



Satisfaction: Intrinsic and Extrinsic Motivation in Engineering Writing Course-work

Dr. Stephanie Pulford, University of California, Davis

Dr. Stephanie Pulford is the Associate Director for Instructional Research & Development of UC Davis' Center for Educational Effectiveness. Dr. Pulford's professional background in engineering includes a Ph.D. in Mechanical Engineering, an M.S. in Engineering Mechanics, and a B.S. in Aerospace Engineering as well as industry experience as an aircraft engineer. Her research and professional interests include faculty development, innovations in engineering communication education, engineering student identity and learning motivation, narrative structure in technical communication, and the improvisatory skills of educators.

Jiahui Tan, University of California, Davis

Michael Raymond Gonzalez, University of California, Davis

Michael works as a research assistant at UC Davis's Center for Educational Effectiveness (CEE), focusing on projects involving engineering students' motivations around writing. To support this work, Michael applies and utilizes the skills he learned through his time as an English tutor, and his BA coursework in English, with an emphasis in literature, criticism, and theory. In addition to the work he does at CEE, Michael's passion for education, pedagogy and the success of students has lead him to conduct his own research on Freshmen, Sophomores and First-Generation students' motivation towards receiving feedback on writing assignments.

Ms. Amanda Modell, University of California, Davis

Amanda Modell is a graduate student researcher at the Center for Educational Effectiveness at UC Davis, where she supports research on engineering writing education. In addition to research, Amanda has worked in graduate student professional development as a Teaching Assistant Consultant and Teaching Assistant Consultant Coordinator, where contemplative, inclusive, and feminist pedagogies informed her work. She has also contributed to curriculum development for graduate student instructors and pedagogy resources for faculty and graduate students. As a Cultural Studies PhD candidate, Amanda's dissertation considers how musical ability becomes understood as hereditary through sciences such as eugenics, genetics, and physical anthropology.

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Abstract

In this paper, we report the results of mixed-methods research on student learning motivation. We aim toward better understanding the roles and interactions of intrinsic and extrinsic motivation for students in engineering writing courses. We first present the results of the intrinsic and extrinsic orientation components of a Motivated Learning Strategies Questionnaire (MLSQ) that was completed by 455 students across 10 engineering disciplines, enrolled in one of seven engineering writing courses at two large public universities, and 16 students who participated in a follow-up interview. On survey items that probed students' intrinsic and extrinsic goal orientations, students reported lower motivation in their writing class than their nonwriting class for items that concerned satisfaction for achievements within the course. Examining these depressions in students' satisfaction revealed that many students found their classes too perfunctory to be intrinsically satisfying. The student interviews further suggested that grades must represent something meaningful to students if grades are to be satisfying extrinsic motivators. We conclude by providing practical ideas for educators that are suggested by our data.

Introduction

An engineer's professional duties typically demand a substantial amount of technical writing [1], [2], and writing plays a role in hire, promotion, and long-term success [3]–[5]. In both industry and academia, writing provides an engineer access to his or her discourse community [6]. While employers, educators, and ABET agree that today's engineer needs to write well, often undergraduate students don't seem to be on the same page. Engineering students are reported to be resistant to writing and technical communication education, demotivated by writing assignments, and dubious of their writing instructors [7], [8]. A common perception inside and outside the engineering community is that our students are unmotivated in their writing classrooms and unmotivated to write in general.

When educators discuss how to motivate engineering students to learn and succeed in writing classes, some of our most common strategies fall within the domains of intrinsic and extrinsic motivation. Intrinsic motivation refers to a learner's motivation to do something because the learning tasks are inherently interesting and enjoyable[9], [10]; for example, students who enjoy the sense of satisfaction that they get from solving multifaceted problems may choose to take a class that involves problem-based learning rather than a class that is heavily concerned with equations and problem sets. Extrinsic motivation refers to a learner's motivation to do something because it has a desirable outcome that is separate from the learned content itself; for example, a student might strive to do well in a class in order to make the dean's list, impress potential employers, or to nudge their GPA over 3.2 in order to apply for graduate school[9], [10].

We as humans know intrinsic and extrinsic motivation to be fairly ubiquitous in our day-to-day and long-term goals, and indeed, concepts involving intrinsic and extrinsic motivations are present in nearly all current cognitive models of learning motivation. Given the intuitive and

scholarly recognition of these modes of motivation, it is hardly surprising that they underlie some of the engineering community's most common assumptions regarding student demotivation in engineering writing classes: first, that students have limited intrinsic motivation for these classes because engineers self-select into the major based on an affinity for math and science coupled with an impatience or dislike for writing; and second, that students perceive writing to be an activity with no value (and thus no reward, separable or otherwise) to an engineering student or a practicing engineer. When faculty stakeholders suggest ways to motivate unmotivated engineering writing students, two of the most common ideas are to make writing prompts and topics interesting so that students may orient themselves towards intrinsically motivating content; or, alternately, grade sternly and steeply to imply importance, so that students may orient themselves toward an extrinsic motivation for a higher grade. (For a discussion of other common attributions and strategies, see also[11].)

Though interesting topics and portentous grading are the most common intrinsic and extrinsic motivational strategies suggested by educators, they are by no means the only intrinsic and extrinsic strategies possible. Given a better understanding of the motivational constructs of intrinsic and extrinsic motivation, and an evidence-based understanding of students' intrinsic and extrinsic motivations in engineering writing classes, we might identify overlooked factors in their motivation that provide new insights into increasing students' motivations to learn and succeed in their engineering writing coursework. Toward this better foundational understanding, this work seeks to explore the following questions:

1. What are the intrinsic and extrinsic learning motivations of students in their engineering writing classes? Are they meaningfully different than students' extrinsic and intrinsic motivations in non-writing engineering classes?
2. In reference to the claim that engineers self-select to be poor writers and are thus intrinsically unmotivated in writing classes, what is the role of students' perceptions of their competence in engineering writing classes?
3. With the understanding that classes are composed of many individuals with different values and motivational orientations, what are some promising evidence-supported avenues to increase students' motivations through intrinsic and extrinsic modes?

