WHY IS IT IMPORTANT FOR STUDENTS AND TEACHERS TO SHARE GOALS?

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ABSTRACT

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Teachers often use instructional goals to guide students' learning and to track their performance. Typically, teachers develop these instructional goals before they meet students and then hand over their list of goals to students during their first class session. Prior research shows that students do not necessarily understand the underlying principles of those broader terms and how they are to be assessed—they don't truly understand what is expected of them, nor how a teacher sets out to help them learn. The inadequacy in students' understanding about instructional goals has been shown to be related to student underachievement, disengagement in classes, and poor student-teacher relationships.

The effectiveness of goal-driven learning is dependent on the learner's ability to make informed decisions about what to learn and what strategies to use to achieve the desired objectives. Given that, I hypothesize that helping students understand their teacher's rationale behind the goal creation process will help students make better decisions with their study, demonstrate stronger motivation, develop better student-teacher relationships, and eventually improve their academic performance.

To test these hypotheses, I created an intervention that required students to have a discussion with their teacher about how the instructional goals were prioritized. Eighty-nine students from an introductory Microbiology class were randomly assigned into three conditions: (1) Goal Listing (GL) condition, in which students read a list of instructional goals as they were in the syllabus; (2) Goal Ranking (GR) condition, in which students read a list of instructional goals that had been ranked according to their importance by their teacher; and (3) Goal Ranking

+ Discussing (GRD) condition, in which students read the ranked goals and discussed them with their teacher in a one-on-one meeting. The measures I used to test the effects of the intervention include study-time allocation, accuracy of self-assessment for an upcoming exam, help-seeking tendency toward the teacher, attitude toward the class and the teacher, and class performance.

Results showed that the GRD group performed significantly better than the other two groups on every behavioral measure, but no significant difference was found between the GR and GL group. Specifically, students in the GRD condition scored significantly higher, planned their study more strategically, predicted their final grade more accurately, and demonstrated stronger tendency to seek help from their teacher. Mediation analyses were conducted to test whether students' metacognitive strategies causally contributed to their better performance. Results show that both study-time planning and self-assessment mediated exam performance for the GRD group, but not for the GR group. This suggests that a discussion on the ranked goals is more powerful in affecting students' learning process than simply showing them the goals without an explanation. In addition to the behavioral measures, we also examined students' attitudes toward their teacher and the course. The results show that the GRD group gave a more positive evaluation of their teacher and perceived the course as more interesting and valuable than the other two groups. This suggests that a discussion of goals can bring about motivational benefits such as improving student-teacher relationships.

This study made unique theoretical and practical contributions to our understanding of how teachers can best communicate goals to their students. First, most previous research on students' goals focused on *what* goals might be beneficial to learning, but did not address *how* to enable students to strategically arrive at those goals. Our study suggests that having teachers explain how their instructional goals were set can be a promising step toward that end. Second,

our findings add to past research on metacognitive training, which largely focused on teaching strategies to students. Our study suggests that we can improve students' use of metacognitive strategies by helping them gain a clear understanding of the instructional goals. Moreover, the study points to the important role of social interaction in enhancing students' self-regulating abilities such as planning and self-assessment. Metacognition is not just about understanding one's own thinking. Understanding the goals of those who are important to one's learning can be helpful to improving one's metacognition. Finally, the study offers clear guidance in how to make teachers' office hours more productive. Goal discussion provides an implementable tool that can improve the effectiveness and efficiency of their communication and their relationship.

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CHAPTER I: INTRODUCTION

Background of the Problem

Low achievement in class is often the result of students failing to understand what their teachers expect of them (Black & Wiliam, 1998, 2010; Gears, 2005). Many teachers address this issue by listing their instructional goals in the syllabus, but this approach seems not quite successful (Moss & Brookhart, 2009). As empirical research suggests, even when instructional goals are explicitly included in the syllabus, students often do not fully understand how these goals are prioritized (Lin, Siegler, & Sullivan, 2010; Shi, Lin-Siegler, & Xu, 2016) and why (Moeller, Theiler, & Wu, 2012). Moreover, the inadequacy in students' understanding about instructional goals has been shown to relate to student disengagement in class (Klem & Connell, 2004), demotivation behavior (Gorham & Christophel, 1992), and poor teacher-student relationships (Wubbels & Brekelmans, 2005).

More alarmingly, neither teachers nor students seem to be aware of the necessity of exchanging opinions on instructional goals. Oftentimes students just take in whatever information provided by their teachers but seldom approach their teachers for a better understanding of why certain content is taught. To many teachers, instructional goals are merely one component of the course description and it never occurs to them that a discussion of these goals might impact their students' learning.

Overview of Theoretical Background

According to the goal-driven model, learning is an active and strategic process in which the learner attempts to identify and satisfy its needs in the context of its task, its prior knowledge and abilities, and environment opportunities for learning (Leake & Ram, 1995). The effectiveness of goal-driven learning depends on the learner's ability to make informed decisions

about when and what to learn, on selecting appropriate strategies to achieve the desired objective, and on regulating the process of applying the chosen strategies. We expected that helping students understand how their teachers select and prioritize course goals would have several beneficial impacts on their learning processes and outcomes.

First, a discussion of goals might affect the way students allocate their attention and time when planning their study. Goals can direct one's attention and time toward goal-relevant objects and away from goal-irrelevant objects and regulate effort expenditure based on the demands of goal-related tasks. This "directional" mechanism of goals has been empirically shown to affect one's performance (for a detailed review, see Locke & Latham 2002). When students study for exams, it will be more effective for them to direct their attention and time to the contents most relevant to the instructional goals.

Second, a discussion of goals can facilitate self-assessment through "informational" mechanism, which provides one with necessary information to make judgments about oneself. Accurate self-assessment has been regarded as key to effective self-regulation (Schoenfeld, 1987). Research shows that students make better decisions with their study when they can accurately discern their strengths and weaknesses (Thiede, 1999; Thiede, Anderson, & Therriault, 2003). A discussion of instructional goals, as we anticipate, may help students reflect on "what I know" and "what I don't know" and consequently lead to a more accurate self-assessment.

Third, a discussion of goals can make students more willing to approach their teachers for necessary help. While effective help-seeking has been shown to be important for successful learning, students often make poor help-seeking decisions – either using resources in a suboptimal manner or avoiding seeking help altogether (Aleven, Mclaren, Roll, & Koedinger,

2006). Discussing goals can help promote students' tendency to seek help by making them aware of their weaknesses and the need to take action. Students will also be more likely to realize the instrumental role that their teacher can play in achieving their learning goals and thus be more motivated to approach them for help.

Overview of the Study

The present study aims to investigate whether explicit discussion of instructional goals causally contributes to student performance and, if so, how it works. Eighty-nine college students from an introductory Microbiology class participated in our study. They were randomly assigned into three conditions: (1) Goal Listing (GL) condition, in which students read a list of instructional goals in the syllabus; (2) Goal Ranking (GR) condition, in which students read a list of instructional goals that had been ranked according to their importance by their professor; and (3) Goal Ranking + Discussing (GRD) condition, in which students read and discussed the ranked goals with their professor in a one-on-one meeting. The outcome measures examined in this study include study-time allocation, accuracy of self-assessment for an upcoming exam, help-seeking tendency toward the teacher, attitude toward the class and the teacher, and class performance.

Research Questions/Hypotheses

This dissertation seeks to answer the following research questions:

1. Do students in the GRD condition perform better than their peers in the GL and GR conditions?
2. Do students in the GRD condition demonstrate more metacognitive skills than their peers in the GL and GR conditions?
3. Does goal discussion bring out motivational benefits?

We have also conducted exploratory analyses to address the following question:

4. Do the increased metacognitive skills of students in the GRD condition causally contribute to their better performance over their peers in the GL and GR conditions?

We hypothesized that students in the GRD condition would outperform their peers in the exam. We also hypothesized that, compared to students in the GL and GR conditions, students in the GRD condition would demonstrate better use of metacognitive skills. Specifically, we measured students' study-time allocation, accuracy of self-assessment of their upcoming exam, and help-seeking tendency toward their professor. In addition, we examined students' perception of their professor in terms of connectedness and instrumentality and their attitude toward the course in respect of interest and value. Students in the GRD condition were hypothesized to hold more positive attitude toward their professor and the course than their peers. Finally, we also hypothesized that students in the GRD condition would outperform their peers because of their better use of the aforementioned metacognitive skills.

Significance of the Study

To our best knowledge, this study is the first naturalistic investigation into the effects of having students and teachers discuss instructional goals on students' learning processes and outcomes. The random-assignment design allows us to establish the relationship between goal discussion and students' academic achievement. More importantly, the study helps to further elucidate the mechanism through which goal discussion leads to a better performance.

From the theoretical perspective, this study would contribute to our understanding of goal communication in relation to learning and point to the important role of social interaction in metacognition.

From the practical perspective, this research would lay the ground work for designing classroom-based interventions that aim to help students learn more effectively and strategically, supporting the development of self-regulated learning. These might be of great interest to teacher training programs of the 21st century.

CHAPTER II: LITERATURE REVIEW

Goals and Instructional Goals

Definition

Because goals have been conceptualized and defined differently by researchers, it is necessary to first provide a definition for "goals" in this study. *Goals* in this study are defined as future valued outcomes (Locke & Latham, 2006). In education, goals have been shown to be a powerful predictor of student academic accomplishment such as course grades and test scores (Coutinho, 2007; Lin et al., 2010), aspects of motivation such as effort, persistence (Vansteenkiste, Lens, & Deci, 2006), and interest (Allen, 1986; Wentzel, Baker, & Russell, 2012), positive classroom behaviors (Wentzel, 1989, 1998), and students' management of their study time (Volet & Lawrence, 1989).

In this study, we specifically zoom in on instructional goals. *Instructional goals* are specific statements that describe what students of a certain course will learn or will be able to do after the course (Seidel, Rimmele, & Prenzel, 2005). For example, "to improve reading comprehension skills, such as guessing word meaning through the context" can be an instructional goal for a foreign language class; "to demonstrate familiarity with major concepts and theoretical perspectives" can be a goal for an introductory psychology class.

Importance to Teaching and Learning

Instructional goals are a vital component of curriculum planning because they specify what concepts and skills students are expected to acquire and determine what kind of learning environment the teacher has to create. In other words, instructional goals help to articulate teachers' vision about how learning can be fostered.

Instructional goals are equally important to students because they not only outline the most important outcomes that students are expected to attain, but also specify how their learning will be assessed. Therefore, instructional goals are usually laid out in the syllabus as the very first item.

While instructional goals are regarded as an indispensable component of the curriculum across subjects, they are particularly critical to domains such as mathematics and science that center on the explicit teaching of a skill-set using lectures or demonstrations. To make *direct instruction* effective, teachers need to specify goals, organize lessons in a step-by-step acquisition of learning contents, and assess student learning outcomes based on the course goals (Cobern et al., 2010).

Although it is agreed that instructional goals are important because they guide both the teaching and learning in the classroom (Ames, 1992; Black & Wiliam, 2010; Harden, 2002), very few studies have investigated whether students and teachers understand the instructional goals differently. What is even less known is whether the difference in their understanding of instructional goals would impact student learning processes and outcomes.

Empirical Studies on Student and Teacher Goals

Goal Difference

There has been growing evidence pointing to a serious question: teachers and students in fact pursue very different goals in the classroom (Cothran & Ennis, 1998; Lemos, 1996; Lin et al., 2010). For example, Lin et al. (2010) surveyed 371 fifth-grade students and their 12 teachers about their goals for going to school. Results showed that the teachers put far more emphasis on the learning goals but many students did not view learning as a high priority. Rather, some students rated other goals such as good classroom behaviors as more important. In Shi, Lin-

Siegler, and Xu (2016)'s study, 48 foreign language students and their teachers rated five goals excerpted from their course syllabus. Results showed that the most important goal rated by the teacher was ranked as only the third most important by the students.

Why do students and teachers have such different understanding of goals for the same course, even after spending an entire semester or year together?

First, the language in which instructional goals are written is vague. As some researchers (Lei, 2010; Seidel et al., 2005) point out, instructional goals are not always student-friendly. For example, instructional goals are usually broad statements about what students should acquire upon completion of a course. To students, these goals are neither "clear" nor "transparent" (Moss & Brookhart, 2009). Students do not necessarily understand what underlie those broader terms and how they are to be assessed (Harden, 2002). As a result, many students find it difficult to identify with the learning contents and integrate instructional goals into their own learning goals (Krapp, 2002a, 2002b).

