Why motivation matters: The relationship between motivation to go to college, effort, and academic performance in early engineering courses

Woo J. Kim, Miami University

Woo J. Kim is a doctorate student in the Social Psychology program at Miami University. His research explores how ”if only” thoughts affect motivation and behavior and how people respond to ostracism.

Ms. Brielle Nikole Johnson, Miami University

Brielle Johnson is a graduate student in the Social Psychology program of the Department of Psychology at Miami University. She earned her B.S. from Grand Valley State University with a double major in Psychology and Sociology. Her research interests include issues related to social class and areas of existential psychology and counterfactual thinking.

Dr. Jennifer Blue, Miami University

Jennifer Blue is a Professor of Physics at Miami University. She works to give more people access to physics. Sometimes that's reforming the curriculum for introductory classes, sometimes it's working with K-12 science teachers, and sometimes it's advocating for traditionally excluded populations, including women in STEM. Her website can be found here: http://www.users.miamioh.edu/bluejm/.

Dr. Amy Summerville, Miami University

Dr. Summerville is a Senior Research Scientist at Kairos research. She was previously an Associate Professor in the Department of Psychology at Miami University. She earned her Ph.D. in Psychology from the University of Illinois at Urbana-Champaign. Dr. Summerville is a social psychologist whose research examines how thoughts of ”what might have been” affect emotion, motivation, and behavior. She was the PI of a grant from NSF's EEC division investigating new interventions in engineering education that utilize social cognitive psychology.

Dr. Brian P Kirkmeyer, Miami University

Brian Kirkmeyer is the Karen Buchwald Wright Senior Assistant Dean for Student Success and Instructor in the College of Engineering and Computing at Miami University in Oxford, Ohio. His background includes BS, MS and PhD degrees in Materials Science and Engineering (specialization in polymers), the former from Purdue University and the latter two from the University of Pennsylvania. He has work experiences in automotive electronics (Delphi Automotive Systems) and consumer products (International Flavors and Fragrances) prior to his current role. He served on the executive committee of the ASEE Women in Engineering division from 2010 to present.

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This is a complete research paper. We surveyed 78 engineering students in early courses about their academic motivation, and they were assigned to one of two conditions: an intervention condition where they wrote about strategies to be more successful in their course, or a control where they were asked about their thoughts and feelings. They were also asked about the strategies they used to be successful in their early engineering courses. Their first exam score and course grade were also reported. We found that course effort was positively correlated with both intrinsic motivation and with extrinsic motivations to go to college. Additionally, course grade was positively correlated with college being personally important to students, and negatively correlated with amotivation. However, amotivation was buffered by the intervention condition; students in the intervention condition did not have their performance affected by their amotivation. Students in the control condition still did. This work is supported by NSF grant 1540627.

Introduction

The demand for engineers in the market is increasing as technology continues to increase in complexity. However, college students in engineering fields often experience decreases in motivation due to loss of interest and reduced competence beliefs [1, 2], which leads to the reduced retention in an engineering major and career [3].

Motivation is an important component in predicting a variety of academic outcomes such as performance, persistence, and learning [4, 5]. In light of the importance of motivation in the academic context, many theories have focused on personal expectancy about goal attainment [e.g. 6, 7], expectancy about value assigned to goals [e.g. 8, 9], the objectives of goal-directed behavior [e.g. 10, 11], and orientation of motivation [e.g. 12, 13]. In this paper, we explore how different types of motivations to go to college are related to effort and performance in early engineering courses.

The source of students' motivation can be either intrinsic or extrinsic, depending on where the motivation is oriented based on self-determination theory [14]. According to self-determination theory, the process of motivation can range in its level of autonomy and control; while intrinsic motivation is considered to be an entirely autonomous process, extrinsic motivation involves some degree of pressure or external control that propels action [14]. Intrinsic motivation involves

doing an activity because of satisfaction derived from the activity itself. For example, a student may pursue an engineering major out of pure interest and for inherent satisfaction. Intrinsic motivation thus leads to self-determined, growth-oriented behaviors [15, 16]. Although past research has examined what fosters or undermines intrinsic motivation [e.g. 17] and consequences of intrinsic motivation [e.g. 18] from a unidimensional approach, Vallerand and his colleagues [e.g. 5] proposed three different types of intrinsic motivation: Intrinsic motivation to know, intrinsic motivation toward accomplishments, and intrinsic motivation to experience stimulation.