About this work

This work is part of a broader study that examines student motivations in engineering writing classes. At present, the body of actionable research on student motivation in engineering writing courses is limited. In absence of such research, teaching designs are likely to be based on common assumptions about our students, some of which no longer reflect today's engineering students and most of which approximate diverse classrooms to a single homogenous motivational profile. Thus the purpose of this work is to begin to provide foundational background research for practicing educators and university stakeholders in order to facilitate new and better designs, particularly student-centered ones; and along the way, to dispel any assumptions that have been misdirecting us as we seek to progress teaching and learning in engineering communication.

A central research assumption at the start of this study, which has indeed borne out in our data collection, is that students exhibit a breadth of motivations. Relatedly, our students' motivations are all influenced—sometimes in divergent ways—by different factors inside and beyond our classrooms. Accordingly, our study has been posed to encourage faculty to expect motivational heterogeneity among their students; and for this reason we avoid a post-positivist approach that might imply that we can perfectly anticipate a given group of students' motivations before interacting with them and plan accordingly. We as instructors will be more successful if we are prepared to accept students as they are, and design courses that assume, welcome, (and perhaps reveal,) the many different kinds of motivations that are undoubtedly present. We hasten to add that we are not in opposition to well-posed post-positivist studies of student motivation by demographic, and in fact believe that this approach may be strongly justified as a component of intersectional research toward inclusion and culture change. However, the present study was designed fill a particular present need in the literature around engineering writing, and pragmatically posed to support student-centered thought and design in engineering writing classrooms; and for these reasons, the present study grounds itself in an assumption of student heterogeneity at all scales of interest.

What follows from this assumption, however, is that in a study that is designed to uncover student heterogeneity, any large and enduring trends across student responses are noteworthy. This is particularly true when these aggregate observations challenge any widely-held belief about student motivation. Accordingly, the results presented herein start with an important framing observation made across the aggregate of student responses, before progressing to informative patterns that emerge among subgroups of students.

The present work focuses exclusively on intrinsic and extrinsic motivation because of our strong intuitive associations of motivation with carrot-and-stick strategies. These strategies can be strengthened and diversified considerably by better insights into the intrinsic and extrinsic values students bring to engineering, and the often-surprising mosaic of values and motivations that may be present in a class that appears uniformly unmotivated. The present work in intrinsic and extrinsic motivation builds upon a previous work that examines the related construct of task value motivation, or in brief, whether a student believes content to be useful toward future goals [11]. This present work's very limited mention of other worthwhile motivating considerations like student self-efficacy, engineering identity, beliefs about writing, and emotional response to writing tasks is not intended as a dismissal of their significance; they will be addressed in future work.

Intrinsic and extrinsic motivation

Intrinsic motivation, referring to motivation via our inherent enjoyment of an activity, and extrinsic motivation, referring to motivation via a separable goal, have long been recognized as relevant motivational orientations in learning psychology. They are present in some form across most modern cognitive learning theories. Scholarly understanding of these constructs has significantly evolved over time, yet the education community's practical understanding has not kept pace.

Intrinsic motivation is often held aloft as the highest quality motivation for learning, as research has consistently shown that intrinsically motivated learners use deep learning strategies, pursue mastery goals, and are generally more successful students. By contrast, extrinsic motivation is often maligned as a last-resort strategy, and often associated as a cajoling or punishing measure to align students to a curriculum. This type of shallow extrinsic motivation has been linked with superficial learning strategies and performance goals. These two motivational alignments were once treated as if they represented opposite endpoints on a spectrum; indeed, the idea that students must be “nudged away” from extrinsic modes of motivation and toward intrinsic modes can still be heard among educators.

A more contemporary understanding of these two modes of motivation is that they are related thematically. Of all proposed types of cognitive learning motivation, intrinsic and extrinsic motivation directly concern the possibility that psychological needs may be met through learning experiences—needs such as stimulation, self-regard, belongingness, approval, or perhaps affirmation of values, identity, or competence. A student who is influenced by intrinsic and extrinsic motivation is likely to experience not simply benefit, but a sense of psychological satisfaction, from goal attainment. Most modern concepts of intrinsic and extrinsic motivation do not cast them as opposing or mutually exclusive, but rather as parallel constructs that may simultaneously be present in a learner, and in fact may have interacting effects[9], [10], [12].

Moreover, our theoretical understanding of extrinsic motivation has deepened significantly. While a popular accounting of extrinsic motivation would suggest that it is a tepid yet universal driver that would ensure only that our students slavishly pursue good grades as a reward in themselves, further work has suggested that students who align themselves with extrinsic goals are often in truth pursuing meaningful internalized or semi-internalized values; and as students pursue extrinsic attainments as proxies for these internalized values, they use deep learning strategies that more closely resemble strategies for intrinsic pursuit of learning. A common illustration of this expanded view of extrinsic motivation is shown in Figure 1, reproduced from Ryan and Deci’s turning-point review of the subject[9]. (We repeat Ryan and Deci’s caveat that this figure, though informative, presents a misleading continuum in which intrinsic motivation is suggested to be the most desirable endpoint of a motivational spectrum; intrinsic value’s inclusion was meant only to highlight the similarities between intrinsic and internalized extrinsic motivation.)

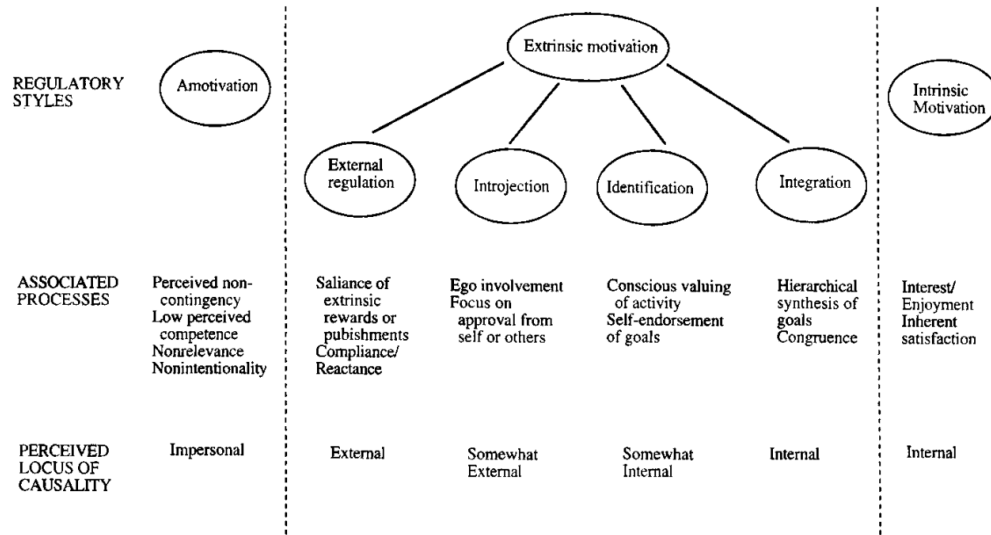


Figure 1. Ryan and Deci’s expanded concept of extrinsic motivation, including a spectrum of external-to-internal loci. As extrinsic motivation approaches an internal locus, its effects on learning strategies and outcomes start to resemble the characteristic depth and persistence associated with intrinsic motivation.[9]