Second, the fact that multiple goals are pursued together in class might cause some confusion. Most courses do not focus exclusively on one single goal, but often have a list of goals for students to achieve. However, not all listed instructional goals are equally important. Some goals are more important to the course than others. Thus, prioritization of the goals is actually the key to understanding the instructional focus of a course. Prioritization concerns relative importance. It guides the allocation of available resources to each of the goals in order to achieve the optimal outcome. To teachers, prioritizing the selected goals might be based on institutional requirements (Wentzel, 2000), national standards (Magnan, 2012), professional experience, or personal preferences (Pushkin, 2001). Yet, none of these reference points is available to students, nor is it common for a teacher to explain the rationale for selecting and

prioritizing instructional goals. Therefore, it would be very difficult for students to make an informed decision as to which goal(s) to spend more time on in front of multiple goals. They may also find it difficult to see the wood for the trees because the massive description of goals can obscure the overarching objective of the curriculum.

The inherent complexity of instructional goals makes us wonder how teachers and students deal with them in their day-to-day classes. Unfortunately, the reality is not encouraging. First, teachers reported that they devoted very little time to discussing the rationale for choosing the goals and their relative importance. Some teachers even said that it never occurred to them that they should talk about them in class. Second, although students know where to find the instructional goals, many of them do not even bother to read them through. It is safe to say that many students are neither aware of the benefits of understanding their teachers' goals, nor the consequence of not knowing their teachers' goals.

In sum, although instructional goals are usually listed on the syllabus explicitly, students often do not fully understand why their teachers choose these goals and how they are prioritized.

Goal Alignment

Does the gap between students and teachers' understanding of instructional goals matter? Growing research, albeit still limited in quantity, supports the positive relationship between goal alignment and student achievement and other learning-related outcomes.

Spera and Wentzel (2003)'s study was one of the few that examined students' and teachers' goals and how they were related to students' social and academic motivation. The findings indicated that high levels of student-teacher goal congruence were positively related to students' interest in class and their evaluation of teacher support. Another study by Wentzel (1989) demonstrated that the goals of high-achieving students (indexed by GPA) were more in

line with the key educational objectives set by the schools than those pursued by the low- and mid-achieving students.

Shi et al. (2016) focused in on course goals that were included in the syllabi of foreign language classes and investigated the goal alignment between students and their teacher within one class. The results showed that the level of student-teacher goal alignment greatly varied between individuals. Furthermore, the study also showed that goal alignment was significantly correlated to students' class grade and motivation, although it did not explore the possible underlying causes. Shi, Lin-Siegler, and Wei (In press)'s study found a significant positive correlation between student-teacher goal alignment and the frequency of their interaction outside of class, and between goal alignment and how students perceived their teacher's instrumentality to their learning. The results suggested that when students' goals were more aligned with their teachers', they were more likely to approach and interact with them. The authors argued that goal pursuit could be examined from the interpersonal perspective, that is, whether and how goal alignment with others might affect the perception and behavior of the goal pursuer. All of these studies, although limited by their correlational nature, provided foundational work for the current study.

To sum up, while instructional goals are mostly generated by teachers, they should be of equal importance to both teaching and learning. In addition, we argue that instructional goals not only describe the intended learning outcomes for students, but also provide a useful vehicle for communication between students and teachers about how to make learning happen (Harden, 2002). In the next section, we will explain why discussing instructional goals can be beneficial to students' learning, which serves as the rationale for our proposed intervention.

Effects of Goal Discussion

Goals and Metacognitive Strategies

Studies on metacognition have offered insights about the traits that differentiate successful students from less successful ones. Students' metacognitive knowledge and use of metacognitive strategies can have an important influence on their academic achievements because they help students monitor and control their learning process (Paris & Winograd, 1990; Pintrich, 1999; Zohar & Barzilai, 2013). Most models of metacognitive control or regulation of cognition include three general types of strategies: planning, monitoring, and evaluating (Livingston, 2003; Vrugt & Oort, 2008). Planning concerns the allocation of resources that affect performance and the selection of appropriate strategies. Monitoring refers to one's awareness of comprehension and task performance. Evaluating is about appraising learning outcomes and efficiency. Goals play an important role throughout the implementation of these strategies. For example, planning usually begins with setting goals for studying. In order to monitor the process and evaluate the outcome, there must be some goals or standards against which comparisons can be made.

Given the importance of goals to both teaching and learning, we hypothesize that helping students understand their teacher's instructional goals will exert influence on their use of metacognitive strategies, which will help improve their academic performance.

Influencing students' study-time allocation. Discussing instructional goals with teachers can affect how students plan their study time, directing their attention to the more important contents to learn.

Goals have been empirically shown to affect performance through the "directional" mechanism (for a detailed review, see Locke & Latham 2002), that is, goals can turn one's

attention and effort toward goal-relevant objects and away from goal-irrelevant objects and help one regulate effort expenditure based on the demands of goal-related tasks. For example, Rothkopf and Billington (1979) found that students with specific goals paid more attention to and understood better goal-relevant prose passages than goal-irrelevant passages.

In Ferretti, Lewis, and Andrews-Weckerly (2009)'s study, 4th- and 6th-graders were asked to write essays about a controversial topic after receiving either a general persuasion goal or an elaborate goal that included sub-goals based on elements of argumentative discourse. Results showed that students in the elaborated goal condition produced more persuasive essays that were responsive to alternative standpoints than students in the general goal condition. The analyses revealed that the elaborate goal induced and guided the treatment group to more likely consider alternative perspectives and refute them. The results confirmed that students' attention and effort was guided by the goals assigned to them and led to their varying learning outcomes.

In line with these studies, we expect that discussing goals can influence students' study-time allocation. When teachers explicitly talk about their instructional goals, students can gain a deeper understanding of the selected goals and their relative importance. Students' attention will be given to the content that are in congruence with the focus of the assessment, which are important to the mastery of the subject knowledge. It can be expected that students will allocate their time more strategically, giving more attention to the chapters that weigh the most in the exam, for example. All in all, discussing instructional goals give students a clear focus and direction to work toward, which makes their planning more efficiently.

Influencing students' self-assessment. Discussing instructional goals with teachers can help students to assess their own performance more accurately.

Accurate self-assessment has been considered an essential component of effective self-regulation (Schoenfeld, 1987). People who can accurately discern their strengths and weaknesses tend to make effective decisions about where and how to apply their learning efforts (Thiede, 1999; Thiede, Anderson, & Therriault, 2003). On the contrary, misjudgment of one's ability can have negative consequences. People who overestimate their capabilities are prone to become demoralized over frequent task failure, while those who underestimate themselves may be reluctant to attempt a manageable task (Dunlosky & Rawson, 2012).

However, making an accurate self-assessment is not easy. A number of studies have shown that people often have illusions of knowing, and exhibit a general pattern of overconfidence during study (Benjamin & Bjork, 1996). Research in education finds that students' assessments of their performance tend to agree only moderately with those of their teachers (DePaulo, Charlton, Cooper, Lindsay, & Muhlenbruck, 1997). Students seem largely unable to assess how well or how poorly they have comprehended material they have just read, or their progress in newly learned skills and contents (Dunning, Heath, & Suls, 2004).

Goal discussion can play an important role in facilitating self-assessment through informational mechanism. People misjudge themselves for various reasons, and *information deficits* (Dunning et al., 2004) has been found to be a major one. A wealth of evidence suggests that erroneous self-assessments arise when people do not have all the information needed to make accurate assessments and do not take into account what they do not know (Dunning et al., 2004). Take science classes as an example. Students oftentimes only know that there are a lot of knowledge and skills to learn, but do not have the information and expertise necessary for them to discern whether deficits still exist. A discussion on instructional goals can help remedy such an information gap, because the goals serve as informational feedback that prompts students to

realize the shortcomings they are unaware of. When students can better identify "what I know" and "what I don't know", they will be able to make a more accurate prediction about their performance. The extent to which a student can accurately make self-assessment also impacts one's learning behavior (Falchikov & Boud, 1989). If a student realizes that she/he does not know very much about a particular topic during the goal discussion, s/he may spend more time studying it or seek different strategies to approach the subject matter and subsequently fill the knowledge gap.

Influencing students' help-seeking tendency. Discussing instructional goals with teachers can make students more willing to approach their teachers for necessary help.

Help-seeking - the ability to solicit help when needed - is theorized to be an important learning strategy and can be instrumental in the development of target skills and abilities (Ames, 1983; Nelson-LeGall, 1981; Newman, 1994). Help-seeking is metacognitive in nature because it reflects how one strategically mobilizes resources besides their cognition. As research repeatedly shows, students must make full use of their self-regulatory resources to attain their goals, which not only include intrapersonal strategies such as self-control (Duckworth, White, Matteucci, Shearer, & Gross, 2016) and willpower (Wei, Wang, & Klausner, 2012), but also interpersonal recourse (Fitzsimons & Shah, 2008; Palomares, 2014). The teacher, who has relevant expertise on the subject matter and who may have designed the course, is a valuable resource for students to utilize.

While effective help-seeking has been shown to be important for successful learning, students often make poor help-seeking decisions – either using resources in a suboptimal manner or avoiding seeking help altogether (Aleven et al., 2006). Studies (Fusani, 1994; Jaasma & Koper, 1999) show that less than half of the surveyed college students reported that they had

visited their professors outside the classroom. The communication between faculty and students has been found to be infrequent and largely limited to formal and structured situations such as classroom lectures (Li & Pitts, 2009). It is no exaggeration to say that the professors, one of the best resources available to college students, have not been utilized enough.

Nelson-Le Gall (1981)'s analyses of the help-seeking process will help us better understand why professors have been under-utilized by students. According to Nelson-Le Gall's model, which was expanded by Newman (1994), the help-seeking process comprises five steps: (1) become aware of need for help, (2) decide to seek help, (3) identify potential helper, (4) use strategies to elicit help, and (5) evaluate help-seeking episode. In this model, a learner must first become aware of the task difficulty or that she or he is stuck. Discussing goals can help promote students' tendency to seek help by making them aware of their weaknesses and the need to take action.

Students will also be more likely to realize the instrumental role that their teacher can play in achieving their learning goals and thus be more motivated to approach them for help. This possibility has been shown in a series of studies investigating goal-dependent effects on interpersonal relationships (Fitzsimons & Finkel, 2011; Fitzsimons & Shah, 2008; Moore, Ferguson, & Chartrand, 2011; Shah, 2003). People tend to feel motivated to approach others who are instrumental in their goal pursuit and avoid those who might act as obstacles. This is one of the outcomes of goal-dependent instrumentality evaluation. In Fitzsimons and Shah (2008)'s study, participants were primed with an achievement goal and then asked to provide self-reports of their motivation level, as measured by response time, to approach or avoid significant others whom they had described as instrumental or non-instrumental for their achievement. Results

showed that participants were faster at approaching instrumental others than non-instrumental others, and avoided non-instrumental targets faster than they did instrumental targets.

Goals and Motivational Outcomes

We expect that the goal discussion intervention will bring about additional effects on students' perceived relationship with their professor and their attitude toward the course.

Students' perceived relationship with teacher. Sharing can lead to connectedness. Researchers have suggested that the sharing of information between students and teachers can improve their attitudes to each other (Davidson, 1999; Lortie, 1975; Wentzel & Wigfield, 1998). In a study by Davis (2001), students reported that the sharing of personal stories with their teachers contributed to their increased connection with one another. Lin and Bransford (2010) showed that exposing students to their professor's personal background knowledge (PBK) was effective in changing their negative attitudes or stereotypes toward the professor and helped to create a class environment more conducive to learning. In Gehlbach et al. (2016) study, the students and teachers in the treatment condition received information on five similarities that they had shared with each other, such as favorite color, sports, and values. Five weeks after the intervention, the students and teachers in the treatment group perceived greater similarity with each other than their counterparts in the other group did. Furthermore, teachers perceived better relationship with students who had shared similarities with them. All these studies attest to the association between in-group sharing and sense of relatedness (Tomasello, Carpenter, Call, Behne, & Moll, 2005). In light of all these findings, we expected that students will feel more connected to their teacher after a discussion of goals with their teacher. Because the discussion of instructional goals may help students learn efficiently, we expected that students will evaluate their professor as more instrumental to their learning.