Intrinsic motivation to know involves engaging in an activity for sheer pleasure and satisfaction while learning, exploring, and acquiring new knowledge out of curiosity and interest. An example of this would be that a student searches for information for pleasure while learning something new from it. Students who are intrinsically motivated toward accomplishments engage in an activity for the pleasure and satisfaction as well as to fulfill achievement-directed goals. For instance, a student may search for information to develop a new skill and increase their level of competence. Intrinsic motivation to experience stimulation leads students to engage in an activity in order to experience sensory stimulation, such as flow experiences, excitement, and cognitive pleasure [5, 10, 19].

In contrast to engaging in activities for their own sake, extrinsic motivation involves an activity as being instrumental in achieving some reward not inherent to the activity. When someone is extrinsically motivated, they engage in activities as a means toward a desired goal. For instance, the reason a student may choose an engineering major may be because there are many promising jobs related to that major. Extrinsic motivation has been characterized as problematic, because in some instances it may undermine intrinsic motivations [20]. However, extrinsic motivation, like intrinsic motivation, is also more nuanced than previous research has implied. Extrinsic motivation ranges in the level of self-determination involved, and the forms of extrinsic motivation can be divided into external regulation, introjection, and identification [5, 12].

External regulation is the least internally founded type of extrinsic motivation. External regulation is the prototypical example of extrinsic motivation, where a person initiates and continues engagement in a behavior entirely as a means to satisfy some externally imposed goal [13]. Introjection involves more internally regulated processes; this type of extrinsic motivation suggests people are motivated to maintain or boost self-esteem, but the conditions of this motivation are largely based on external pressures. Therefore, people might engage in activities that enhance their sense of self-worth [14]. Extrinsic motivation can also be mostly self-determined when regulated by processes of identification. Identification involves the alignment of an activity with one’s personal values; even if a person does not see an activity as inherently interesting, they may engage in behaviors that contribute towards the achievement of a personally identified value [14]. Therefore, identification is perceived as highly autonomous because activities are pursued based on a personally derived value system.

In the current research, we tested to see how different motivations to go to college would be associated with students' effort and performance in early engineering courses. In addition, we examined the possible effectiveness of an intention intervention in the relationship between motivation and course performance. Planning is a self-regulatory strategy involving a mental simulation of concrete actions in future situations. By simulating future events, individuals would be able to anticipate possible obstacles and make pre-planned, more realistic strategies. This active mental representation thus leads people to have greater accessibility to the plans and act as planned [21]. Therefore, by planning, students may devote more time to study and find more effective ways to perform better in the course even if their motivation to go to college is low.

Methods

The engineering majors at Miami University have several required courses that they take in their first year before they really take engineering courses in their majors. These early engineering courses, calculus, physics, and programming, can be obstacles for the students. They are often difficult, and students need to earn a C or better in these courses to remain on track to graduate with their chosen major in four years.

We invited 104 students enrolled in early engineering courses via email to participate in an online study. In this intake survey, participants provided informed consent and a FERPA release which allows us to access participants' grades.

After their first exams, 78 (75%) participants returned and reported their exam grade and motivation to go to college. To probe motivation, we used the Academic Motivation Scale [22], which is reproduced in Appendix A. This scale assesses 3 intrinsic motivation (intrinsic motivation to know, intrinsic motivation toward accomplishment, and intrinsic motivation to experience stimulation), 3 extrinsic motivation (identification, introjection, and external regulation), and amotivation. We asked participants to what extent each item corresponds to a reason why they go to college on a 7-point scale ranging from 1 ("Does not correspond at all") to 7 ("Corresponds exactly"). They were also randomly assigned to one of two conditions. In the intention intervention condition, we asked participants to write about specific strategies they could use to be more successful in the course. In the control condition, they wrote about their thoughts and feelings regarding the remainder of the course.[1] The exact wording we used for the two conditions is reproduced in Appendix B.