Methods

Approach: The work described in this paper is part of a broader inquiry into engineering student motivations in writing classes. The initial quantitative component of this study is a student survey that includes the Motivated Strategies for Learning Questionnaire (MSLQ), which is based on the Expectancy Value theory of learning motivation. The MSLQ includes individually validated scales for a number of motivational orientations, including intrinsic and extrinsic goal orientation[13], [14]. The survey used in this study also incorporates the Writing Apprehension Test, to examine affective components of students’ learning motivation in writing classes[15].

In consideration of the needs of practicing educators, a purely quantitative study would have a few shortcomings. The first, of course, is that our natural interpretation of quantized aggregate data tends to emphasize the results of the majority, which is not always a useful approach in educational contexts—particularly engineering education, which concerns itself with building a more welcoming culture for a breadth of students, including those who are presently underrepresented. The second shortcoming of quantitative measures is that while survey instruments can reveal broad trends in student attitudes, surveys have limited ability to explore the reasons and influences that underlie these trends, nor to enlist the collaboration of survey participants in considering alternatives. A survey can describe student information, but cannot capture nor react to student voice.

For these reasons, this study takes a pragmatic, mixed-methods approach, encompassing broad surveys and deep interviews. These sources are triangulated via a “holistic description” design, provisionally coded around themes that emerge in the survey analysis, in order to reveal contexts and background that contribute to trends in quantitative data[16]. By showcasing the stories beneath the survey, we provide images of possible student thoughts and reactions that may yield transferrable insights for educators. A schematic of the research is shown in Figure 2, and an explanation of each component follows.

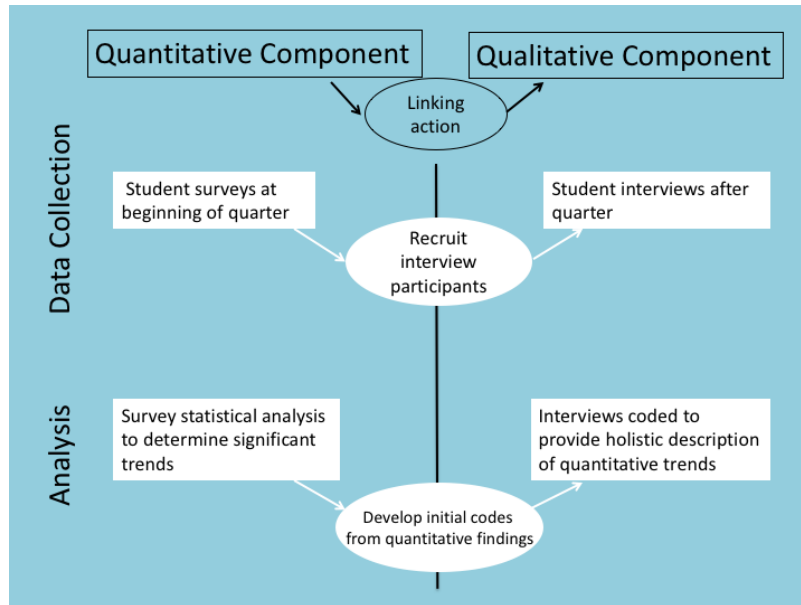


Figure 2: A schematic of the research design.

1. Student Surveys

The quantitative component of this research was collected via a survey administered to students online, through their participating engineering writing class, near the beginning of the quarter. This survey included motivational items from the MSLQ regarding their writing class, and parallel MSLQ items regarding a non-writing engineering class in which they were concurrently enrolled (a practice that has some precedent in comparative studies where no continuous control was available[17]). The survey also included the 20-item Writing Apprehension Test, as well as some short-answer items. (In the present work, we will focus mostly on the results of the Intrinsic and Extrinsic goal orientation scales, except for a brief examination of correlation between intrinsic and extrinsic motivation and types of motivation that are related to students' perceptions of their own competence.)

The survey was completed by 455 consenting students across 10 engineering disciplines, ranked freshman through super-senior, who were enrolled at one of two large public research universities. These students were enrolled in one of 13 sections of seven engineering writing classes, offered by three disciplines, between Fall 2014 and Fall 2017. All students were required to take their respective engineering writing class as a condition for graduation. As all surveys except three were incentivized by instructors, response rates in all but two classes were over 80% and most approached 90-95%. We stress that these surveys were considered in aggregate as a snapshot of a breadth of potential engineering writing students as they enter courses, and not intended as a post-positivist comparison of the motivations at different large public universities; accordingly, we do not consider results from the two universities separately in this study, a convention that has precedent in person-centered studies [18]. Supporting this decision, our data suggest that any major differences in student responses between these universities are negligible compared to the breadth and variation of student responses within each university. Respondent demographics are summarized below [Table 1]. Please note that for the purposes of this study,

“represented minorities” include those of Asian and Middle Eastern descent and “underrepresented minorities” include those who identify as Black or African American, Hispanic or Latino/a, Native American, or Native Hawaiian or other Pacific Islander.

2. Analysis

The quantitative data’s statistical significance was calculated by assuming a linear numerical distribution of Likert terms (Not True = 1; True = 5). The student MSLQ responses regarding their writing class was paired with the corresponding set of responses regarding their non-writing class. A Wilcoxon Signed-Rank test (with a threshold of $p = 0.05$) was used to determine the significance of students’ differences in response regarding their writing and non-writing class task value motivation.