Students' attitude towards the course. Students learn better if they find the classes interesting and perceive the course to be valuable to them (Deci, 1992; Harackiewicz, Barron, Tauer, & Elliot, 2002; Hulleman & Harackiewicz, 2009). Research and surveys show that students' interest and perceived value of the course might decline over time due to various reasons, such as the course contents are becoming increasingly difficult (Gottfried, Marcoulides, Gottfried, Oliver, & Guerin, 2007; Osborne, Simon, & Collins, 2003; Potvin & Hasni, 2014). Among the interventions designed to curb students' declining motivation, the ones aiming to make them see the relevance of the content materials to their academic and professional lives appeared to be effective (Assor, Kaplan, & Roth, 2002; Hulleman, Godes, Hendricks, & Harackiewicz, 2010). Seeing the relevance gives students purpose to spend time studying contents they may not find inherently interesting.

We expect that goal discussion might produce similar effects on students' attitude toward the course. Professors normally have a clearer perspective on the larger picture about the course than their students do. When professors talk about how the content will help students prepare for subsequent courses or an intended profession, they are helping them gain a better appreciation of the course. Students will be more likely to perceive the course in a positive way.

Explicit Discussion

The way to make instructional goals explicit to students also matters (Archer & Hughes, 2010; Brookfield & Preskill, 1999). In this study, we are particularly interested in the explicit discussion of goals between students and teachers due to several reasons. We anticipate that explicit discussion would be more effective than simply showing students the instructional goals because during the discussion, teachers can: (1) articulate and clarify by giving detailed explanations to help students better comprehend the chosen instructional goals; (2) provide

justifications about why some goals are more important than others; (3) use concrete examples to help students see the connections between instructional goals and class assignments; (4) model how a teacher with expertise perceives and approaches the content.

During the discussion, students can indicate their understanding or lack of understanding of the instructional goals, which will allow teachers to notice the gap if there is one. Students can ask questions, give comments, and talk about their own goals for the course. Our discussion-based intervention, in this sense, is a means by which the thinking process in the teacher's head is brought to light so that students can reflect on their own thinking and make necessary adjustments.

In real classrooms, some teachers write their lesson objectives on the board or in the syllabus. This method is probably better than not mentioning the learning goals at all. However, as noted in the earlier section, this passive informing approach is mostly unsuccessful (Brookfield & Preskill, 1999; Kappes & Shrout, 2011). We expect that presenting students with the ranked instructional goals (without a discussion) will not be as effective as having them discuss the goals with their teachers.

CHAPTER III: METHODOLOGY

Participants and Setting

Participants were undergraduate students recruited from a General Microbiology course at the St. John's University. Performance in this course was important to the participants: It was required for a number of majors such as Physician-Assistant, and provided foundational knowledge and skill to majors such as Biology. The course was given in the form of a large lecture class by a female professor.

All students in the class were given the opportunity to participate in this study for extra points. Originally 106 students indicated their interest to participate and were randomly assigned to three groups of approximately equal size. However, 8 students quit the course afterwards and 9 students did not complete the required surveys. These 9 students were excluded from the analyses related to the surveys, but their final scores were used for comparison on performance.

A final sample of 89 students (M_{age} = 19.2, *SD* = 1.39) completed all study requirements. Participants were 31% Caucasian, 43% Asian, 12% Hispanic, 5% African American, and 9% of other ethnic backgrounds; 82% were female. A more detailed demographic description can be found in Table 1. They all had STEM majors, including Physician-Assistant (*n* = 60), Biology (*n* = 27), Chemistry (*n* = 1), and Clinical Laboratory Sciences (*n* = 1).

Table 1

Demographic Description of the Three Conditions

	Goal Listing (*n=25*)	Goal Ranking (*n=31*)	Goal Ranking + Discussing (*n=33*)	Total
Gender				
W	21	28	24	73
M	4	3	9	16
School Year				
Sophomore	20	26	24	70
Junior	3	5	6	14
Senior	2	0	3	5
Ethnicity				
Asian	12	9	17	38
Caucasian	7	14	7	28
Hispanic	4	1	6	11
Black/Other	2	7	3	12

Procedure and Study Design

Individual students were randomly assigned to one of the three conditions: the Goals Listing condition (n = 25), the Goals Ranking condition (n = 31), or the Goals Ranking + Discussing condition (n = 33). As noted earlier, the unequal size of the three conditions was due to the attrition of participants during the study.

All surveys and interventions were introduced to participants as attempts to "better understand what college students think about STEM courses, as well as to identify effective strategies they can use in the future."

The week after the midterm exam, all participants were instructed to complete their first online survey (Pre-intervention survey in Appendix A) on their own. This survey measured how students perceived the course, how they perceived their professor, how many hours per week

they studied for the course, and how they ranked the course goals by importance. The purpose of the survey was to obtain the baseline of the measures that we were interested in. The survey questions were identical across conditions.

After the survey, all students watched a video clip that contained either a treatment or a control message. In all three videos, a fictitious student, Alex, first talked about his experience in his biology class, and then shared a piece of advice that was in line with the condition (as elaborated below). The videos were made with simple scratch clip art and had a male voice.

In the Goals Listing (GL) condition, the message Alex conveyed was that in order to succeed academically, students need to know the instructional goals clearly.

In the Goals Ranking (GR) condition, the message Alex conveyed was that it was important for students to know how their professor prioritized the instructional goals.

In the Goals Ranking + Discussing (GRD) condition, the message Alex conveyed was that knowing how the instructional goals were prioritized by the professor was important, and discussing them with the professor was the next essential step.

After the video, students in the GL condition were then shown the instructional goals as listed on their syllabus. Students in the GR and GRD conditions were then shown the instructional goals ranked by their professor.

At this point, the first survey and intervention were completed for students in the GL and the GR conditions. Students in the GRD condition were additionally instructed to sign up for a 10-minute individual office session with their Microbiology professor within the following two weeks. They were also explicitly asked to discuss the ranked instructional goals with their professor during the session. To ensure attendance, students were informed that the office session was necessary for them to earn the extra credits.

Because the discussion of course goals was a critical and indispensable component of our intervention, we designed a *Goal Discussion Guideline* for the professor to follow. The guideline laid out the steps that the professor should follow when leading the discussion. When a student came into the office, the professor would first ask the student if he/she had questions about the ranked course goals. Then, the professor would explain the relative importance of the goals and her rationale. After addressing the student's questions about the goals, the professor asked whether the student had other questions. When the discussion was over and the student left the office, the professor would write down the student's name and date and time of the visit. Some common office-visit topics were listed on the guideline; the professor was asked to check off the topics that had been discussed with each student.

There was an interval of about four weeks between the office session and the final exam. In consultation with the professor, we deemed this timing to be ideal for exerting an impact on students' exam preparation because it gave them enough time to adjust their strategies in studying for the final exam, but also was not so early as to seem irrelevant.

In the week before the final exam, all students completed the second online survey (End-of-semester survey in Appendix B) on their own. This survey included the same questions as the Pre-intervention survey but also included additional questions measuring the outcome variables that we were interested in. Students' grade reports were provided by the professor one week after the final exam was graded.

Measures

Performance

Students' exam scores were used to reflect student performance throughout the course. Their midterm scores (M = 74.1, SD = 11.9) were used as baseline; their final exam scores and their lab scores were aggregated (M = 79.0, SD = 8.9) to represent end-of-semester performance.

All items in the midterm and final exams were multiple-choice questions. We chose course scores over standardized proficiency tests as the measure because course scores are classroom-based evaluation that can reflect student achievement in a specific course. All exams were created by the teacher and had been used for at least three semesters. They were not designed for the sake of this study. The extra-credit points students received for participating in the study were excluded from the analyses.

Metacognitive Measures

Study-time allocation. In the End-of-semester survey, all students were given eight modules[1] that covered all concepts and topics that had been taught throughout the semester and were asked to choose the three most important modules to review for the final exam. Their judgments reflected their understanding of the relative importance of the instructional goals and potentially regulated how they allocated their study time. We also asked the professor to identify three most important modules for the final exam. Then we compared students' predictions against the teacher's selection. For each module that was accurately predicted, the student was given one point. The average prediction accuracy for students was 1.8 (SD = .81).

Self-assessment. In the End-of-semester survey, we asked all students "Within what range (10 points) do you expect your final exam grade to be?" This question intended to assess

[1] These modules were provided by the professor who taught the course.

the accuracy of students' judgments about their performance. After we obtained their final scores, we compared their predicted score ranges against their actual scores. If a student's actual score fell within his/her predicted range of score, the student was coded Accurate. Otherwise, the student was coded Inaccurate.

Help-seeking tendency. In the End-of-semester survey, we asked students an open-ended question: "*When you encounter difficulties in Biology class, who is the person you would like to ask for help? Why does this person come to mind first?"* This question aimed to measure students' help-seeking tendency toward their professor. Students' responses were coded as Professor vs Non-professor. Non-professor responses included friend, classmate, family member, YouTube, and self.

Motivational Measures

To examine other psychological processes that may also have benefited from this intervention, we measured, both in the pre- and post-survey (see Appendix A and B), students' attitude toward their professor, and their attitude toward the course. Although these variables were not the primary targets of our intervention, they were possibly affected by the intervention and we were interested in exploring whether there was a group difference in these aspects.

Teacher instrumentality. Students' perceptions of teacher instrumentality was assessed with a two-item scale (Cronbach's $\alpha = .78$) adapted from Fitzsimmons and Anderson (2011). To make the items more relevant to our research question, we explicitly defined the goals in the items as the goals for the course. Students were asked to rate their agreement with two statements: "*I find my professor to be very helpful with my goals for the course.*" and "*My professor is a real source of strength for me in pursing my goals for the class.*" on a 6-point scale, with 1 = absolutely disagree and 6 = absolutely agree.

Connectedness. Students' perceived connectedness to their professor was measured by the IOS Scale (Aron, Aron, & Smollan, 1992). The IOS scale is a one-item pictorial measure of closeness. Based on the notion that closeness can be viewed as an overlap between self and other (Aron et al., 1992; Aron, Aron, Tudor, & Nelson, 1991), it taps into people's sense of interpersonal connectedness. Students were asked to choose from six pairs of circles the one that best represented their relationship with their professor: the more the circles overlap, the more connected the student feels to their professor.

Course interest. Students' interest in the course was assessed with a three-item scale (Cronbach's $\alpha = .80$) adapted from the Intrinsic Motivation Inventory (IMI) (Ryan & Deci, 2000). Students were asked to rate their agreement with statements such as: "*I would describe the Microbiology class as interesting.*" on a 6-point scale, with 1 = absolutely disagree and 6 = absolutely agree.

Course value. Students' perception of the course value was assessed with a two-time scale (Cronbach's $\alpha = .72$) adapted from Husman, Derryberry, Crowson, and Lomax (2004). Students were asked to rate their agreement with statements such as: "*The information presented in the Microbiology class is important for my future academic success*." on a 6-point scale, with 1 = absolutely disagree and 6 = absolutely agree.

In addition to the above measures, we also asked students how many hours they spent on this course after class. Students were asked to choose the alternative that best described them (1 = less than 1 hour; 2 = 1~3 hours a week; 3 = 4~6 hours a week; 4 = 7~9 hours a week; 5 = 10~12 hours a week; 6 = more than 12 hours a week).

CHAPTER IV: RESULTS

Manipulation Check

To assess the effectiveness of the goal discussion intervention on students' understanding of the instructional goals, we compared students' ranking of goals with their professor's. Because the professor's ranking of the instructional goals did not change throughout the semester, we can identify whether students' goals changed due to the intervention by comparing the extents of students' goal alignment with their professor in the pre- and post-test.

We first ran a one-way ANOVA to compare students' goal alignment with their professor across conditions before the intervention. As illustrated in Table 2, there was no significant effect of condition on the level of student-teacher goal alignment at baseline, $F(2, 86) = 0.938$, $p = .40$. A one-way analysis of covariance (ANCOVA) revealed that students' goal alignment with their professor at the post-test differed by condition, $F(2, 85) = 5.07$, $p < .01$, $\eta_p^2 = .11$. Pairwise comparisons revealed that students in the GRD group ($M = 77\%$, $SD = 17\%$) held more aligned goals with their teacher than students in either the GR group ($M = 63\%$, $SD = 25\%$), $p < .01$, $d = .65$, or the GL group ($M = 61\%$, $SD = 22\%$), $p < .01$, $d = .81$. However, there was no difference between the GR group and the GL group ($p = .97$). Thus, we could be assured that the GRD students went to the office hours and discussed the goals with their professor.

