Motivation is a Two-Way Street: Pedagogies Employing Discussion in Addition to Lecture Display More Positive Student Motivational Response

Mr. Alexander E. Dillon, Franklin W. Olin College of Engineering

Prof. Jonathan D. Stolk, Southern Methodist University

Jonathan D. Stolk currently serves as the Executive Director of the Caruth Institute for Engineering Education, the TI Distinguished Chair in Engineering Education, and a Professor in Simmons School of Education and Human Development at Southern Methodist University. Stolk strives to design and facilitate extraordinary learning experiences. As a start-up faculty member at Olin College (2001-2015), Stolk created numerous project-based and interdisciplinary courses and programs that invite students to take control of their learning, grapple with complex systems, engage with each other and the world in new ways, and emerge as confident, agile, self-directed learners. Stolk’s research aims to understand how students experience different classroom settings, particularly with regard to how individuals express situational motivations and develop their own beliefs about learning. A core aspect of his professional work involves translating research to practice, by equipping instructors with design tools and conceptual frameworks that enable them to understand their classrooms in new ways, and to gain confidence in trying new approaches and deploying course prototypes. Stolk consults with a wide range of academic institutions on the design of unconventional curricula, and he offers hands-on workshops to faculty around the world.

Dr. Yevgeniya V. Zastavker, Franklin W. Olin College of Engineering

Yevgeniya V. Zastavker, Ph.D., is an Associate Professor of Physics at Franklin W. Olin College of Engineering. She earned her B.S. degree in Physics from Yale University in 1995 and her Ph. D. degree in Biological Physics from MIT in 2001. Dr. Zastavker’s research interests lie in the field of STEM education with specific emphasis on innovative pedagogical and curricular practices at the intersection with the issues of gender and diversity. Dr. Zastavker is currently working with Dr. Stolk on an NSF-supported project to understand students’ motivational attitudes in a variety of educational environments with the goal of improving learning opportunities for students and equipping faculty with the knowledge and skills necessary to create such opportunities. One of the founding faculty at Olin College, Dr. Zastavker has been engaged in development and implementation of project-based experiences in fields ranging from science to engineering and design to social sciences (e.g., Critical Reflective Writing; Teaching and Learning in Undergraduate Science and Engineering, etc.) All of these activities share a common goal of creating curricular and pedagogical structures as well as academic cultures that facilitate students’ interests, motivation, and desire to persist in engineering. Through this work, outreach, and involvement in the community, Dr. Zastavker continues to focus on the issues of women and minorities in science/engineering.

Dr. Michael D. Gross, Wake Forest University

Dr. Michael D. Gross is an Assistant Professor of Chemistry and a member of the Center for Energy, Environment, and Sustainability at Wake Forest.
Motivation is a Two-Way Street: Examining Correlations Between Student Motivations and Incidences of Lecture and Discussion Activities

Abstract

This research paper investigates the relationship between two of the most ubiquitous classroom activities – lecture and discussion – and their correlation to student motivation. This investigation uses a dataset from 27 introductory STEM classes across 7 institutions that participated in weekly surveys, in which students listed the activities they had recently undertaken and then completed a multiple choice motivation survey. The motivation survey, based on the Self-Determination Theory (SDT) framework, measured the levels of four distinct types of motivation - amotivation, external regulation, identified regulation, and intrinsic motivation - which were compared, in turn, to the balance of Lecture and Discussion activities in the participating classrooms. The correlations between classroom activity and average level of student’s motivation response were found to be significant for intrinsic motivation and external regulation, and insignificant for identified regulation and amotivation. The purpose of this paper is to stimulate discussion around the implications of these preliminary results for pedagogical practice.

Introduction

Motivation – the psychological drive to take action – is frequently cited both colloquially and academically as a powerful factor for understanding individuals’ engagement, behavioral patterns, and performance. Since William James’s early explorations of will in 1890,¹ the existence and influence of motivation have been studied in numerous environments including, notably, academic settings. Strong correlations have been found between a person’s motivational state and short, medium, and long-term outcomes such as performance, satisfaction, and persistence - three goals central to pedagogical refinement and revision. Specifically, research conducted over the past three decades strongly suggests that motivations are tightly linked to outcomes such as self-efficacy, critical thinking, creativity, self-regulation, and pro-social behavior²-⁸ - goals that are identified as critical to the professional success, and in particular, to the success of STEM graduates.⁹-¹³