The survey results were further analyzed for correlations with other MLSQ constructs (Self Efficacy, and Control of Learning Beliefs) as well as Writing Apprehension by first dividing the intrinsic and extrinsic responses into low/medium/high thirds and placing each survey into a category defined by its intrinsic and extrinsic range; and then calculating the category’s average score on the third construct (which was similarly divided by thirds for the MLSQ constructs, but left as a whole number value between 40-100 for the Writing Apprehension Score). The approach of dividing MSLQ scores into thirds (or approximate thirds) has been used before to make student response differences visible, given a common positive skew of students’ answers to the MSLQ[12]. Tables of results by category were first analyzed for significance through ANOVA, and then for relationships via a Tukey test.

3. Student interviews

From the pool of 455 survey participants enrolled in engineering writing classes at two large research universities, 16 volunteers were recruited for a follow-up interview. These interviews took place after the students’ participating engineering writing class had concluded, in order to focus more generally on student attitudes and perceptions about writing and engineering rather than their reactions to classes in progress. These semi-structured interviews included questions about the students’ background as writers, readers, and as engineering students; their concepts regarding engineering writing; and their ideas regarding writing education in engineering. The

Table 1: Survey Participant Demographics

Class level	Count	Race, ethnicity	Count	Gender Identity	Count
Freshman	4	Caucasian, White	168	Female	126
Sophomore	28	Represented Minority	168	Male	311
Junior	183	Underrepresented Minority	47	Other/Nonbinary Identity	5
Senior or Super-senior	229	Mixed Racial/Ethnic Identity	41	Prefer not to state	13
Graduate Student	1	Prefer not to state	31		

interviewer also prompted students to clarify, validate, or explain trends in their survey responses, and to comment on ideas they had offered in the survey. Of particular interest were students' ideas about the value of writing to an engineer and their imagined approach to ensuring student motivation in a similar writing class. The 16 participants were ranked sophomore through super-senior, and were enrolled in five engineering disciplines. Effort was made to oversample women and under-represented minorities; however, our efforts were limited by the voluntary nature of interview recruitment. Ten interviewed students were white, and six were represented minorities. Ten of the participating students were male and six were female. For three interview participants, English was not their first language.

4. Qualitative analysis

Interview transcripts were coded via a Provisional Coding strategy[19]. The intrinsic and extrinsic motivation constructs, content related to the quantitative MSLQ items, and interesting statistical data trends from the quantitative analysis formed an initial set of codes to analyze qualitative results for related insights. For any given trend-code drawn from survey data, special notation was given to interview participants whose survey answers reflected the trend, and these were coded holistically in order to identify common themes that helped to explain students' responses[19]. Using this planned compatibility as a guide, themes in student interviews were triangulated via holistic design to trends in the quantitative analysis[16].

Results and discussion

The aggregated survey results for intrinsic and extrinsic goal orientation suggest a positive message for educators: for all items, *a majority of students self-reported positive intrinsic and extrinsic motivations for their writing classes* (Figure 3). This result, in itself, is an important insight for frustrated educators and stakeholders. Given that these survey results were taken near the beginning of an engineering writing class, these results undermine a common conception that writing students arrive at our classrooms with no motivation. Student responses on the Likert spectrum strongly skewed toward positive. The mode student entered these writing classes with a motivational orientation that is conducive to successful learning.

It has been our incidental finding during this study that student participants seem to generally arrive at most of their classes with positive expectancy-value motivation regardless of writing content, as measured through the MSLQ. Indeed, a glance at Figure 3 suggests that the median student answers moderately positively ("Mostly True Of Me") for all items; in all but one case, positively motivated responses are a majority over all neutral and nonmotivated responses; and notably, there were no students who reported strong nonmotivation ("Not True Of Me") for any intrinsic or extrinsic goal orientation item, in either a writing or a non-writing class.