Preliminary Analyses

We first tested whether student characteristics such as gender, school year, and ethnicity had a main effect or interacted with the conditions. We tested them by ANCOVA. For example, when we tested gender, we set the experimental condition and gender as independent variables, final score as a dependent variable, and midterm score as a covariate. Results showed that there

was no difference across conditions in gender, school year, or ethnicity, nor did they moderate the analyses. Therefore, these variables were not included in subsequent analyses.

Primary Analyses

Comparisons of Performance

1. *Do students in GRD condition perform better than their peers who did not discuss goals with the professor?*

We first ran a one-way ANOVA to compare students' midterm scores across conditions. There was no significant differences in student performance prior to the intervention across the three conditions, $F(2, 86) = 0.005$, $p = .995$. Means and standard deviations for all three conditions are presented in Table 2.

Next, we assessed the effects of the intervention on students' final scores. Controlling for the midterm scores, a one-way analysis of covariance (ANCOVA) revealed a main effect of condition on final scores, $F(2, 85) = 6.59$, $p < .01$, $\eta_p^2 = .13$. As shown in Figure 1, pairwise comparisons revealed that students in the GRD group ($M = 82.41$, $SD = 7.74$) outperformed students in either the GR group ($M = 78.03$, $SD = 8.51$), $p < .5$, $d = .54$, or the GL group ($M = 75.82$, $SD = 9.53$), $p < .01$, $d = .76$. However, there was no difference in performance between the GR group and the GL group ($p = .26$).

Table 2

Means and Standard Deviations for the Three Conditions, and Analyses of Variance Results

	Goal Listing (*n=25*)		Goal Ranking (*n=31*)		Goal Ranking +Discussing (*n=33*)		ANOVA results		
Variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η_p^2
Study-time allocation (Post)	1.48	.92	1.71	.82	2.15	.57	5.82**	<.01	.12
Performance									
Pretest (Midterm)	73.87	12.47	74.08	12.77	74.19	11.02	.005	.99	
Posttest (Final)	75.82	9.53	78.03	8.51	82.41	7.74	6.59**	<.01	.13
Course interest									
Pretest	4.19	.75	4.16	.83	4.22	.81	.047	.95	
Posttest	3.97	.97	4.23	.74	4.57	.69	5.57**	<.01	.12
Course value									
Pretest	5.12	.70	5.24	.64	5.08	.92	.391	.68	
Posttest	4.20	1.29	4.62	.95	5.21	.74	7.98**	<.01	.16
Teacher instrumentality									
Pretest	4.14	.99	4.08	1.10	4.31	.93	.48	.62	
Posttest	3.92	1.19	4.19	1.03	4.68	.74	5.31**	<.01	.11
Connectedness									
Pretest	2.24	1.23	1.94	.96	2.21	.96	.78	.46	
Posttest	2.16	1.14	2.32	1.14	2.91	1.04	5.68**	<.01	.12
Goal alignment									
Pretest	58%	22%	65%	27%	66%	22%	.94	.40	
Posttest	61%	22%	63%	25%	77%	17%	5.07**	<.01	.11

Note. * $p < .05$. ** $p < .01$.

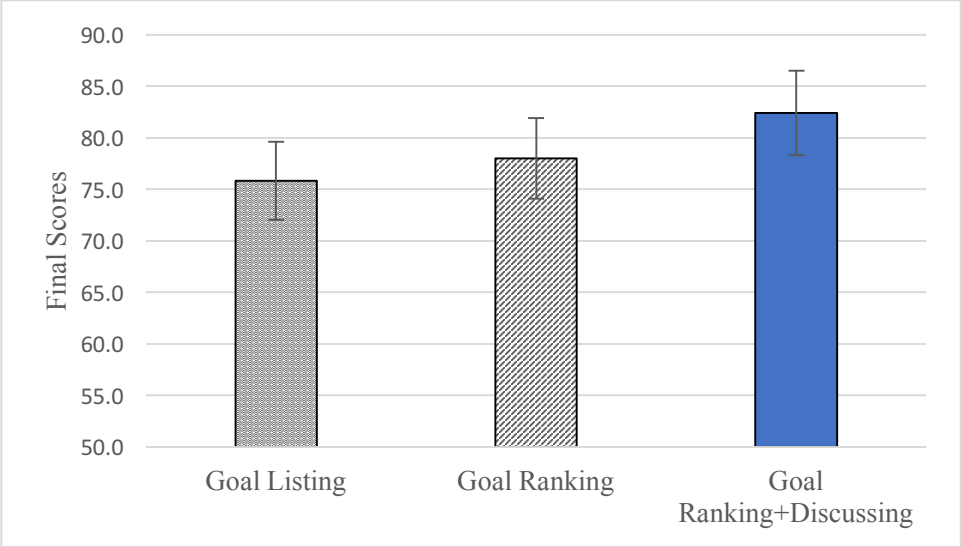


Figure 1. Students' final scores across conditions. Error bars represents 95% confidence intervals.

We also conducted an intent-to-treat analysis by comparing the performance of all students (n = 98) randomly assigned to a condition, regardless of whether they completed the surveys. This can avoid the self-selection bias potentially introduced by analyzing only students who completed all the surveys in either condition. The intent-to-treat analyses found that students in the GRD condition (n = 35, M = 81.93, SD = 8.95) outperformed students in either the GR group (n = 33, M = 76.79, SD = 9.72), $p < .05$, d = .55, or the GL group (n = 30, M = 74.11, SD = 10.32), $p < .01$, d = .81. However, there was no significant difference in performance between the GR group and the GL group (p = .17). In both of the two approaches of analyses, students in the GRD group achieved higher scores than those in the other two conditions. The treatment effect of goal discussion on performance was shown.

To rule out the possibility that the difference in performance was caused by the difference in students' study time, we tested whether there was a significant difference in their self-reported study time. Results show that no statistically significant difference was found between groups in

how much time they spent studying after class (*ps* > .05). This suggests that the treatment effect on performance was not driven by students in the GRD condition spending more time studying the course materials.

Comparisons of Metacognitive Strategies

2. Do students in GRD condition demonstrate more metacognitive skills?

Study-time allocation. A one-way ANOVA revealed that students' study-time allocation differed by condition, $F(2, 86) = 5.82$, $p < .01$, $\eta_p^2 = .12$. As shown in Table 2 and Figure 2, pairwise comparisons revealed that students in the GRD group ($M = 2.15$, $SD = .57$) planned their study time in a way that was more aligned with the focus of the final exam than students in either the GR group ($M = 1.71$, $SD = .82$), $p < 0.5$, $d = .62$, or the GL group ($M = 1.48$, $SD = .92$), $p < .05$, $d = .88$. However, there was no significant difference between the GR group and the GL group ($p = .27$).

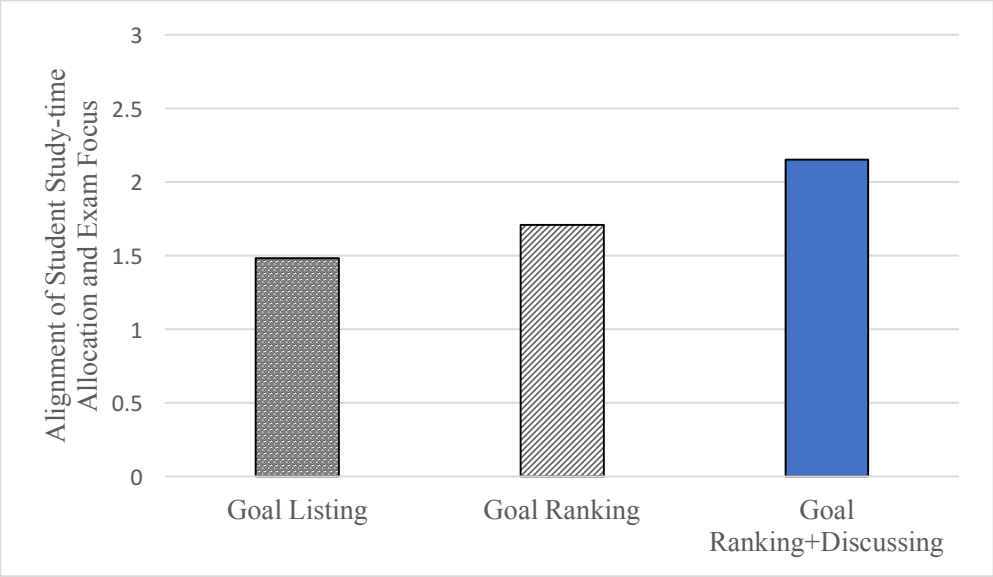


Figure 2. Students' study-time allocation across conditions. Numbers on the Y-axis are points that students received from accurately predicting which module would be important for the final exam.

Self-assessment. Results revealed group differences on this measure: $\chi^2(2, N = 89) = 9.02$, $p < .05$. More students in the GRD condition accurately predicted their final score than in the GR group, χ^2 $(1, N = 64) = 6.22$, $p < .05$, or the GL group, χ^2 $(1, N = 58) = 6.85$, $p < .01$. As Figure 3 shows, about 2/3 of the students in the GRD group correctly predicted their final score, whereas only 1/3 of the students in either the GR or GL group did so. However, there was no significant difference between the GR group and the GL group, χ^2 $(1, N = 56) = 0.075$, $p = .78$.

We also analyzed the type of incorrect predictions by categorizing them into Overestimated and Underestimated. It appears that the group difference was due to more students in the GL group (64%) and GR group (51.6%) overestimating their final score than students in the (27.3%).

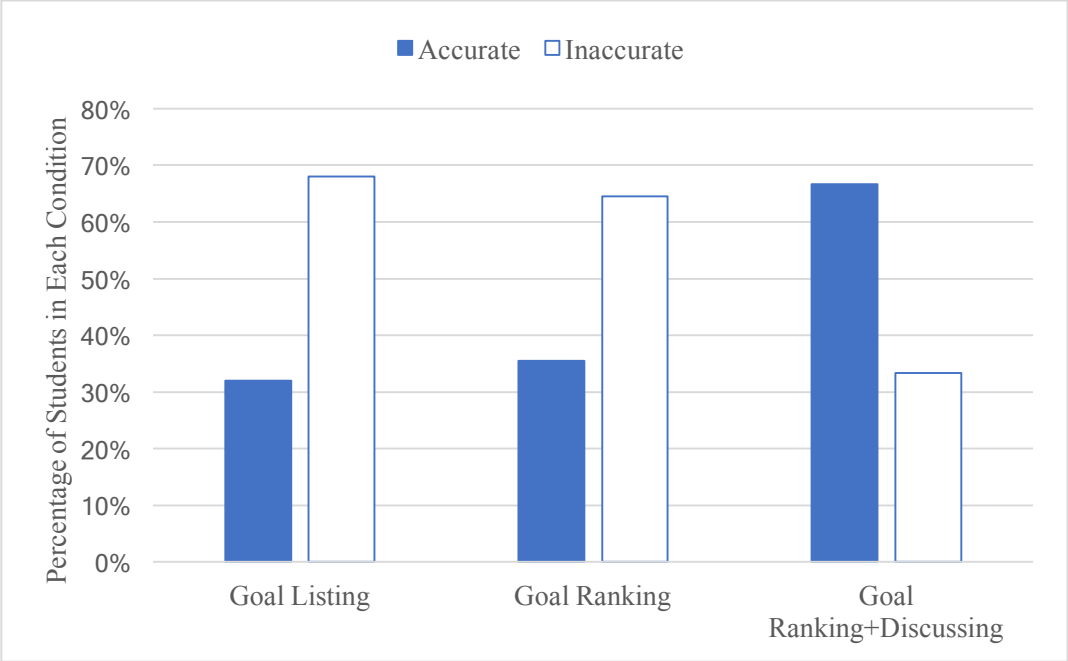


Figure 3. Students' self-assessment across conditions. Percentages of students who had accurately or inaccurately predicted their final scores were shown.

Help-seeking tendency. Group differences were found on this measure, $\chi^2(2, N = 89) = 11.87$, $p < .01$. More students in the GRD condition reported that their professor would be the first person they would reach out when encountering course-related difficulties than students in the other two conditions. As shown in Figure 4, students in the GRD group indicated stronger tendency to approach their professor as opposed to other relational partners for help than students in the GR group, χ^2 (1, $N = 64$) = 5.07, $p < .05$, or the GL group, χ^2 (1, $N = 58$) = 10.95, $p < .01$. The GR group, however, did not differ from the GL group, χ^2 (1, $N = 56$) = 1.63, $p = .20$.