One useful framework for characterizing the dynamics of motivation is Self-Determination Theory (SDT), which suggests that motivation is not a simple binary phenomenon – something “students either have or they don’t” – but is instead a complex sensation resulting from the satisfaction or frustration of three fundamental psychological needs: autonomy, relatedness, and competence. SDT posits that the degree to which an activity does or does not satisfy these fundamental needs influences whether one does or does not sense the drive to engage in that activity as coming from within one's self: this dynamic allows motivation to be characterized along a continuum of internalization.¹⁴ While the range from external to internal motivation is theoretically continuous and possibly multi-dimensional, for practical discussion and study it can be simplified to a set
of usefully distinct categories along a single axis of perceived self-determination, shown in Figure 1 with degree of internalization increasing from left to right. An important nuance regarding motivational responses lies in recognizing that the four types of motivation are not mutually exclusive. Depending on the situation, individuals may simultaneously show high levels of two or more of the motivation types.\textsuperscript{15,16}

### self-determination continuum

<table>
<thead>
<tr>
<th>Motivation Type</th>
<th>Amotivation</th>
<th>External Regulation</th>
<th>Identified Regulation</th>
<th>Intrinsic Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>disconnection between actions and outcomes (good or bad)</td>
<td>striking to earn rewards, or avoid punishments</td>
<td>identifying importance of a task</td>
<td>striving based on personal interest, curiosity, and passion</td>
</tr>
<tr>
<td>Example SIMS Items</td>
<td>I don’t see what this activity brings me.</td>
<td>I am supposed to do [the activity].</td>
<td>I think that this activity is good for me.</td>
<td>This activity is fun.</td>
</tr>
<tr>
<td></td>
<td>I do this activity but I am not sure if it is worth it.</td>
<td>I don’t have any choice.</td>
<td>I believe that this activity is important for me.</td>
<td>I feel good when doing this activity.</td>
</tr>
</tbody>
</table>

**Figure 1.** The self-determination continuum, showing the four types of motivation measured in this study, along with example SIMS survey prompts. Figure adapted from [14].

For the purposes of this study, we consider four distinct types of motivation along the continuum: amotivation, external regulation, identified regulation, and intrinsic motivation. Amotivation describes a condition that occurs when learners find no value in the learning activity and expect no desirable outcomes. Amotivated students may say things like "it doesn’t matter how hard I study, I’m going to fail this exam.” On the other extreme of the continuum lies intrinsic motivation, a state described by self-assessed interest, enjoyment, inherent satisfaction, and personally valuable goals. Intrinsically motivated students may make comments like “I get to do what I love in this class!”

Between the two ends of the internalization continuum are extrinsic motivations, in which initiative and regulation of action may be prompted by inputs ranging from external rewards and punishments (external regulation) to an identification of value in the learning activity (identified regulation). Classic “extrinsic motivation” is best described by external regulation: students motivated primarily in this way might say “just tell me what I need to do to get an A in this class,” or “if I don’t get good grades, my parents are going to kill me.” Identified regulation, on the other hand, is a more internalized form of extrinsic motivation, described by such student comments as “I don’t love this class, but I see why it’s important to my major,” or “this experience will help me reach my personal goals.”

Measurement of these motivations is enabled through the psychological research community’s development of validated survey instruments,\textsuperscript{17,18} which have been employed by members of the education research community to establish a host of valuable relationships between motivational orientations and educational outcomes. Fundamentally, it has been shown that not all types of motivation are equally effective for learning. For example, students with high intrinsic motivation and identified regulation show enhanced learning engagement, improved self-regulation, more
persistence, better performance, and healthier academic development.\textsuperscript{3,14,19-27} Conversely, desirable learning outcomes correlate negatively with high levels of external regulation and amotivation.\textsuperscript{20,28,29}

For those concerned with the perceived tension in STEM education between the need for educational rigor and the needs for increased student persistence in STEM disciplines, the correlation between internalized motivations and cognitive engagement and performance may be of particular interest. In fact, the aforementioned results suggest these two desired outcomes can be satisfied by stimulating the exact same thing: students’ intrinsic motivation. While there is certainly still room to investigate the extent of correlation vs. causation within the cited literature, these results nevertheless seem to urge the exploration of how student intrinsic motivation can be meaningfully and practically cultivated in the classroom. In this study, we endeavor to examine the extent to which this cultivation may be possible by shifting classroom communication from a unidirectional paradigm, represented by lecture, to a method that includes bi- or multi-directional communication, represented by classroom discussion.