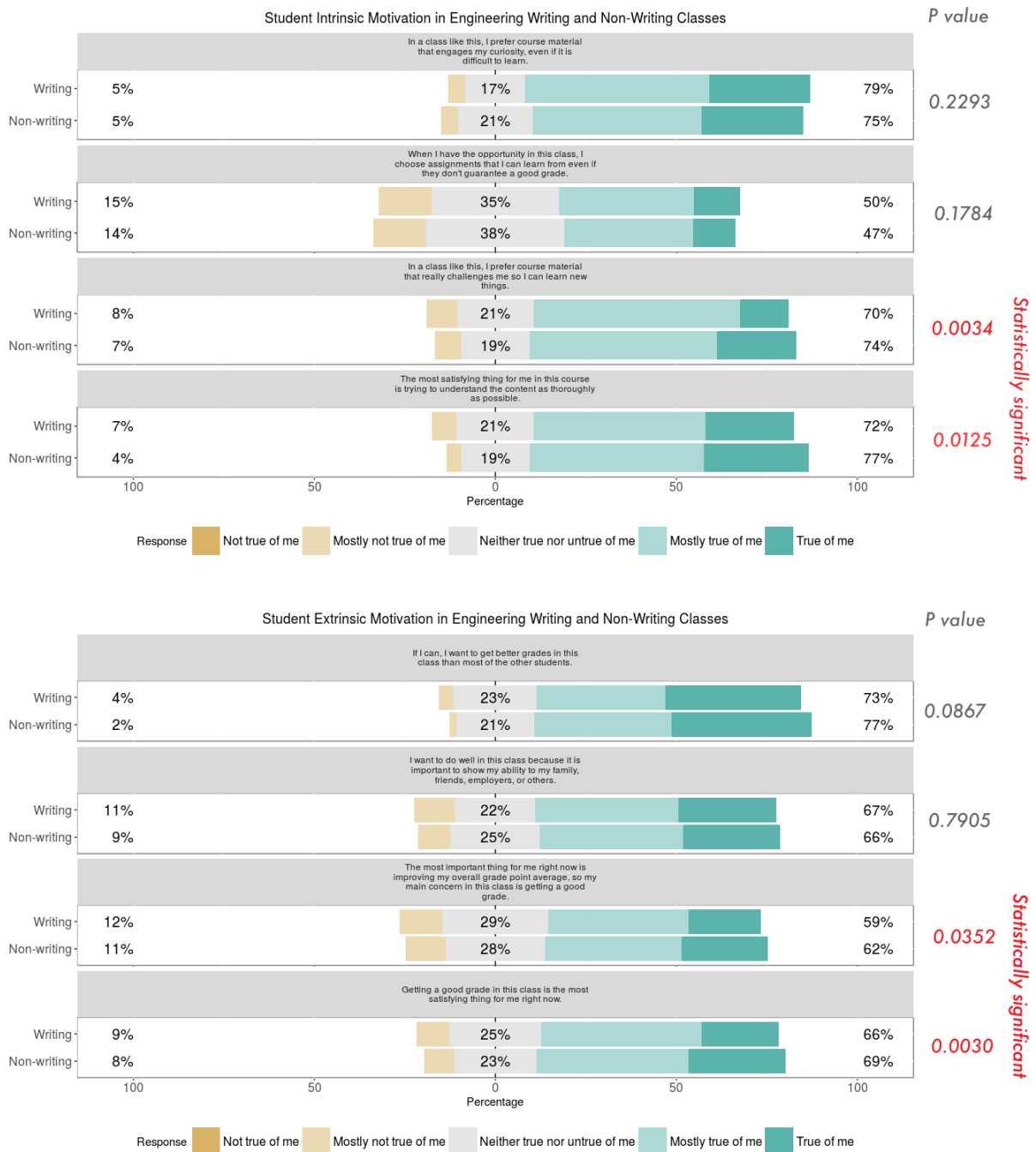


Figure 3: Student responses to intrinsic and extrinsic goal orientation scale items on the MSLQ instrument, for their engineering writing class and for a concurrent non-writing engineering class. For each writing-nonwriting class corresponding pair, a Wilcoxon Rank-Sum test was performed in order to test whether there was a significant difference in student response between the two course types.

Though these survey results are positive overall, students reported slightly less intrinsic and extrinsic motivation for their engineering writing classes to a statistically significant degree on four of the eight items. In particular, it is notable that students responded less enthusiastically to the two questions that inquire about a student's sense of *satisfaction* surrounding intrinsic and extrinsic goals related to their engineering writing classes. Of all the motivational constructs examined in our broader work, intrinsic and extrinsic goal orientation are the ones that correspond most directly with students' existing basic psychological needs—for stimulation, self-regard, the approval of others, belonging, and reward. It's reasonable to understand that the promise of satisfaction of these needs plays into a student's motivation as he or she enters a given class.

So, what is it about engineering writing classes that students perceive to be less satisfying, on average, than non-writing engineering courses they are beginning at the same time? To explore the reasons underlying students' depressed motivational responses for writing courses, we examined themes within the semi-structured student interviews.

Discussing negative factors within a positive aggregate

By transitioning from a discussion of the positive aggregate motivations of these students toward an exploration of interesting patterns of motivational deficits, this paper risks clouding a positive message of student motivation by fixating on small negatives. In order to simultaneously clarify our further discussion and serve as a reminder not to hyperbolize negative patterns within this data, we pause to define and position two kinds of negative motivation responses that we'll explore in subsequent sections.

- **Students with depressed responses:** These are students whose survey responses were less positive for their writing class than for their non-writing class on a given item. Students with depressed responses may still be positively motivated in writing classes: for example, consider a student who answers “Mostly True Of Me” for their writing class and “True Of Me” on the corresponding item for their nonwriting class.
- **Students with low responses:** These are students whose survey responses were “Neutral” or “Mostly Not True Of Me” on a given item regarding their non-writing class. As there were no student responses that were strongly negative on the relevant parts of the survey (“Not True Of Me”), it should be understood that “low” is generally an amotivated response rather than an unmotivated or hostile response. Again, students with low responses on a given item may be positively motivated overall – for example, consider a student who answered “Neutral” on a given item and “True Of Me” on all others.

Intrinsic satisfaction: deep learning and challenge

Among three interview participants who discussed at length their positive intrinsic goal orientation motivation at the start of their engineering writing classes, two major themes

emerged. First, predictably, these students valued and enjoyed writing to such a degree that the opportunity to write and learn more about it was inherently appealing. Additionally, these students predicted that the project-based structure of a writing class would prove satisfying, by giving them an opportunity to take a deep dive into engineering problems that they found to be lacking in their broader engineering curriculum.

Based on this, a straightforward hypothesis of students' lower or depressed intrinsic motivation on items related to satisfyingly deep learning might be that if students who like writing believe that they will be satisfied in engineering writing classes, students who dislike writing will prefer technical classes; and students who dislike writing are often believed to be the majority in engineering. However, this hypothesis was only true for one of the five interview students whose intrinsic satisfaction rating was depressed for their engineering writing class.

Among the other four students with depressed intrinsic satisfaction, a much different explanation emerged. All four of these students expressed a high value for communication skills, both in engineering and in life. All four students' interviews contained a persistent theme of learning for intrinsic reasons, both in their classes and as a general practice. And these students all shared an impression, at the start of their engineering writing classes, that the content of their engineering writing classes would be shallow, and mostly focused on demonstrating a particular form. To these students, participating in engineering writing classes was mostly performative. These students did not perceive the content of their engineering writing classes to be content that *could* be learned deeply, and perceived little chance of a strongly satisfying experience.

As one student described, the only way to succeed in her engineering communication class was hardly satisfying: "Need to practice, practice, practice... [By contrast, in my programming course], I feel like if I put enough effort on it, I can get [actionable] feedback sometimes."

Another student offered damningly faint praise for an engineering writing course: "I liked that it was *easy*." He dismissed a second engineering writing class that he'd taken as "mostly documentation." Moments before, this student had described his enjoyment of reading a book about rhetorical techniques through history, thus making it very clear that this student had no inherent disinterest in learning about communication. His low intrinsic value for his engineering writing classes was related to his regard of their perfunctory content.

Indeed, the perception that engineering writing courses contained little to learn was strong across all interviewed students who professed low intrinsic motivation at the beginning of their engineering writing classes. For most of these students, their initial belief that courses would be shallow and performative had been confirmed by their experience. And dishearteningly, two of the three students who'd initially discussed their intrinsic satisfaction for learning deeply in their classes were ultimately disappointed by the lack of challenge and depth they'd encountered within their technical writing classes, and became less motivated by intrinsic satisfaction over time.