In the follow-up survey administered later in the semester, 66 (85%) participants (M_{age} = 19.42, SD_{age} = 1.38; 81.8% White; 60.6% male) returned and rated how many days they used specific strategies (e.g., "Reviewed slides or handouts from class.") on a 7-point scale from 1 ("Haven't done"), 2 ("1 day"), to 7 ("More than 5 days"). This list of student strategies is reproduced in Appendix C.

At the end of the semester, course instructors provided final grades.

Results and Discussion

We first explored the associations of motivation to go to college with course effort (i.e.., implementing specific study strategies) and performance (i.e., final course grade). We calculated course effort by averaging out the days participants used 19 specific study strategies, and performance by transforming the letter grade into numerical values ranging from 0 to 4. We further created the composite variables for motivation sub-components: intrinsic motivation to know ($\alpha = 0.81$), intrinsic motivation toward accomplishment ($\alpha = 0.91$), intrinsic motivation to experience stimulation ($\alpha = 0.90$), identification ($\alpha = 0.51$), introjection ($\alpha = 0.82$), external regulation ($\alpha = 0.83$), and amotivation ($\alpha = 0.90$).

Then we conducted a partial correlation analysis while controlling for first exam grade. we computed Pearson's correlation coefficients between variables above and beyond the associations with first exam grade. As shown in Table 1, the results indicated that performance

Table 1. Partial correlations controlling for first exam grade

	1	2	3	4	5	6	7	8	9
1. Performance	1	.02 (.86)	-.04 (.75)	-.05 (.69)	.24 (.06†)	.03 (.83)	.10 (.43)	-.23 (.08†)	.03 (.80)
2. IM-to know		1	.81 (.00***)	.72 (.00***)	.30 (.02*)	.51 (.00***)	-.32 (.01*)	-.14 (.29)	.22 (.09†)
3. IM-accomplishment			1	.64 (.00***)	.43 (.00***)	.61 (.00***)	-.11 (.37)	-.17 (.18)	.32 (.01*)
4. IM-stimulation				1	.14 (.28)	.58 (.00***)	-.45 (.00***)	.01 (.92)	.31 (.01*)
5. EM-identification					1	.29 (.02*)	.28 (.03*)	-.43 (.00**)	.30 (.02*)

6. EM-introjection		1	-.03 (.84)	.07 (.58)	.30 (.02*)
7. EM-external regulation			1	-.12 (.37)	.16 (.21)
8. Amotivation				1	.04 (.74)
9. Course effort					1

IM: intrinsic motivation, EM: extrinsic motivation. P-values are displayed in parentheses. $^{\dagger}p < .1$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

was positively correlated with identification ($r = 0.24$, $p = 0.06$). This means that the extent that going to college is personally important to the participants tends to increase course grade. In other words, participants who identified personal importance in going to college received higher course grades than those who could not find the value of going to college. In contrast, performance was negatively correlated with amotivation ($r = -0.23$, $p = 0.08$). Namely, participants who lacked motivation to go to college received worse course grades compared to those who were less amotivated to go to college. Further, course effort, which represents the mean of the number of days participants spent using specific study strategies, was positively correlated with both intrinsic and extrinsic motivations to go to college. Specifically, the more participants were intrinsically motivated to know ($r = 0.22$, $p = 0.09$), to accomplish something ($r = 0.32$, $p = 0.01$), and to experience stimulation ($r = 0.31$, $p = 0.01$), the more effort participants put into study. Further, externally motivated participants who identified with the value of going to college (identification, $r = 0.30$, $p = 0.02$) and who only partially internalized regulations (introjection, $r = 0.30$, $p = 0.02$). That is, regardless of the source of motivation (intrinsic or extrinsic), greater motivation was related to increased efforts. The types of motivation unrelated to course effort were when students were motivated by external rewards ($r = 0.16$, $p = 0.21$) and amotivated ($r = 0.04$, $p = 0.74$). Course effort was not associated with performance ($r = 0.03$, $p = 0.80$).