**Data Collection Methods**

As part of a larger mixed-methods study of student motivation in introductory STEM classes, participating students were asked to complete a two-part survey about classroom activities and student motivational attitudes in one week periods over the course of the semester. In the first part of the survey, activity data were collected through an open-ended question that included a sample list of potential activities students may have been involved in (Lectures, Readings, Problem-Solving (in class or homework), Lab Work, Field Trips (industry, community, etc.), Project Work, Design/Fabrication, Discussion, Other). In the second part of the survey, students reported their motivations using the Situational Motivation Scale (SIMS).\textsuperscript{17} SIMS is a validated and robust survey, which adapts motivational constructs from SDT and combines them with a 1-7 Likert scale to indicate how strongly a respondent is experiencing four types of motivation: amotivation, external regulation, identified regulation, and intrinsic motivation.

Seven study sites participated in the study and the data were collected from 31 unique courses taught by 29 unique instructors. After reviewing the data, we chose to require at least 30 survey responses in a given class to calculate representative means, leaving 27 courses for further analysis. The study sites ranged from large to small, public to private, and technical to liberal arts, and were located throughout the continental United States; class sizes ranged from very small (<15) to very large (>500).

**Analytical Methods and Results**

Figure 2 summarizes the most frequent keyword responses to the first part of the survey, which asked students to specify their course activities from the past week. This question was posed in free-response format but was accompanied by the aforementioned list of common activities to help jog a participant’s memory. The original intent of this prompt was to solicit moderately in-depth descriptions of activities, but we found that most
students simply listed whichever of the provided activities occurred during the week with no further elaboration. Although a limitation in the study design, this survey instrument feature became an advantage in post-hoc analysis of the aggregated dataset because the consistent use of a select few keywords facilitated cross-course comparisons in a way that true free-response data may not have. In addition to the anticipated course activity language, other common words such as “class” and “week” appeared frequently in students’ responses, e.g., “This week in class, we worked on problem solving.” For the purposes of this analysis, nouns such as these were not removed from the dataset as they hinted at how students were using the text box.

Figures 2 and 3 illustrate the percent of collected responses which contain a given activity, on an overall and per-class basis respectively. These demonstrate a clear hierarchy in the frequency of references: for instance, there is typically a very sharp drop-off in mentions between the 1st and 5th most common mentions.

![Figure 2](image)

*Figure 2 – The top 10 most-frequently cited course activity keywords across the dataset. The y-axis represents the percentage of student responses that included the course activity keyword. This paper focuses on lecture and discussion activities, which are highlighted in black and white, respectively.*

Reviewing the overall prevalence of activities and the patterns in the hierarchy of their mentions allowed us to establish sets of unifying and distinguishing characteristics. Activities such as “problem solving” and “reading” appeared in all sampled courses, while “discussion” and “lecture” appeared in most – these observations were useful for establishing a common basis of comparison across the dataset. Next, a starting point for establishing a basis for differentiation arose by comparing the activities’ relative prevalence. In a first pass, traditional pedagogies were identified by the characteristically
Figure 3 – Histogram of activity keyword presence in surveys from each course. Courses with sections taught by different instructors are distinguished with a numeric suffix, and courses that were primarily lab sections carry a parenthetical note. Analysis of the most frequently cited activities enabled an aggregate data-driven assessment of course pedagogy as traditional, non-traditional, or mixed. Lecture (black) and Discussion (white) activities were present to various degrees in nearly every course; this facilitated the development of a scale defining an activity balance continuum, referred to later as the Lecture Discussion Metric, against which all the courses’ motivation data could be compared.
dominant mentions of either “lecture” or “lab,” followed by other typical technical course activities such as “problem-solving” and “reading,” and with infrequent mention of non-traditional activities such as “project work.” Mixed pedagogies were identified in courses where “lecture” was still the most cited activity, but in which a non-traditional activity such as “project work” was cited within the top set of mentions. While we initially suspected “non-traditional” courses would be predominantly project-based, we found two courses with listed activities similar to those of a traditional or mixed pedagogy course, but with the opposite relative prevalence of activity references: in these courses “discussion” activities were dominant in a way that was otherwise unique in the dataset. This led us to include “discussion” as a keyword that could indicate a non-traditional pedagogy, which informed our second pass of classifications, reflected in Figure 3.