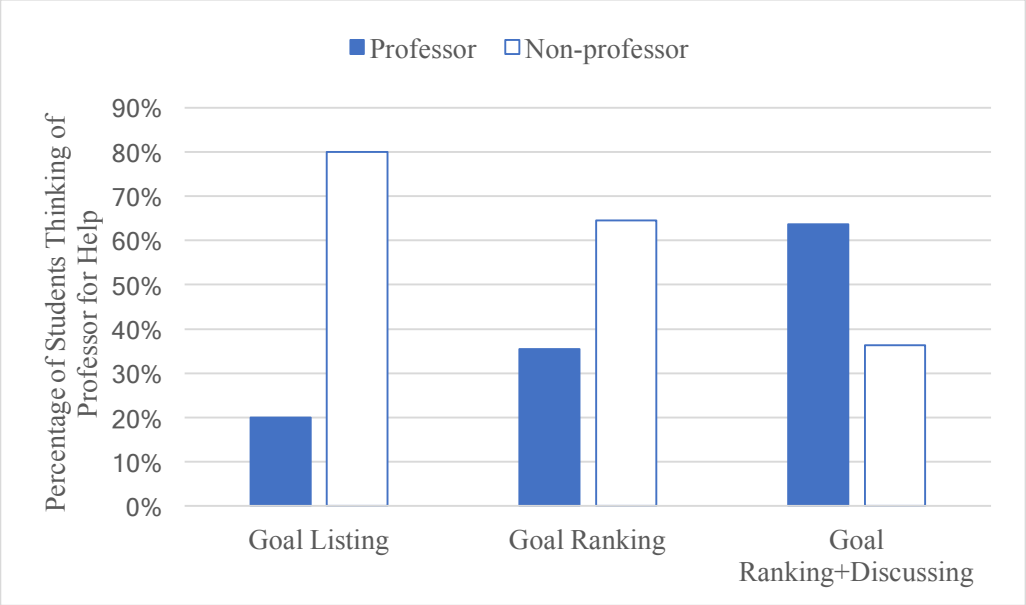


Figure 4. Students' help-seeking tendency toward teacher across conditions. Percentage of students who had thought of their professor for help were shown.

Comparisons of Motivational Outcomes

3. Does goal discussion bring out motivational benefits?

We examined additional effects of the interventions on students' motivational outcomes, including students' attitude toward their professor and the course.

Teacher instrumentality. We first ran a one-way ANOVA to compare students'

perception of teacher instrumentality across conditions before the intervention. As illustrated in Table 2, there was no significant effect of condition on teacher instrumentality at baseline, $F(2, 86) = .48$, $p = .62$. Although teacher instrumentality did not significantly differ at the pre-test, we decided to include it as a covariate in the subsequent analyses to control its possible effect on the post-test.

A one-way analysis of covariance (ANCOVA) revealed that students' perception of teacher instrumentality at the post-test differed by condition, $F(2, 85) = 5.31$, $p < .01$, $\eta_p^2 = .11$. Pairwise comparisons revealed that students in the GRD group ($M = 4.68$, $SD = .74$) perceived their teacher as more helpful than students in either the GR group ($M = 4.19$, $SD = 1.03$), $p < 0.1$, $d = .69$, or the GL group ($M = 3.92$, $SD = 1.19$), $p < .01$, $d = .87$. However, there was no significant difference between the GR group and the GL group ($p = .13$).

We were also interested in the change of students' perception over time. As Figure 5 shows, students in the GRD condition appeared to perceive their professor more instrumental while their peers in the GL and GR conditions did not show much changes.

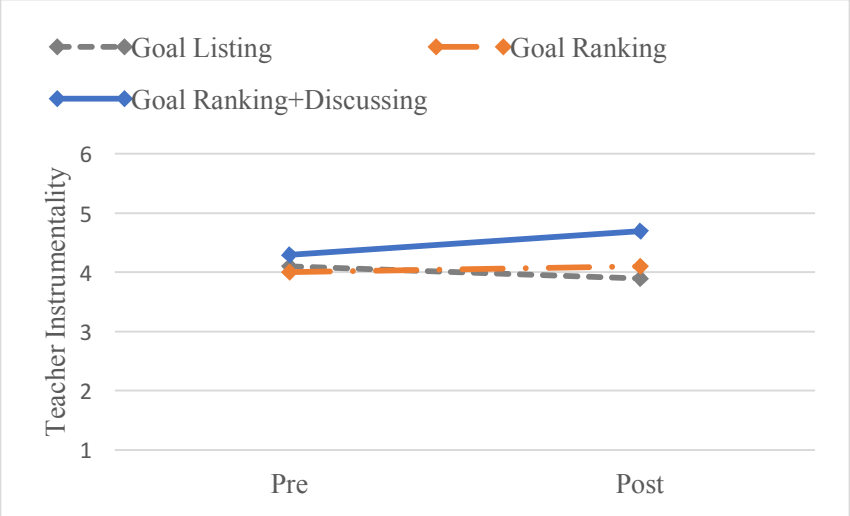


Figure 5. Change of students' perceptions of their professor's instrumentality.

Connectedness. The same analyses were conducted to assess students' connectedness with their professor. As illustrated in Table 2, there was no significant effect of condition on connectedness before the intervention, $F(2, 86) = .78$, $p = .46$.

A one-way analysis of covariance (ANCOVA) revealed that the students' connectedness with their professor at the post-test differed by condition, $F(2, 85) = 5.68$, $p < .01$, $\eta_p^2 = .12$. As shown in Table 2, pairwise comparisons revealed that students in the GRD group ($M = 2.91$, $SD = 1.04$) reported greater connectedness to their professor than students in either the GR group ($M = 2.32$, $SD = 1.14$), $p < 0.1$, $d = 0.57$, or the GL group ($M = 2.16$, $SD = 1.14$), $p < .01$, $d = 0.76$. However, there was no significant difference between the GR group and the GL group ($p = .12$).

As Figure 6 shows, students in the GRD condition appeared to feel more connected to their professor over time while their peers in the GL and GR conditions did not show much changes.

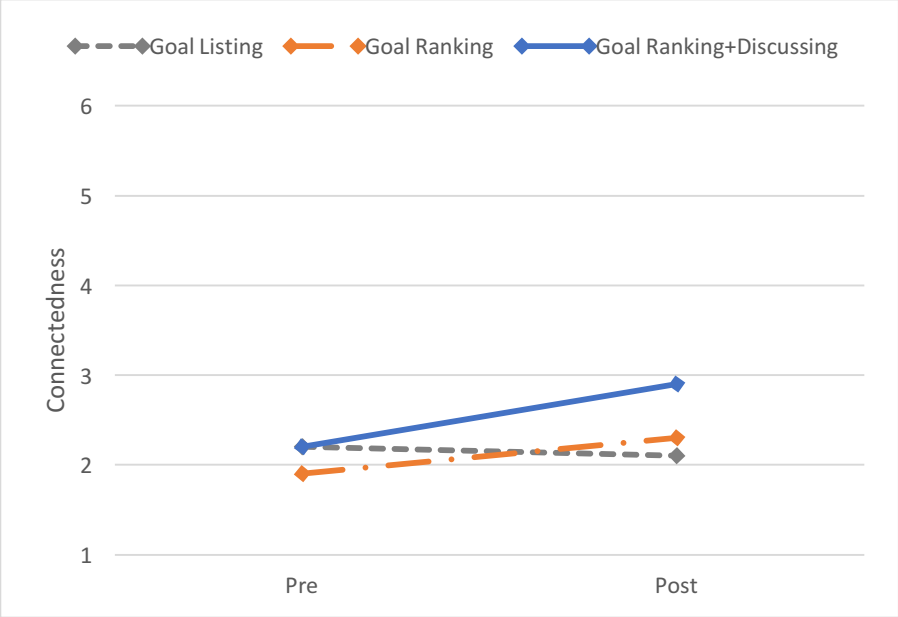


Figure 6. Change of students' perceived connectedness to their professor.

Course value. The same analyses were conducted to assess students' perceived value of the course across condition in the pre- and post- surveys. As illustrated in Table 2, there was no significant effect of condition on the level of interest at baseline, $F(2, 86) = 0.391$, $p = .68$.

A one-way analysis of covariance (ANCOVA) revealed that students' perceived course value at the post-test differed by condition, $F(2, 85) = 7.98$, $p < .01$, $\eta_p^2 = .16$. As shown in Table 2, pairwise comparisons revealed that students in the GRD group ($M = 5.21$, $SD = .74$) perceived the course more important than students in either the GR group ($M = 4.62$, $SD = .95$), $p < 0.05$, $d = .70$, or the GL group ($M = 4.20$, $SD = 1.29$), $p < .01$, $d = .95$. The GR group, however, did not differ from the GL group ($p = .15$).

As Figure 7 shows, students in the GL and GR conditions appeared to find the course less valuable to them over time, suggesting a declining motivation. In contrast, students in the GRD condition found the course to be more valuable after the goal discussion.

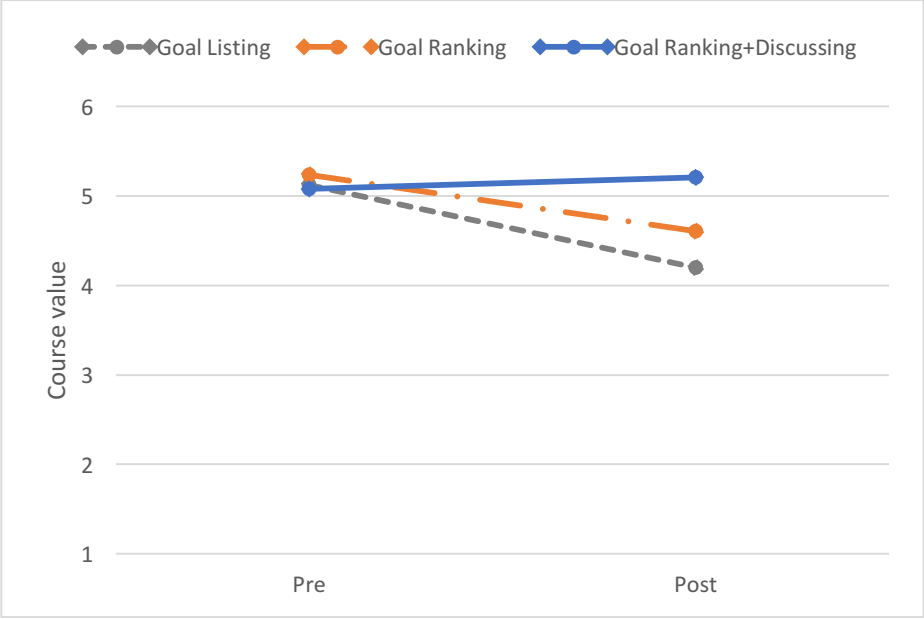


Figure 7. Change of students' perceived value of the course.

Course interest. The same analyses were conducted to assess students' interest across conditions in the pre- and post- surveys. As illustrated in Table 2, there was no significant effect of condition on the level of interest at baseline, $F(2, 86) = 0.047$, $p = .95$.

A one-way analysis of covariance (ANCOVA) revealed that interest level at the post-test differed by condition, $F(2, 85) = 5.57$, $p < .01$, $\eta_p^2 = .12$. As shown in Table 2 and Figure 8, pairwise comparisons revealed that students in the GRD group ($M = 4.57$, $SD = .69$) found the course more interesting than students in either the GR group ($M = 4.23$, $SD = .74$), $p < 0.1$, $d = .56$, or the GL group ($M = 3.97$, $SD = .97$), $p < .01$, $d = .83$. However, there was no difference between the GR group and the GL group ($p = .12$).

In summary, group differences were found on all the outcomes. The GRD group demonstrated more positive attitude toward both their professor and the course than the other two groups.