We further exploratorily investigated how the intention intervention changes the influences of motivation on course effort and performance. With exam grade as a covariate, course effort and performance separately were regressed on each motivation sub-component, condition (0 = the control condition, 1 = the intention intervention condition), and the interaction of the two. We

found that the intention intervention buffered the negative effect of amotivation on performance (b = 0.29, p = 0.05, 95% CI = [0.01, 0.57], see Figure 1). Specifically, participants assigned to

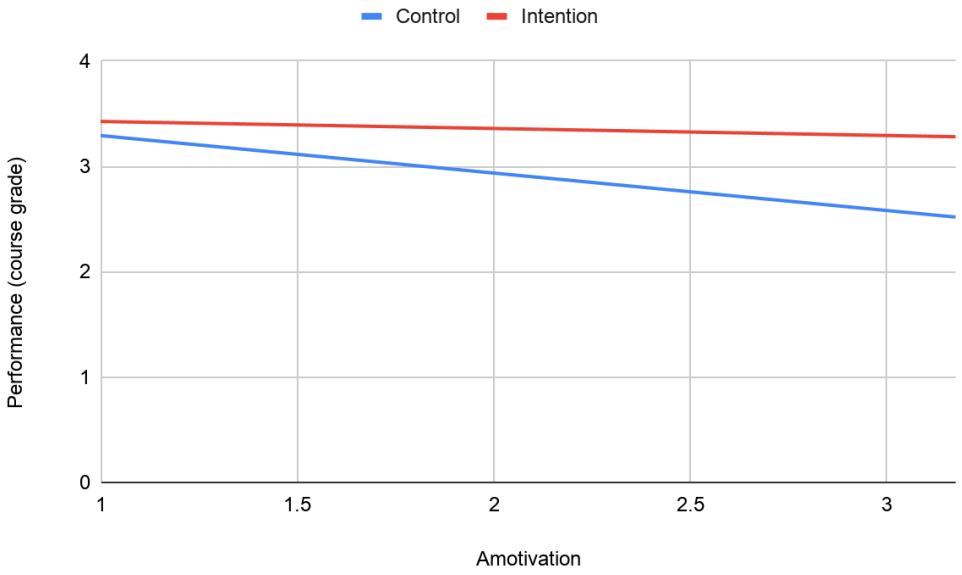

Figure 1. The moderating effect of the intention intervention on the relationship between amotivation and performance.

the intention intervention task were not affected by amotivation to go to college (b = -0.07, p = 0.49, 95% CI = [-0.26, 0.13]). However, for participants in the control task, amotivation was negatively impactful on their course grade (b = -0.36, p = 0.001, 95% CI = [-0.56, -0.15]). The intention intervention did not alter the other influences of the motivation components on course effort and performance with the significance level at 0.05.

Overall, we found that students who personally identified the value of going to college tended to receive a better grade whereas students who lack motivation to go to college received a worse grade. The adverse impact of the lack of motivation on performance could be impeded by making detailed plans for the remainder of the course through the intention intervention. Also, intrinsic and more internalized sources of motivation are likely to improve students' effort in the course.

Based on our findings, instructors should promote to students that higher education is valuable for their success. Even with motives that originate from external sources, internalizing them seems beneficial in terms of both performance and effort. That is, it is important that instructors help facilitate students internalizing initially external regulation. For example, if one goes to college to have a better salary in the future, which would be external regulation, this appears to be ineffective for academic achievement. Rather, making the slight change to having students

believe that higher education could improve one's competence in the job market would successfully improve both students' effort and performance.