These students' negative response to shallow coursework reveals a serious tradeoff to a common curricular norm that these courses should be easy to accommodate low ability or tolerance for

writing. By removing deep or nuanced content, we are also affecting a students' ability to find an engaging level of challenge and satisfaction in achievement within engineering writing courses.

Extrinsic satisfaction: grades as proxies for other values

A common assumption of educators regarding extrinsic motivation is that students will always rationally orient themselves toward the highest grade, and grades are a strong motivator of otherwise disaffected students. The comments of students interviewed for this study severely complicate this assumption. Only one of the 16 students described an economically rational attitude toward grades. Most other students described a more complex relationship between grades, satisfaction, and motivation. The overarching theme across these students was that in order for grades to motivate, the grades had to represent something else that was meaningful to a student—generally something in the realm of belongingness, meeting the standards set by a respected figure, or achieving a positive external appraisal for an achievement that the student regarded as personally worthwhile.

Figure 4 summarizes stories within the interviews about students' motivation with grades, using Ryan and Deci's expanded conception of extrinsic motivation as a framework[9]. The stories that students told in these interviews, in general, suggest a more positive and constructive relationship between grades, extrinsic motivations, and student values than is generally acknowledged. Indeed, students' most motivating experiences regarding grades approach a strongly internalized motivation; and true to Ryan and Deci's suggestion, the strategies that students used to pursue the satisfaction of grades in these instances were deep-learning strategies, much like we'd expect of students with strong intrinsic motivations.

Given a foundational understanding that these students' grades are satisfying and motivating when they mean something, we find a powerful theme across the stories of eight students who reported depressed or low satisfaction and motivation relating to grades: for each of these students, the grades in their writing class had failed to represent any important partly or fully internal value that had meaning to the students.

In some cases, this failure seems to have been a fairly innocuous lack of connection; for example, one student was so intrinsically motivated to improve his writing that he admitted that a bad grade didn't make much of a difference to him. However, a much more prevalent and deleterious theme among these students were that they didn't feel that grades in their writing classes were likely to represent accurate appraisals of meaningful achievements.

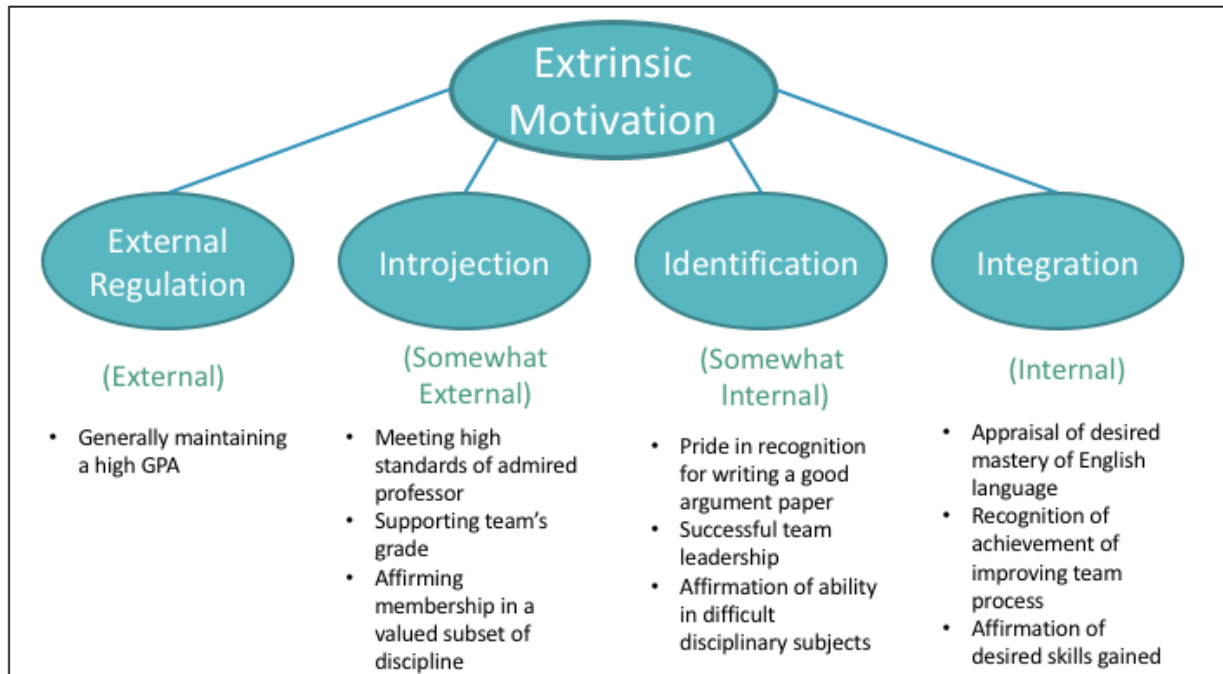


Figure 4: Grades-related intrinsic motivations of interviewed students, categorized according to Ryan and Deci's expanded concept of extrinsic motivation.

For example, one student who had a high (internalized) regard for writing quality recalled a formative experience in an earlier college composition class. Though he'd used the class as an opportunity to practice writing, he referred to the course as "a joke" in which he "learned nothing at all". He directly mentioned course grades—for his own work and for others'—as part of his demoralization:

"Looking back on the grade that I got for it – good grades for bad writing."

After that experience, he believed that his grades in writing classes would not reflect actual achievements. That formative experience had undermined his ability to feel like a writing grade represented an appraisal of his accomplishment, and thus had undermined his ability to experience satisfaction from his grade in a writing class. In cases such as these, a student's feeling of mismatch between a high personal value for writing and an instructor's inability to provide calibrated appraisals created a deeply demotivating situation. Perceptions of arbitrary or inflated grading caused highly capable students who had high personal values for writing to become deeply demotivated, and to rebel by putting little effort into achievement in their engineering writing classes.

Taken altogether, these results deeply complicate any notion that we may use grades as a universal motivator for our students, and they challenge the assumption using grades alone as a cudgel will yield motivating results. Instead, these results support the idea that generally, grades must mean something to students before grades can be useful motivators. Rather than depending on grades to communicate value, we would do better to ensure that students can have faith that our appraisals are meaningful. We might also find success by building stronger bridges between

our value for communication and the values students frequently bring to our classroom for engineering, literature, and human-centered design.