The inclusion of “discussion” as an indicator of non-traditional pedagogy was opportune, as limitations of the pedagogy classification process were becoming clear. Using “project” mentions as the indicator would have greatly limited the scope of the investigation: in most courses students did not report project activities. Furthermore, when comparing the prevalence of project activity citations in different courses, it was clear that “project-based” is not a binary identifier, and should be thought of as existing on a continuum. However, because only a few of the classes had significant numbers of project references, even if we were seeking to categorize along a continuum, many of the courses would be placed at zero.

In an attempt to find a more useful pedagogical basis for examining student motivation across courses, we turned to the “discussion” activity. Because this specific activity appeared to some degree in most courses, it had the immediate advantages of not only incorporating the majority of the sampled courses, but also doing so in a way that supported portraying pedagogy in a continuous, as opposed to categorical, manner. Perhaps more powerfully, the ubiquity of at least some “discussion” mentions across the dataset could lead one to infer that discussion is an activity of practical relevance to all of the STEM instructors in our study.

To investigate the relationship between motivation and pedagogy, the dependent variable (mean motivation) was calculated by averaging all of the motivation classroom data. The independent variable construct was calculated based on two major assumptions: (1) all class activities may affect students’ overall motivations; and (2) since “lecture” and “discussion” were mentioned to various degrees in nearly every course studied, and those degrees of mention can be used as defining characteristics of those courses pedagogical classification, these activities (or a balance between them) may serve as a metric for an independent variable.

The following metric was therefore used as the independent variable:

\[
\text{Discussion/Lecture Metric} = \left( \frac{n_{\text{discussion}}}{n_{\text{maximum}}} \right) - \left( \frac{n_{\text{lecture}}}{n_{\text{maximum}}} \right)
\]
where \( n \) represents the per-classroom number of references to “discussion,” \( n_{\text{discussion}} \), “lecture,” \( n_{\text{lecture}} \), and the most frequently cited activity, \( n_{\text{maximum}} \), which could be “lecture,” “discussion,” or some other activity such as “project” or “reading.” This independent variable construction is convenient as its values are bound between +1 (a class, in which “discussion” is the most frequent activity, no “lecture”) and -1 (a class, in which “lecture” is the most frequent activity, no “discussion”). Zero-values then correspond to a class in which either (a) students did not cite neither “lecture” nor “discussion” as activities or (b) students cited both “lecture” and “discussion” evenly. We used ordinary least squares regression and two-tailed hypothesis testing, implemented in the R statistical computing language, to check for correlations across our dataset between the Discussion / Lecture Metric and each of the four types of motivation measured by the SIMS.

When correlated against the four types of motivation measured in the quantitative surveys, the Discussion / Lecture Metric was found to be highly statistically significant for two motivation types, and insignificant for the other two. This result validated our use of the metric in that it did not create numeric distributions that were biased to the point of only producing one result or the other.

Highly significant correlations were found between the Discussion / Lecture Metric and Intrinsic Motivation (positive correlation, \( p < .01 \)) as well as between Discussion / Lecture Metric and External Regulation (negative correlation, \( p < .001 \)), as shown in Figure 4. That these two types would show similar strength of correlation in opposite directions is in line with the SDT literature, in that these two types of motivation are often counterpoised such that the presence of one likely indicates the absence of the other.\(^7\) We found no significant correlations for either Identified Regulation or Amotivation levels, as shown in Figure 5.

Figure 4 – Intrinsic (left) and External (right) Motivation means versus Discussion / Lecture Metric for each sampled course. Shapes represent the dominant pedagogical approach: square = traditional, diamond = mixed, and circle = non-traditional. Lab courses are denoted with an “(l)”; while they can be seen to have metric values similar to mixed pedagogy non-lab courses, Figure 3 demonstrates these courses are dominated by the traditional “labwork” activity. These types of motivation were found to be highly significantly correlated with the Discussion / Lecture Metric.
Discussion

The highly statistically significant correlation between intrinsic motivation and the Discussion / Lecture Metric suggests that there is potential for a complex and powerful psychological factor like internalized drive to be meaningfully linked to a practical and accessible in-class activity like discussion.

This analysis also demonstrates that pedagogical methods do not need to be mutually exclusive within a course. Although many of the sampled courses employed the traditional approach of lecture with problem solving and readings, several courses engaged students in a more balanced mix of conventional and active pedagogies. Given the positive relationship between active engagement (via discussion or projects) and motivation illustrated in this analysis, instructors may want to consider shifting some course activities toward engaging classroom approaches. If discussion is indeed a meaningful factor for student drive, then its implementation is likely to be less daunting compared to, for example, project-based learning methods, which are often discounted as prohibitively demanding of personal and materials resources or not suitable for a given content. Discussion represents an accessible and scalable starting point for instructors who may be curious about how to facilitate greater intrinsic drive in their courses.