Lacking motivation to go to college did not change effort levels but reduced course grade. Interestingly, this harmful impact of amotivation was eliminated when an intention intervention was implemented. We had students in the intention intervention condition think about detailed plans and strategies that may improve their success in the course. This intervention served as a buffer against amotivation. Thus, providing a detailed study guide or having them write about study plans intermittently during the semester would be beneficial.

The intention intervention implemented in this research can be a metacognitive regulation activity, which involves planning, monitoring, and evaluation [23, 24]. Our intervention is especially associated with planning that identifies appropriate strategies, formulates action plans, and allocates resources for better performance. Past research has shown that students who conducted metacognitive activities, such as having participants say out-loud any thoughts arising during a reading task, or were high on metacognitive awareness tended to be successful learners [25, 26, 27, 28]. Therefore, our intervention suggests not only a possible, novel role of metacognitive regulation as a buffer against amotivation but also metacognitive activities for planning (e.g., asking students to share their study plans while the partner records their plans, switch roles, and then exchange the recordings) could prevent the negative impact of amotivation.

One thing that is worthwhile to point out is the link between performance and effort. Intrinsic and somewhat internalized motivation led students to make more of an effort to spend more time studying. However, this effort did not result in increased performance. This may occur when, for instance, the course is excessively difficult or the study strategies are not effective or efficient. Future research should identify whether difficulty, either objective or subjective, of the class makes effort fruitless. In addition, given that early engineering courses are not easy, instructors need to help guide their students into choosing where to make the efforts such that there is a real improvement in course performance as a result.

It would be also interesting to look at a vicious cycle between amotivation to go to college and performance in future studies. Using longitudinal surveys, the current research provides causal evidence that lacking motivation to go to college tends to decrease course grade and this tendency can be prevented by inducing specific plans for success in the remainder of the course. It may also be the case, however, that low performance or undesirable course grade as a result of much effort causes decreased motivation to go to college. This should be addressed in future research.

The present research shows preliminary evidence about the relationships between motivation, effort, and performance, and the role of an intention intervention as a buffer for the negative effect of amotivation on performance. It should be noted, however, that the current research is

exploratory by its nature and has a relatively small sample size. In addition, the participants of the current research were predominantly White and about 60% male. Past research demonstrates that minorities tend to report higher extrinsic motivation, which diminishes over time, and male (vs. female) students' motivation decreases more drastically [29]. Thus, this research should be interpreted with caution, and further research with a priori hypotheses and a larger number of participants that will allow for considering gender and ethnic differences is required.

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Appendix A: Academic Motivation Scale [from 22]

Using the scale below, indicate to what extent each of the following items presently corresponds to one of the reasons why you go to college.

	Does not correspond at all (1)	(2)	(3)	Corresponds moderately (4)	(5)	(6)	Corresponds exactly (7)
Because with only a high-school degree I would not find a high-paying job later on. (1)	○	○	○	○	○	○	○
Because I experience pleasure and satisfaction while learning new things. (2)	○	○	○	○	○	○	○
Because I think that a college education will help me better prepare for the career I have chosen. (3)	○	○	○	○	○	○	○

For the intense feelings I experience when I am communicating my own ideas to others. (4)	○	○	○	○	○	○	○
Honestly, I don't know. I really feel that I am wasting my time in school. (5)	○	○	○	○	○	○	○
For the pleasure I experience while surpassing myself in my studies. (6)	○	○	○	○	○	○	○
To prove to myself that I am capable of completing my college degree. (7)	○	○	○	○	○	○	○
In order to obtain a more prestigious job later on. (8)	○	○	○	○	○	○	○
For the pleasure I experience when I discover new things never seen before. (9)	○	○	○	○	○	○	○

Because eventually it will enable me to enter the job market in a field that I like. (10)	○	○	○	○	○	○	○
For the pleasure I experience when I read interesting authors. (11)	○	○	○	○	○	○	○
I once had good reasons for going to college; however, now I wonder whether I should continue. (12)	○	○	○	○	○	○	○
For the pleasure that I experience while I am surpassing myself in one of my personal accomplishments. (13)	○	○	○	○	○	○	○
Because of the fact that when I succeed in college I feel important. (14)	○	○	○	○	○	○	○
Because I want to have "the good life" later on. (15)	○	○	○	○	○	○	○

