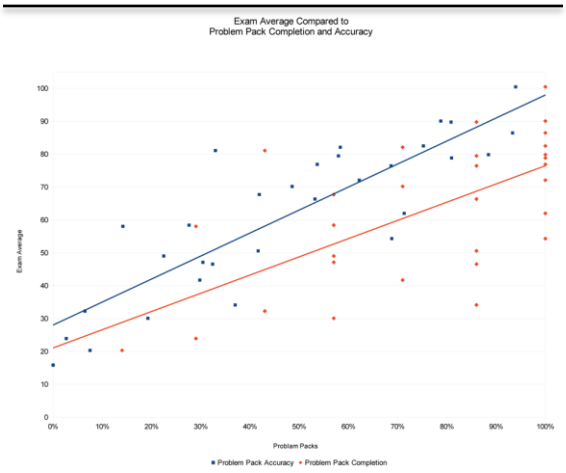


Figure 4. Relationship between average exam grade and homework completion versus homework accuracy.

Student Characteristics

We considered the relationship between intelligence, conscientiousness, attitude, and study style with homework completion and found conscientiousness ($r(29)=.62$, $p<.001$), attitude ($r(29)=.54$, $p<.01$), and intelligence ($r(29)=.36$, $p<.05$) were all significantly related to homework completion. In addition to having a strong correlation to homework completion, the three student characteristics correlated with each other significantly. Intelligence was significantly correlated with conscientiousness ($r(29) = .388$, $p < .05$), but not with attitude ($r(29) = .349$, $p = .054$). Conscientiousness and attitude were strongly correlated ($r(29) = .757$, $p < .001$).

We also measured the relationship between study style and completion of required and extra credit problem packs. Of 31 students, 14 did not report that they used their homework to study for exams, while 17 did. A *t*-test revealed that this relationship was significant ($t(29) = -2.24$, $p < .05$); students who used homework to study completed more homework overall.

Summary

Students have a wide variety of motivating and demotivating factors. Students in this class were motivated to do homework assignments due to credit value offered for the assignment, the utility of assignments in studying for exams, and a need to learn the material. Students who viewed themselves to be intelligent, conscientious, and have a positive attitude toward school were more likely to complete their assignments regardless of credit. Students were less likely to complete homework assignments if they were busy or if the assignments were perceived to be too complicated. Overall, we found a positive relationship between homework completion and academic achievement within this college genetics course.

DISCUSSION AND IMPLICATIONS

The purpose of this study was to understand the role homework plays in academic achievement in upper-level postsecondary courses. Our findings suggest that the relationship between homework and academic achievement established at the K-12 level (e.g., Cooper et al., 1998; Cooper et al., 2006; Trautwein et al., 2006) also holds true at the college level. In addition, we found credit to be a powerful motivator for college students (Ryan & Hemmes, 2005). We found most students were motivated to complete homework because they want to learn the course material and earn credit. In this course, reinforcement of course material was the primary goal of the homework. Thus, students' reported views were similar to the instructor's. However, we found that reinforcement alone was not as strong a motivator as student self-reports would suggest. Students whose goal was reinforcement should have been equally likely to complete any type of assignment. All assignments covered the same material and would have prepared students equally well for exams. However, we found discrepancies between students' reported motivation and actual completion rates. Students were pragmatic in practice given that they were more likely to attempt assignments that directly impacted their grade. It is more likely that most students are motivated by a combination of factors. Thus, even students who are motivated by reinforcement are more likely to complete credit assignments than non-graded assignments. Extra-credit is not as powerful a motivator as credit, but more powerful than no credit. Thus, an implication of this finding is that to better motivate students to complete homework, instructors should assign credit value for integral homework assignments and assign extra credit to less critical assignments.

We found students were less likely to complete homework when they felt overwhelmed by time demands, when assignments were perceived as too complex, or they thought the assignments would take too long to complete. An implication of this is that to maximize homework completion, an instructor may want take an honest evaluation of homework requirements. If assigning a problem of extreme difficulty, they may want to limit the number of tasks and try to set standards on expected completion times. Thus, students can then structure their

schedules with a precognition of how much time they need to regularly dedicate to assignments.

The positive relationship of conscientiousness, attitude, and study style on academic achievement observed by Busato et al. (2000) may be working through the mediating factor of homework completion. These findings suggest it is important for college instructors to craft homework assignments in such a way to maximize student completion. Positive attitudes about the course and studying is likely to be self-reinforcing, so ways to improve student attitudes about homework, such as emphasizing its utility in preparing for exams, should be explored. In addition, courses that help students improve their study skills should be considered a more essential part of college curricula. Instructors could also potentially create homework assignments that factor into a portion of the exam grade. Even without this factor, students who do homework tend to do better on exams than those who do not, but this credit assignment would increase student motivation to complete homework and make the assignments an integral part of the learning system. We still need to explore the issue if homework completion is what directly improves the exam performance or whether students who are motivated to complete homework assignments are also motivated to study well for the exam, increasing their overall performance. In the case presented, the academic end result remains that homework completion and exam performance are positively linked.

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