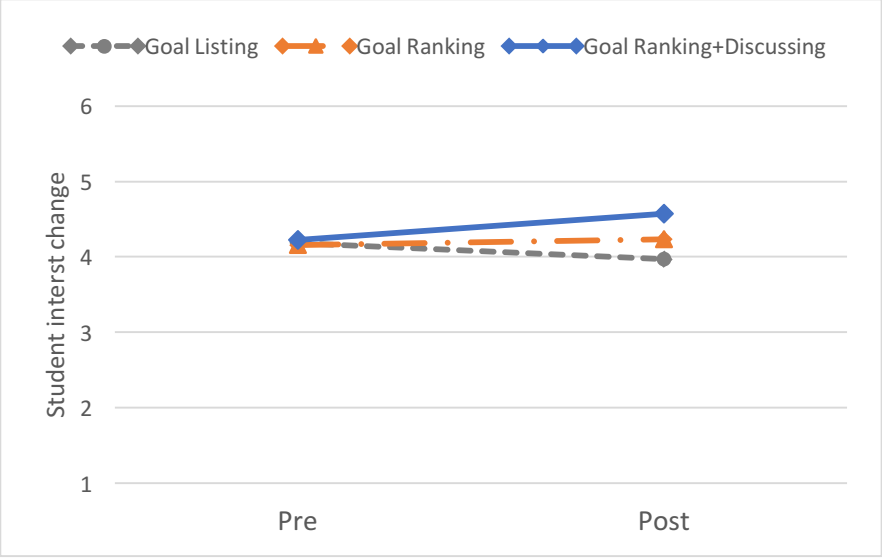


Figure 8. Change of students' perceived interest of the course.

Exploratory Analyses

Causal Relationship between Metacognitive Strategies and Performance

4. *Do the increased metacognitive skills of students in the GRD condition causally contribute to their better performance over their peers?*

We first tested whether study-time allocation mediated the effect of condition on students' performance. Hayes and Preachers's (2014) Mediate Macro for SPSS was used for this analysis. Two dummy codes were created for the GR and GRD groups (coded as 1) with the GL group serving as the reference group (coded as 0). We found that study-time allocation mediated performance for the GRD group (indirect effect = 4.40; 95% bootstrapped confidence interval, CI: [1.62, 8.26]), but not for the GR group (indirect effect = 1.51; 95% bootstrapped confidence interval, CI: [-1.60, 3.55]), relative to the GL control group (see Figure 9). The results also show that the GRD condition was no longer a significant predictor of student performance after controlling for effort planning (B = 2.17, SE = 1.95, *ns*), which suggests a full mediation. This supports our hypothesis that goal discussion would enable students to allocate their study time more effectively, subsequently leading to their superior performance in the exam. The results also suggest that simply showing students their professor's ranking of instructional goals would not affect how students plan their time and effort.

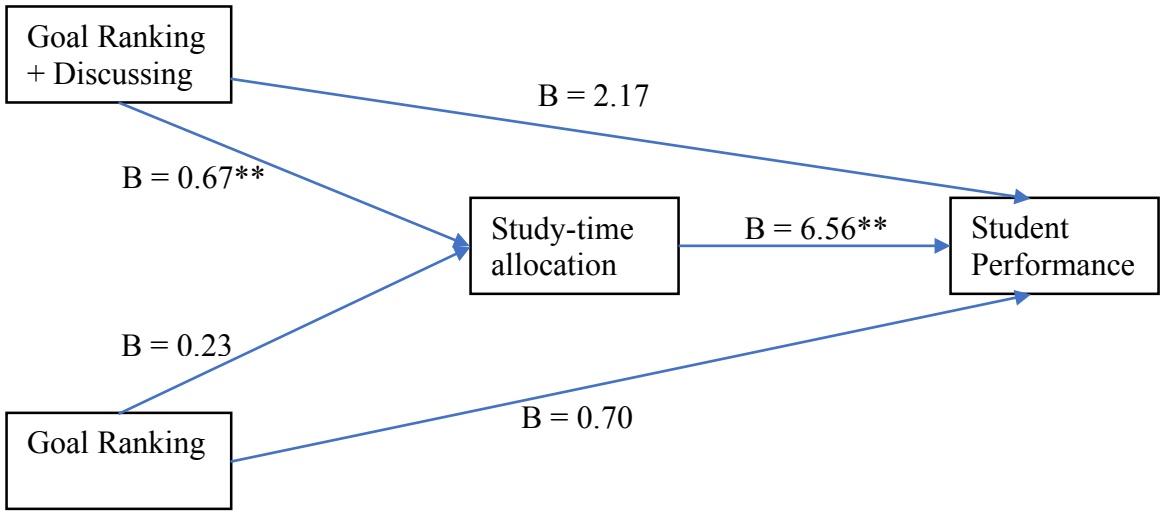


Figure 9. Mediation analyses of study-time allocation on performance. The coefficients shown are unstandardized. Condition effects are relative to the control group (dummy coded as 0).
* p < .05. ** p < .01.

Table 3

Mediation Analyses for Study-time Allocation

Outcome:	*M*		*Y (Performance)*			
		Coefficient (*SE*)		Coefficient (*SE*)		Coefficient (*SE*)
Constant	i_1	1.48**	i_3	75.83**	i_2	66.12**
		(0.15)		(1.71)		(2.00)
D1 (GR)	a_1	0.23	c_1	2.20	c'_1	0.70
		(0.21)		(2.30)		(1.88)
D2 (GRD)	a_2	0.67**	c_2	6.58**	c'_2	2.17
		(0.20)		(2.26)		(1.95)
M					b	6.56**
						(0.97)

Note. Estimated coefficients using indicator coding. Standard errors are in parentheses.
* *p* < .05. ** *p* < .01.

Then we tested whether the accuracy of self-assessment mediated the effect of condition on students' performance. Because self-assessment was a dichotomous variable, we used Mplus (Muthen, Muthén, & Asparouhov, 2016) and MLR to estimate the indirect effect. The same dummy codes were the GR and GRD groups (coded as 1) with the GL group serving as the reference group (coded as 0). We found that self-assessment partially mediated performance for the GRD group (indirect effect = 3.44; *SE* = 2.00, $p < .01$), but not for the GR group (indirect effect = 1.89; *SE* = 2.16, *ns*), relative to the GL control group (see Figure 10). The results also show that the GRD condition remained as a significant predictor of student performance after controlling for self-assessment ($B = 3.14$, $SE = 1.23$, $p < .05$), which suggests a partial mediation. This supports our hypothesis that goal discussion would help students develop a more accurate self-assessment, which partially explained why their performance was better than their peers. The results also suggest that simply showing students their professor's ranking of instructional goals would not lead to a more accurate self-assessment.

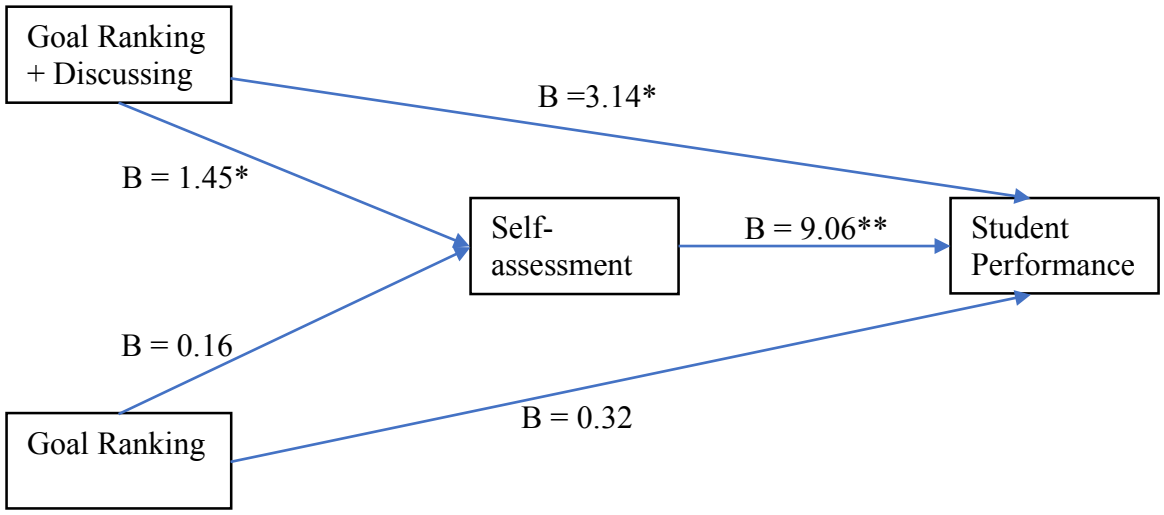


Figure 10. Mediation analyses of self-assessment on performance. The coefficients shown are unstandardized. Condition effects are relative to Control group (dummy coded as 0).
* $p < .05$. ** $p < .01$.

Table 4

Mediation Analyses for Self-assessment

Outcome:	*M*		*Y (Performance)*			
		Coefficient (*SE*)		Coefficient (*SE*)		Coefficient (*SE*)
Constant	i_1	0.75	i_3	75.83**	i_2	72.93**
		(0.43)		(1.71)		(1.78)
D1 (GR)	a_1	0.16	c_1	2.20	c'_1	0.32
		(0.57)		(2.40)		(1.15)
D2 (GRD)	a_2	1.45*	c_2	6.57**	c'_2	3.14*
		(0.56)		(2.29)		(1.23)
M					b	9.06**
						(1.54)

Note. Estimated coefficients using indicator coding. Standard errors are in parentheses.
* $p < .05$. ** $p < .01$.

Then we used the same Mplus and MLR to test whether student help-seeking tendency mediated the effect of condition on students' performance. Results show that help-seeking tendency was not a significant predictor of performance ($B = 2.21$, $SE = 1.68$, *ns*). Then we conducted a Sobel test and the result ($z' = 1.21$, $SE = 3.55$, $p = .23$) confirmed that there was no mediation effect of help-seeking tendency on performance.

Because we were interested in how much variance could be explained by the mediating variables, we conducted regression analyses with study-time allocation and self-assessment being the predictors. The results show that more than 50% of the variance in student performance was accounted for by these two predictors, $F(2, 86) = 47.56$, $p < .001$, with an $R^2 = 52.5$.

Additional Analyses

Effects of Office Visit

Although the effects of goal discussion on students' performance were confirmed by the analyses, there remained one factor that might have played a role in boosting performance: the frequency of office visits. It is possible that the more students visited their professor, the better scores they achieved. In other words, it could be due to the office visit, not the goal discussion that impacted students' performance. To test this possibility, we conducted the following analyses.

In the end-of-semester survey, we asked all participants to report how often they visited their professor during office hours in the last month of the semester. We also asked the professor whether students had discussed the instructional goals with her during the last month, and the professor confirmed that no one did. Most visits concerned students' coursework such as clarifying confusions about the content or assignments.

Based on students' responses, all students were split into Visit (n = 26) and No-visit (n = 63) group. The t-test results show that there was no significant different in their final scores ($t(87) = 1.78$, $p = .078$) between the Visit group ($M = 81.6$, $SD = 8.13$) and the No-visit group ($M = 78.0$, $SD = 9.01$). It appeared to suggest that a single visit to their professor did not help their scores significantly, but it should note that there is a large difference in the number of students between Visit and No-visit group.

Then we took a closer look at the Visit students, and found a significant difference across the three conditions, $\chi^2(2, N = 89) = 12.95$, $p < .01$. As Figure 11 shows, more students in the GRD condition reported that they had revisited their professor during office hours than in the GR group, $\chi^2\ (1, N = 64) = 10.81$, $p < .01$, or the GL group, $\chi^2\ (1, N = 58) = 6.00$, $p < .05$.

However, there was no difference between the GR group and the GL group, χ^2 (1, N = 56) = 0.52, p = .47.

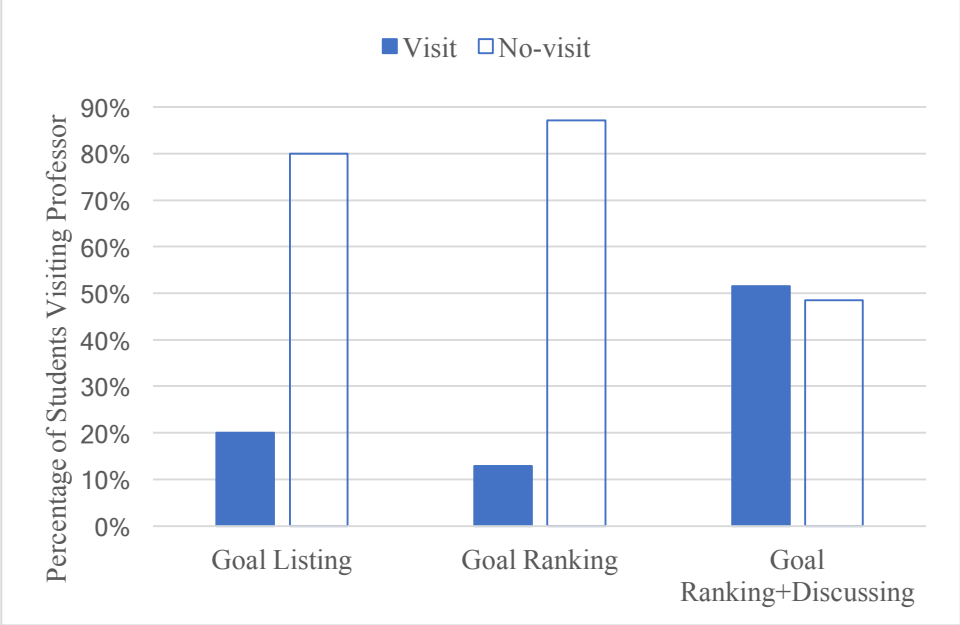


Figure 11. Percentage of students who visited their professor in the last month.