Intrinsic and extrinsic motivation, and students' perceptions of competence

An oft-repeated attribution for students' low motivation in engineering writing classes is that engineering students are likely to find writing difficult and unenjoyable; therefore, it stands to reason that students will have decreased intrinsic motivation in writing classes. Perhaps the reason that this attribution is so common is that we intuitively understand that our perceptions of our own competence and ability affect our enjoyment of a learning task. Naturally, we find it more enjoyable and satisfying to learn within domains that allow us to build upon existing areas of competence. Most theories of learning motivation include a foundational role for self-perception of competence in shaping intrinsic motivation and learning enjoyment.

Ryan and Deci have proposed a role for competence as a foundation for extrinsic motivation as well[9]. This less-intuitive role for competence makes sense when we consider that internalized extrinsic motivations tend to approach intrinsic motivations psychologically; if a learner feels capable in a particular domain, that learner is likely to orient positively toward appraisals and internalize the values expressed through positive assessment within that domain.

We sought to examine the potential role for student-perceived competence in intrinsic and extrinsic values through three related survey constructs: writing apprehension (which is a student's affective regard of writing, an inherent characteristic of a student that may change slowly with time, as expressed on the Writing Apprehension Test portion of the survey); self-efficacy for learning (a student's belief that they are capable of achievement in a given learning situation, as expressed on the MLSQ); and control-of-learning beliefs (a student's belief that a course's content is indeed learnable at all, also expressed on the MLSQ).

Our quantitative evidence of the relationship between students' intrinsic and extrinsic motivations and the three measures of perception of competence can be seen in Figure 5. Across the 432 survey respondents whose scores were complete enough to characterize, there was a statistically significant relationship between intrinsic goal orientation and writing apprehension, self-efficacy for learning, and control-of-learning beliefs, which can be modeled as a linear correlation. There was also a statistically significant linear relationship between extrinsic goal orientation and self-efficacy for learning, and control-of-learning beliefs.

These correlations support the idea that within the surveyed students, feelings of competence and intrinsic and extrinsic motivation may be linked, and likely interlinked as well. While these results are correlative and do not directly suggest causation, they still contain a practical message for educators: we do well to understand that our students have a variety of possible motivational orientations and profiles, and there is increasing evidence that no single motivational strategy provides a silver bullet toward helping our students to succeed. Rather, we will provide the best learning environment for our students if we broaden our palette of motivational strategies, and include less obvious tactics that help a student to build positive expectancies for learning along with the satisfactions of intrinsic and extrinsic rewards.

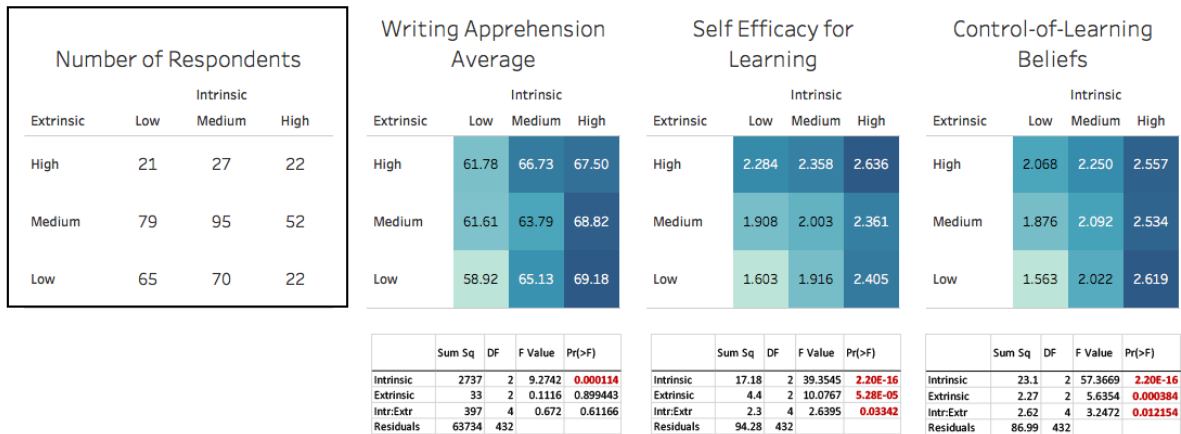


Figure 5: Correlations between low/medium/high ranges of students’ intrinsic and extrinsic motivations, and each group’s average for three items related to student perception of competency: writing apprehension (note that high scores indicate *less* apprehension), self-efficacy for learning, and control of learning beliefs. Included are ANOVA tables of significance; red P values are statistically significant.

The interviews provide many illustrative examples of students with depressed intrinsic and/or extrinsic motivation in their writing class that in some way was related to perceptions of competence; for example,

“I think I can do a mediocre job and turn something out. Maybe – I think the lack of certainty in my own writing abilities come from my general feeling of being uneducated in certain senses.”

“I’ve never done presentation before. I was like “Oh my god.” It’s not long, it’s like five minutes, but I was so nervous, like the whole class would be listening to my voice... I fear, oh, my English is not good enough, or my pronunciation is not perfect, a lot of things going on.”

However, in many cases the cause of the students’ feelings of motivation-depleting incapability had as much to do with their perceptions of the subjectivity of the courses as their own inherent ability.

“And the TA gave me an A originally on the paper and the professor knocked it down to a C because of a whole bunch of garbage, in my opinion. And so, to me, that just fuels that distaste for super-subjective course grading.”

“There was a generally objective rubric of what has to be in the lab report. But a completely subjective evaluation of it. I put all of the things in that have to be there, and I format it correctly, and then beyond that? Trying to guess what they like more.”

It’s notable that the student who offered the second quote was a capable and enthusiastic writer outside his engineering writing classes; his low self-efficacy was not for writing itself, but for his writing courses. His eventual reaction to the subjective nature of his writing courses was that he

decided to only work hard enough to get a C, despite being capable of much better. In such cases, grades not only fail to motivate, but act as a directly demotivating factor[20].

Writing about interesting topics: a catch-all motivator?