For the pleasure that I experience in broadening my knowledge about subjects which appeal to me. (16)	○	○	○	○	○	○	○
Because this will help me make a better choice regarding my career orientation. (17)	○	○	○	○	○	○	○
For the pleasure I experience when I feel completely absorbed by what certain authors have written. (18)	○	○	○	○	○	○	○
I can't see why I go to college and frankly, I couldn't care less. (19)	○	○	○	○	○	○	○
For the satisfaction I feel when I am in the process of accomplishing difficult academic activities. (20)	○	○	○	○	○	○	○
To show myself that I am an intelligent	○	○	○	○	○	○	○

person. (21)							
In order to have a better salary later on. (22)	○	○	○	○	○	○	○
Because my studies allow me to continue to learn about many things that interest me. (23)	○	○	○	○	○	○	○
Because I believe that a few additional years of education will improve my competence as a worker. (24)	○	○	○	○	○	○	○
For the "high" feeling that I experience while reading about various interesting subjects. (25)	○	○	○	○	○	○	○
I don't know. I can't understand what I am doing in school. (26)	○	○	○	○	○	○	○

Because college allows me to experience a personal satisfaction in my quest for excellence in my studies. (27)	○	○	○	○	○	○	○
Because I want to show myself that I can succeed in my studies. (28)	○	○	○	○	○	○	○

Note. Intrinsic motivation to know: 2, 9, 16, 23; intrinsic motivation toward accomplishment: 6, 13, 20, 27; intrinsic motivation to experience stimulation: 4, 11, 18, 25; identification: 3, 10, 17, 24; introjection: 7, 14, 21, 28; external regulation: 1, 8, 15, 22; amotivation: 5, 12, 19, 26.

Appendix B: Exact Language for Intention Condition and Control Condition

The intention condition: We'd now like you to think about the rest of the semester in this course. What things can you do (or do differently, or stop doing) that will help you be more successful in the course going forward? What steps do you need to take to actually do these things? (For instance, if you want to spend more time studying for the course, you might need to schedule time on your weekly calendar; if you want to go to office hours, you might need to look up the time and location, etc.) Please include enough detail so that someone else could understand your plans, but leave out any details like names that would allow someone to identify you or others.

The control condition: We are interested in your thoughts and feelings about this course in the remainder of the semester. In the space below, please describe your thoughts and feelings about the remaining weeks in the course. Please include enough detail so that someone who is unfamiliar with you and the course would understand your thoughts, but omit any details like names, section numbers, etc. that might allow someone to specifically identify you or others:

Appendix C: Student Strategies

Different students adopt different strategies in their courses. Below is a list of things some students might or might not do in different courses. We are interested in the things you are and are not doing in your physics course. Please ONLY indicate the things you've done in your physics course, not any other courses you are taking.

Think back over the past 2 weeks. Have you done any of the following things in PHY 191 during the past 2 weeks? Please give your best estimate of how many times you've done each of these things. (Each item had a 7-point scale, with the points “Haven’t done”, “1 day”, to “More than 5 days”.)

1. Read the textbook
2. Reviewed slides or handouts from class
3. Reviewed your own notes from class
4. Attended class
5. Met with the professor outside class (e.g. office hours)
6. Met with the TA outside class (e.g. office hours)
7. Gone to a tutoring session for this course
8. Asked a question during class
9. Gone to a general study skills workshop
10. Had a study group with classmates
11. Done the homework for class
12. Done additional practice problems
13. Taken notes during class
14. Taken notes while reading the textbook
15. Gone to the writing center for help with an assignment in this course
16. Read something other than the textbook or handouts from class (e.g., a study guide, a different textbook, etc.)

17. Posted a question to an online discussion board

18. Answered a question in class

19. Re-read sections of the textbook to review material

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[1] Although this was not the original rationale for using this intervention, we thought this additional relationship was worth exploring.