Then we analyzed whether or not GRD students' revisit to their professor caused differences in the measures of our interest. (Because GRD students all had a 10-min office visit due to the intervention requirement, we called their visits taking place in the last month as "Revisit".) As Table 5 shows, there was no significant difference between the two sub-groups in their performance and metacognitive measures. The two groups were quite similar in their final score (t(31) = .038, p = .97), study-time allocation (t(31) = .257, p = .799), accuracy of self-assessment χ^2 (1, N = 33) = .029, p =.866, and help-seeking tendency χ^2 (1, N = 33) = .732, p =.392, The results suggest that the one goal discussion seemed to be enough to prompt more metacognitive activities. Revisiting the professor did not help to further boost students' performance and metacognition skills.

On the measures of attitude toward teacher, the results show that there was a marginal

difference between the two GRD sub-groups. Students who had revisited office hours appeared to perceive their professor to be more instrumental ($t(31) = 1.92$, $p = .064$) and felt more connected to her ($t(31) = 1.93$, $p = .063$) than their peers who did not revisited. However, their attitude toward the course showed no significant difference (Table 5).

Table 5

Means, Standard Deviations, and T tests for Revisit and No Revisit Students in the GRD Condition

	No Revisit (*n=16*)		Revisit (*n=17*)		t test results	
Variables (Post-test)	*M*	*SD*	*M*	*SD*	*t*	*p*
Study-time allocation	2.1	0.6	2.2	0.5	0.257	.799
Performance	82.3	8.1	82.4	7.6	0.038	.97
Course interest	4.4	0.6	4.7	0.7	1.49	.146
Course value	5.4	0.6	5.0	0.8	1.75	.090
Teacher instrumentality	4.4	0.8	4.9	0.6	1.92	.064
Connectedness	2.6	1.0	3.2	0.9	1.93	.063
Goal alignment	73%	16%	82%	18%	1.50	.143

Note. * $p < .05$. ** $p < .01$.

CHAPTER V: DISCUSSION

Summary

This study showed that a dialogue-based goal discussion had a significant impact on students' exam scores, metacognitive skills, and attitude toward the course and the professor. Compared to the control group (who read the instructional goals as listed in their syllabus) and the comparison group (who read the instructional goals as ranked in order of importance by their professor), the treatment group who discussed the ranked goals with their professor performed significantly better in the final exam, demonstrated superiority in study-time allocation, accuracy of self-assessment, and help-seeking tendency, and gave a more positive evaluation about the course and the professor.

Goal Discussion and Performance

The first noteworthy finding of the study pertains to the effects of goal discussion on students' academic performance. Academic performance is a critical indicator of the extent to which a student, teacher, or institution has achieved their short or long-term educational goals, and it has been shown to be related to college students' satisfaction with their study (Kim & Lee, 2015), retention rate (Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008), and job placement upon graduation (Karathanos & Karathanos, 2005; Ming Chia, 2005). Thus, it is of paramount importance for educators to search for ways to improve student achievement. Our study shows that having a 10-minute discussion on the instructional goals might be an effective way. As our study shows, students who discussed the goals with the professor achieved significantly higher scores in the exam taking place one month later. It should be noted that GRD students' better scores in the final exam could not be a result of their professor's favorable treatment to them because all questions were multiple choices which were graded by an electronic reader. What is

more interesting is that GRD students' better performance was also not because they spent more time studying for the exam. As our analyses show, the three groups reported that they had spent a fairly similar amount of time in preparing for the final exam. This gave us reason to believe that the GRD students must have done something differently from the other two groups that helped them do better in the exam. We will discuss this further in a later section. What we want to point out here is the practical implication of the effects of goal discussion on student performance. It is a known fact that college students grapple with multiple tasks at the same time in both school work and personal life that compete for their limited time. When it is not feasible to ask students to spend more time on every course they are taking, we should find ways to help them better use their time and make more out of their limited time and effort. A discussion of instructional goals appears to be one effective means to reach that goal.

Goal Discussion and Metacognitive Strategies

Our hypotheses about the effects of goal discussion on students' use of metacognitive strategies are supported by the findings. First, students in the GRD condition appeared to be more strategic about their review materials than their peers. They knew which chapters should be prioritized. It is likely that the goal discussion allowed the GRD students to gain a much better understanding about which chapters were more important for succeeding in this course. Because of the more strategic planning, GRD students were more likely to spend their time efficiently, which directly affected their performance. This possibility was also supported by the mediation analyses of study-time allocation on performance. As the analyses show, having students discuss the instructional goals with their professor proved to be effective in directing their attention to the more important contents. In fact, prior research has also shown that students are able to be strategic when they are in control of their own learning behaviors (Kornell & Metcalfe, 2006;

Metcalfe, 2009). For example, a study showed that students tended to spend their time on question items that would have the highest payoff in terms of test performance when only a restricted amount of time was available (Son & Metcalfe, 2000). Yet students do not always study strategically, and one of the reasons lies in that students do not necessarily have a clear understanding about which course contents are more important and which are less important (Shi et al., 2016). Our study suggests that a discussion of the instructional goals can be useful in helping students to make accurate metacognitive judgments about the relative importance of the course contents, which can result in optimal learning outcomes.

The second metacognitive benefit of the goal discussion is that it helped students make more accurate self-assessment. In our study, students in the GRD condition made significantly more accurate predictions about their exam scores than their peers. In contrast, more than 2/3 of students in the GR and GL conditions overestimated how well they would do in the final exam, which is in line with previous research that shows that students tend to have inflated judgments about what grades they can achieve in a course (Dunning et al., 2004). We reason that GRD students' more accurate predictions of their final scores were a result of their professor's explanation of the instructional goals, which helped them to see the difference between where they perceived themselves to be and where they actually were. When students were made aware of what they did not know, they became more realistic about their performance in a future exam. The mediation analyses of the self-assessment on performance show that students' increased exam scores can be partially attributed to their more accurate self-assessment. Prior research has shown that making accurate self-diagnoses can play an important role in guiding one's study decisions. For example, if a student makes the judgment that his or her knowledge is lacking in a particular area, then s/he could fill the gap by re-studying that section. In other words, a better

self-assessment not only helps students identify their weaknesses, but also makes it possible for them to find ways to compensate for their weaknesses.

Third, the goal discussion led the GRD students to show significantly stronger tendency to reach out to their professor for help rather than their family members or friends. This indicates an improvement on their metacognitive awareness about the instrumentality of their professors, who are a most valuable resource for their learning. Yet such an increased awareness of the professor's role in their study did not add much to their performance. As the mediation analyses show, students' help-seeking tendency toward their professor did not correlate with or predict their performance. This made us wonder why help-seeking tendency did not affect performance the same way as study-time allocation and self-assessment did. We reason that this is probably due to the gap between tendency and action. As previous studies show, improvement in performance requires putting plans into practice (Gollwitzer, Wieber, Myers, & McCrea, 2010). Better study-time allocation and more accurate self-assessment exerted an impact because they were changes at the behavioral level, whereas an altered help-seeking tendency was still a change at the perceptional level. The results suggest that merely knowing where to find effective help cannot, by itself, boost students' grades. Still, we think the effect of goal discussion on students' help-seeking tendency is not without merit. As many previous surveys and studies show, professors are one of the most underutilized resources for students' academic and career development. One of the reasons that students are not taking advantage of this useful resource is that they do not realize the importance and value of interacting with their professors. Our study suggests that a required goal-themed discussion might be useful to give students reasons and impetus to engage in interactions with their professors.

In sum, the results suggest that the process that goal-themed discussion sets in motion goes well beyond the goals per se; it triggers metacognitive judgments about how one can approach their learning more effectively. Collectively, the planning of study time and self-assessment were shown to explain a large portion of the variance in students' performance. The self-regulatory process of strategically selecting study items and making self-assessment based on instructional goals significantly contributed to students' performance.

Goal Discussion and Motivation

Our results show that the goal discussion also brought about motivational benefits to students. First, the goal discussion affected students' attitude toward the course. Compared to students in the GL and GR conditions who showed declining affects toward the course, students in the GRD condition perceived the course as equally interesting and more valuable to their future over the course of the semester. These findings are of great interest to the motivation research in the field of STEM. For example, the issue of declining motivation toward science classes has been widely reported (Drew, 2011, Nov 4; King, 2014, July 25). Previous research has also suggested that one effective way to maintain and enhance student motivation may be to help them find value and meaning in their schoolwork (Hulleman et al., 2010). Our approach, having students and teachers share their goals for the course, appeared to be able to prevent students' interest in the course from declining. This was probably because the discussion of instructional goals helped students to better understand the importance and relevance of the course content to themselves. Second, the goal discussion affected students' attitude toward their teacher. The GRD students rated their professor as more instrumental and felt closer to the professor than students in the GR and GL conditions. These findings suggest that an

individualized discussion of goals between students and teachers might be a promising tool for improving student-teacher relationship, especially in large lecture-based classes.

One finding that is at odds with previous theories and empirical research is the relationship between students' motivation and the time they spend in studying. It has been suggested that students' increased motivation usually results in more study time, which in turn, explains their improved scores (Eppler & Harju, 1997; Singh, Granville, & Dika, 2002). However, we did not find that the GRD students spent more time in studying even though their reports indicated stronger motivation. One explanation could be that the relationship between time spent and motivation is moderated by the amount of available time. For example, when students are faced with multiple deadlines and exams, they simply cannot afford to allocate their time based on intrinsic motivation such as interest or value, but have to base their decisions on practical matters such as making deadlines or passing exams. Thus, it is possible that, even though the GRD students had a stronger motivation toward the course, they did not have any extra time to spare for that course. Another possibility is that the 10-minute goal discussion, albeit useful, did not produce an effect strong enough to impact students' behavior.

Forms of Goal Sharing

In our study, the inclusion of the GR condition was purposeful and the results are worth further discussion. Overall speaking, students who read about their professor's ranked instructional goals did not show any significant difference from the control group who did not know how the goals were ranked. One possibility is that students perceived the ranked goals as a business-as-usual message, so they did not pay much attention to them. Because they read them cursorily and quickly, they remembered just as little as the control group. This is shown in their similar levels of goal alignment in the post-test. It is also possible that even though students saw

the difference between their professor's ranking and their own ranking, they still lacked a grounded understanding of the goals. They still did not know how these goals were tied to their assignments and tests. We also noticed that the GR students spent less time studying after they saw the ranked goals. We speculate that these students were possibly misled to believe that since they knew more about the instructional goals, they would not need to make as much effort as before. This suggests that it might even be harmful to simply show students the prioritization of instructional goals.

As previously discussed in the literature review section, it is not just what goals, but why the goals are chosen that matters to students. This is important because it can help us better understand how teachers should communicate their goals to students. Our study findings show that simply showing students how the goals were prioritized did not trigger as much metacognitive activity as students who also had a discussion about it with their professor. In order for students to reflect upon their own understanding and strategically plan their time, a direct dialogue with the professor would bring more benefits.

In summary, it is no secret that students learn best when they self-regulate – setting their academic goals, developing strategies to achieve them, and reflecting on their academic performance. However, educational studies increasingly show that many students are still passive consumers of the information fed to them by their teachers. They lack a clear direction and tactical awareness when studying, which may substantially limit what they can achieve in their classes. Our study suggests that if teachers weave strategies that induce metacognitive activities into their teaching, students may be able to better realize their potential.

Implications

The study offers several unique theoretical and practical contributions.