Pedagogical experimentation coupled to motivational measurement should be encouraged because, among other reasons, currently the exact catalysts of the hypothesized discussion-motivation relationship are not clear. Since intrinsic motivation in many ways represents the inverse of external regulation, one could question the fundamental directionality of our observations: do discussion activities increase intrinsic motivation, reducing external regulation as an after-effect? Or does the effect run vice versa? On the one hand, a student’s feeling that their voice is heard in a class context could act to

Figure 5 - Identified Regulation (left) and Amotivation (right) means versus Discussion / Lecture Metric for each sampled course. Shapes represent the dominant pedagogical approach: square = traditional, diamond = mixed, and circle = non-traditional. Lab courses are denoted with an “(l)”, see Figure 4 caption for further comment. These two types of motivation were not found to have any significant correlation with the Discussion / Lecture Metric
mitigate an otherwise perceived lack of agency in that class. In this case external regulation may be reduced, and intrinsic motivation might increase as a by-product. On the other hand, SDT suggests that actions are integrated with the self when they are perceived to satisfy three fundamental psychological needs – autonomy, relatedness, and competence – so the apparent effect of increased intrinsic motivation or decreased external regulation could be further investigated by examining the extent to which basic needs are addressed in the course activity.\(^{21}\) For example, positive interactions in group discussions could trigger feelings of relatedness to other students and the instructor; open expression of ideas could contribute to students’ sense of control and autonomy; and the use of higher-level cognitive strategies in situated social interactions could bolster a sense of competence.\(^{30-34}\) Ultimately, the trends observed across our dataset are likely the result of some combination of both of these factors, as well as other personal and social-contextual influences not yet identified.

The insignificant connection between amotivation and the Discussion / Lecture Metric could be attributed to the fact that overall levels of amotivation are very low, which makes it difficult to establish a strong correlation for this particular motivation type. This result was not surprising, given students’ choice to attend college and opt into a specific STEM major.

The absence of correlation between identified regulation and the Discussion / Lecture Metric was not expected. Identified regulation occurs when individuals recognize and personally endorse the reasons for engaging in an activity and is described by feelings of importance or utility;\(^{15,29}\) while intrinsic motivation indicates a fully internalized drive based on personal interest, enjoyment, or passion. It is an intriguing outcome that intrinsic motivation showed a meaningful correlation with activity balance while identified regulation did not, given the strong coupling between these two forms of motivation frequently cited in the literature.\(^{17}\) One possible approach to resolving this apparently counterintuitive result is to consider the underlying reasons for students’ learning and academic trajectory: namely, consideration of the extent to which the value of STEM learning is couched in a professional context that may be associated with value or utility. In this case, identified regulation could serve as an indication of how relevant or important students felt the course activities were to their chosen path toward a desired academic major or professional career. Since it could be argued that this path is sometimes driven by desires for prestige or financial success, this may help explain how identified motivation could display dynamics different from those associated with a more fundamentally internal construct such as intrinsic motivation.

It is evident from the relatively high mean scores on identified regulation that students in most of the sampled STEM courses found some version of value, utility, or importance in their learning activities. Interestingly, a preliminary analysis of this dataset suggests that identified regulation appears to couple with intrinsic motivation in the non-traditional courses, but with external regulation in more traditional course formats. In traditional courses, where intrinsic motivation is lowest and external regulation is highest, students may primarily view course activities as valuable stepping stones towards an explicit career or professional goal. The optional comment field in the surveys often contained
references to the need for a good grade for medical school or to pursue a major – which would align with the utility-as-career perception.

In sum, this analysis highlights the important connections between instructors’ use of common pedagogical techniques — lecture and discussion — and students’ motivational responses in STEM courses. Our findings show that interaction via classroom discussion could play an important role in enhancing students’ intrinsic motivation, and decreasing extrinsic drive. We hope these observations may be useful for the education community to consider within a variety of contexts, from course designs in the near-term to strategic visions for educational impact in the long-term. We aspire to have helped make the powerful domain of motivation seem more realistically accessible, and we encourage the community to engage in its continued exploration.

Acknowledgments

This work was supported in part by a grant from the National Science Foundation (DUE-1322684, DUE-1445950, and DUE-1156832). All opinions expressed are those of the authors and not necessarily those of the National Science Foundation.

References