If we cannot trust grades to be a universal motivator of our students, there is a different strategy that students seem to respond well to, including students with low perceptions of competence and low intrinsic or extrinsic motivations: the ability to write about interesting topics. We have previously reported on students' positive responses to assignments that allowed them to write about something that interested them[11]. Within the context of this present work, it became clear in the interviews that interesting writing-to-learn assignments appealed to students across a spectrum of existing intrinsic (and extrinsic) motivations for their writing classes.

Students with high intrinsic motivations predictably used writing projects as an enjoyable way to develop their ideas and synthesize knowledge. But students with low intrinsic and/or extrinsic motivation also responded positively to interesting topics, for a different reason: these students, in effect, were able to use their interest in some other topic as a grappling hook to engage with the writing. In many cases these students deeply valued the opportunity to choose a topic, implying that if they could not be otherwise find a motivating satisfaction in the class, then at least they should be permitted to motivate themselves.

This theme across the surveys and interviews supports an idea in the Self-Determination Theory of learning motivation that autonomy is an important component of motivation, and indeed, that intrinsic motivation often depends on a sense of autonomy as well as competence[9], [10]. Students' positive responses to interesting content continue to suggest that writing-to-learn is a good match to engineering, and a promising way to introduce more writing into the engineering curriculum[21]. It is notable that a majority of interviewed students could not only talk about a complex topic that they'd enjoyed writing about, but that many students followed up with an enthusiastic and articulate description of the principles they'd learned. This spontaneous and joyful recall suggested that this material (and their ability to communicate it) had stayed fresh to these students over the months or years that had passed since they'd initially explored the topic within their writing assignment.

Conclusions

The sum of this data challenges many common ideas about students' intrinsic and extrinsic motivations within engineering writing classes. First, students' self-report of their intrinsic and extrinsic goal orientations at the beginning of their engineering writing classes were overwhelmingly positive, suggesting that students arrive at engineering writing classes with largely positive and constructive motivation. However, students' responses also revealed small deficits in their extrinsic and intrinsic motivation for their writing classes with respect to other traditional non-writing engineering classes, notably around items that concerned satisfaction: for learning and constructive challenge, and for achieving good grades.

Within our data we saw instances of intrinsic motivational deficits being due to the simple explanation that engineers might simply prefer technical courses to writing courses. However, a

stronger theme within our data points to students' perception that engineering writing courses don't contain material that can be learned deeply or satisfyingly.

Examining students' depressions in extrinsic motivation, towards achieving satisfaction through grades, revealed a more constructive relationship between students and their grades than they're often given credit for. Within this study, a large majority of the students' experiences indicated that grades must be tethered to psychological needs and values in order for them to be strongly motivating; and in most cases, the values students associated with motivating grades were positive, constructive, and at least partially internalized. These results deeply challenge a common motivational strategy that simply grading more sternly (or more leniently, for that matter) will prompt students to align themselves toward better performance and respect for writing subject matter. This respect, it seems, must come *before* grades can be motivating.

Finally, the results of this study supported a widespread idea that students' intrinsic interest in a course is related to their feelings of competence in the subject matter. The results also supported a less-often referenced relationship between extrinsic goal orientation and feelings of competence, perhaps reflecting the frequency with which students professed extrinsic motivations linked with internalized values. This relationship casts further doubt on the strategy that students with low competence and low motivation may be spurred toward learning by grades alone.

This study has suggested a number of actionable takeaways for educators:

1. Grades must be proxies for some other meaningful attainment in order for them to be strongly satisfying or motivating. Some promising grade-related attainments suggested in this data are social belongingness (perhaps via group projects), engineering achievement or identity (through authentic work, or credible appraisers), or at very least, a feeling that good grades are representative of high achievements. Toward this last point, activities that encourage students' accurate self-assessment (e.g., many of the suggestions in Bean's classic *Engaging Ideas*[22]) are promising toward helping them to understand and internalize levels of quality in writing.
2. Toward supporting both intrinsic and extrinsic motivation, perfunctory coursework does our students few favors. A frequent claim among curriculum decision-makers has been that engineering writing classes need to be easy, in order to accommodate low-achieving writers. Seen in light of the results of this study, such easy courses are likely to have a depressing effect on students' intrinsic and extrinsic learning motivations. A more promising strategy would be to raise the threshold of these courses, and focus on providing learning experiences that build writing self-efficacy such as feedback, revision opportunities, progressively challenging projects and rubrics, and opportunities to read and critique other students' or practicing engineers' work.
3. If students expect engineering writing coursework to be shallow, we are in a position to pleasantly surprise them. Engineering writing is commonly taught as a "low-threshold" skill, such that performance to a particular minimal standard is all that is necessary or beneficial. However, we as educators often have an intrinsic interest for engineering communication that is informed by a complementary interest in rhetoric, communication theory, information logistics, engineering practice, learning science, and human-centered design, none of which are shallow or

low-threshold areas of inquiry. A skilled instructor might find many ways to allow students to access this more challenging material without compromising the basic objectives of the course.

4. There are practical reasons not to allow students omnipotence over the topics that they write about—for example, the lack of liberating constraints is a deterrent to some students, and makes it easy for others to plagiarize. However, finding small ways to allow students more autonomy and more ways to use writing assignments as tools for learning and discovery is a promising way of providing an intrinsically motivating experience for all students, allowing them to use deep-learning strategies and persist through long assignments while enabling them a secondary channel to learn transferrable content in the engineering writing classroom.

Future work

Work in this study to date has examined task value as well as intrinsic and extrinsic motivation, as these are the cognitive constructs that we as educators most intuitively reach for when considering ill-motivated students. However, these are not the only means for motivation; in fact, they only represent the Value component of the Value-Expectancy motivation model that underlies this study. When we repeatedly and exclusively suggest value-related strategies of improving student learning motivation, we are likely to ignore the wealth of less obvious but equally powerful motivational factors and strategies that concern students' expectations of success, as well as their affective motivations in our class. Preliminary analysis of our data relating to expectancy constructs such as writing apprehension, self-efficacy, and control of learning beliefs has suggested strong themes in these realms that often lie under the surface, overshadowed by more visible Values-component modes of motivation. We will consider student data in light of other promising motivational factors in future work.

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