First, the study added to the current goal setting research by exploring and showing how teachers can best communicate goals to their students. Most previous research on students' goals focused on *what* goals might be beneficial to learning, but did not address *how* to enable students to strategically arrive at those goals. Our study shows that having teachers explain how their instructional goals are set can be a promising step toward that end. Goal research is also largely intrapersonal, focusing on how one sets his own goals and implements them (Gollwitzer et al., 2010; Harkins & Lowe, 2000). However, it is a fact that people set and pursue their goals in contexts. Contextual factors, such as the goals of others, also affect the results of the goal pursuit (Shah, 2003; Shteynberg & Galinsky, 2011). In the classroom setting, teachers' goals are such an important yet underexplored factor that affects students' goal pursuit. Previous research shows that the misalignment of goals between students and teachers not only prevails, but also correlates to learning outcomes (Shi et al., In press). The current study further shows that with a better understanding about teachers' goals, students will more likely make informed decisions and plans that are conducive to their own goal pursuit.

Second, the practical aspect of the study sheds lights on the design of effective instructions and metacognitive strategy training. Instruction in STEM classrooms is largely designed to teach students content knowledge and problem-solving skills (Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016). The content-focused instruction is unarguably important, but how students perceive the content and the instruction also matters (Finn & Schrodt, 2012; Rønsen, 2013). As our study shows, students learned better not because the content changed, but because the way they perceived the content changed. Thus, we suggest that teachers should

create opportunities to help students better understand the purposes and rationales underlying their instruction. The study also points to the important role of social interaction in enhancing students' use of metacognitive strategies. Discussing goals appears to be a useful means to bring together students and teachers in an effort to make their own beliefs and purposes transparent and explicit. With the discussion comes very good opportunities for students to reflect on their own goals and learn how to set effective goals under given constraints. We also suggest using more active measures like face-to-face communication to make goals explicit. Passive methods such as simply informing students of the goals might not bring about the psychological processes necessary for them to pay attention and reflect on their learning.

Limitations and Future Directions

The current study has several limitations that should be addressed in future research.

Although we established the relationship between goal discussion and improved achievement, it remained unclear what aspect(s) of the discussion caused the effects. Because of the IRB requirements, we were not allowed to record the discussions between students and their professor. In the future, we need to come up with creative methods to document what transpired during the discussion.

The current design could not rule out the possibility that any discussion with the professor, rather than a specific discussion around goals, would have caused the same effects. This is a highly possible scenario with students' help-seeking tendency and attitude towards the professor. Adding a control group, who meet with their professor to discuss goal-irrelevant topics, may help to clear the doubt.

Third, we measured students' metacognitive skills by single-item questions. Measurement error on predictor variables inflates standard errors. Thus, a longer, multi-item questionnaire on their metacognitive activities might have provided more precise estimates of the benefits of goal discussion.

Fourth, as there was only one professor involved in this study, we could not test whether teacher factors, such as gender, race, years of teaching experience, and personality, etc. might impact the intervention effects. A more diverse teacher population might help to answer this question.

Future research is also needed to determine the durability of the goal discussion intervention. We measured the effects of the interventions approximately one month after they were executed, but we did not measure them beyond that time point. We are interested in knowing whether the improved metacognitive skills would last. Recent research on "psychologically wise" interventions has shown enduring effects of very brief interventions on academic outcomes (Walton, 2014). We are also interested in knowing whether goal discussion may kickoff a recursive process. The mediation analyses about effort planning and self-assessment shed light on this possibility, but it can only be confirmed by longitudinal experiments with more extended time frames.

REFERENCES

Aleven, V., Mclaren, B., Roll, I., & Koedinger, K. (2006). Toward meta-cognitive tutoring: A model of help seeking with a Cognitive Tutor. *International Journal of Artificial Intelligence in Education, 16*(2), 101-128.

Allen, J. D. (1986). Classroom management: Students' perspectives, goals, and strategies. *American Educational Research Journal, 23*(3), 437-459. doi:10.2307/1163059

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*(3), 261-271. doi:10.1037/0022-0663.84.3.261

Archer, A. L., & Hughes, C. A. (2010). *Explicit instruction: Effective and efficient teaching*. New York, NY: Guilford Press.

Assor, A., Kaplan, H., & Roth, G. (2002). Choice is good, but relevance is excellent: Autonomy-enhancing and suppressing teacher behaviours predicting students' engagement in schoolwork. *British Journal of Educational Psychology, 72*(2), 261-278.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, policy & practice, 5*(1), 7-74.

Black, P., & Wiliam, D. (2010). Inside the black box: Raising standards through classroom assessment. *Phi delta kappan, 92*(1), 81-90.

Brookfield, S. D., & Preskill, S. (1999). *Discussion as a way of teaching*: San Francisco: Jossey-Bass.

Cobern, W. W., Schuster, D., Adams, B., Applegate, B., Skjold, B., Undreiu, A., . . . Gobert, J. D. (2010). Experimental comparison of inquiry and direct instruction in science. *Research in Science & Technological Education, 28*(1), 81-96.

Coutinho, S. A. (2007). The relationship between goals, metacognition, and academic success. *Educate~, 7*(1), 39-47.

Deci, E. L. (1992). The relation of interest to the motivation of behavior: A self-determination theory perspective. In K. A. Renninger, S. Hidi, & A. Krapp (Eds.), *The role of interest in learning and development* (pp. 43-70). Hillsdale, NJ: Lawrence Erlbaum Associates.

DePaulo, B. M., Charlton, K., Cooper, H., Lindsay, J. J., & Muhlenbruck, L. (1997). The accuracy-confidence correlation in the detection of deception. *Personality and Social Psychology Review, 1*(4), 346-357.

Drew, C. (2011, Nov 4). Why Science Majors Change Their Minds. *The New York Times.* Retrieved from http://www.nytimes.com/2011/11/06/education/edlife/why-science-majors-change-their-mind-its-just-so-darn-hard.html

Duckworth, A. L., White, R. E., Matteucci, A. J., Shearer, A., & Gross, J. J. (2016). A stitch in time: Strategic self-control in high school and college students. *Journal of Educational Psychology, 108*(3), 329-341. doi:10.1037/edu0000062

Dunlosky, J., & Rawson, K. A. (2012). Overconfidence produces underachievement: Inaccurate self evaluations undermine students' learning and retention. *Learning and Instruction, 22*(4), 271-280.

Dunning, D., Heath, C., & Suls, J. M. (2004). Flawed self-assessment: Implications for health, education, and the workplace. *Psychological Science in the Public Interest, 5*(3), 69-106.

Eppler, M. A., & Harju, B. L. (1997). Achievement motivation goals in relation to academic performance in traditional and nontraditional college students. *Research in Higher Education, 38*(5), 557-573.

Falchikov, N., & Boud, D. (1989). Student self-assessment in higher education: A meta-analysis. *Review of Educational Research, 59*(4), 395-430.

Finn, A. N., & Schrodt, P. (2012). Students' perceived understanding mediates the effects of teacher clarity and nonverbal immediacy on learner empowerment. *Communication Education, 61*(2), 111-130.

Fitzsimmons, G., & Anderson, J. (2011). Interdependent goals and relationship conflict. In J. P. Forgas & K. K. Williams (Eds.), *The psychology of social conflict and aggression.* New York, NY: Psychology Press.

Fitzsimons, G. M., & Finkel, E. J. (2011). Outsourcing self-regulation. *Psychological Science, 22*(3), 369-375.

Fitzsimons, G. M., & Shah, J. Y. (2008). How goal instrumentality shapes relationship evaluations. *Journal of Personality and Social Psychology, 95*(2), 319.

Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of Research on Adolescence, 20*(2), 507-537.

Fusani, D. S. (1994). "Extra-class" communication: Frequency, immediacy, self-disclosure, and satisfaction in student-faculty interaction outside the classroom. *Journal of Applied Communication Research, 22*(3), 232-255.

Gears, C. (2005). Classroom assessment: Minute by minute, day by day. *Assessment, 63*(3), 19-24.

Gehlbach, H., Brinkworth, M. E., King, A. M., Hsu, L. M., McIntyre, J., & Rogers, T. (2016). Creating birds of similar feathers: Leveraging similarity to improve teacher–student relationships and academic achievement. *Journal of Educational Psychology, 108*(3), 342.

Gollwitzer, P. M., Wieber, F., Myers, A. L., & McCrea, S. M. (2010). How to maximize implementation intention effects. In C. R. Agnew, D. E. Carlston, W. G. Graziano & J. R. Kelly (Eds.), *Then a miracle occurs: Focusing on behavior in social psychological theory and research*, 137-161. New York, NY: Oxford University Press.

Gottfried, A. E., Marcoulides, G. A., Gottfried, A. W., Oliver, P. H., & Guerin, D. W. (2007). Multivariate latent change modeling of developmental decline in academic intrinsic math motivation and achievement: Childhood through adolescence. *International Journal of Behavioral Development, 31*(4), 317-327.

Harackiewicz, J. M., Barron, K. E., Tauer, J. M., & Elliot, A. J. (2002). Predicting success in college: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. *Journal of educational Psychology, 94*(3), 562.

Harden, R. M. (2002). Learning outcomes and instructional objectives: Is there a difference? *Medical Teacher, 24*(2), 151-155.

Harkins, S. G., & Lowe, M. D. (2000). The effects of self-set goals on task performance. *Journal of Applied Social Psychology, 30*(1), 1-40.

Hulleman, C. S., Godes, O., Hendricks, B. L., & Harackiewicz, J. M. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology, 102*(4), 880.

Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science, 326*(5958), 1410-1412.

Husman, J., Derryberry, W. P., Crowson, H. M., & Lomax, R. (2004). Instrumentality, task value, and intrinsic motivation: Making sense of their independent interdependence. *Contemporary Educational Psychology, 29*(1), 63-76.

Jaasma, M. A., & Koper, R. J. (1999). The relationship of student-faculty out-of-class communication to instructor immediacy and trust and to student motivation. *Communication Education, 48*(1), 41-47.

Kappes, H. B., & Shrout, P. E. (2011). When goal sharing produces support that is not caring. *Personality and Social Psychology Bulletin, 37*(5), 662-673.

Karabenick, S. A., & Knapp, J. R. (1991). Relationship of academic help seeking to the use of learning strategies and other instrumental achievement behavior in college students. *Journal of Educational Psychology, 83*(2), 221.

King, D. (2014, July 25). Tech camps, other programs hope to keep girls interested in STEM fields. *The Baltimore Sun*. Retrieved from http://www.baltimoresun.com/news/maryland/bs-md-women-in-stem-20140725-story.html

Kornell, N., & Metcalfe, J. (2006). Study efficacy and the region of proximal learning framework. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 32*(3), 609.

Lei, S. A. (2010). College research methodology courses: Revisiting general instructional goals and objectives. *Journal of Instructional Psychology, 37*(3), 236.

Lin, X., & Bransford, J. D. (2010). Personal background knowledge influences cross-cultural understanding. *Teachers College Record, 112*(7), 1729-1757.

Lin, X., Siegler, R. S., & Sullivan, F. R. (2010). Students' goals influence their learning. In D. D. Preiss & R. J. Sternberg (Eds.), *Innovations in educational psychology: Perspectives on learning, teaching, and human development* (pp. 79-106). New York, NY: Springer.

Lin-Siegler, X., Ahn, J. N., Chen, J., Fang, F.-F. A., & Luna-Lucero, M. (2016). Even Einstein Struggled: Effects of Learning About Great Scientists' Struggles on High School Students' Motivation to Learn Science. *Journal of Educational Psychology, 108*(3), 314.

Livingston, J. A. (2003). Metacognition: An Overview. Retrieved from ERIC website: https://eric.ed.gov/?id=ED474273

Locke, E. A., & Latham, G. P. (2006). New directions in goal-setting theory. *Current Directions in Psychological Science, 15*(5), 265-268.

Metcalfe, J. (2009). Metacognitive judgments and control of study. *Current Directions in Psychological Science, 18*(3), 159-163.

Moeller, A. J., Theiler, J. M., & Wu, C. (2012). Goal setting and student achievement: A longitudinal study. *The Modern Language Journal, 96*(2), 153-169.

Moore, S. G., Ferguson, M. J., & Chartrand, T. L. (2011). Affect in the aftermath: How goal pursuit influences implicit evaluations. *Cognition and Emotion, 25*(3), 453-465.

Moss, C., & Brookhart, S. (2009). Leveling the playing field: Sharing learning targets and criteria for success. In C. M. Moss & S. M. Brookhart (Eds). *Advancing formative assessment in every classroom*. Alexandria, VA: Association for Supervision & Curriculum Development.

Muthen, B., Muthén, L. K., & Asparouhov, T. (2016). *Regression and mediation analysis using Mplus*: Muthén & Muthén. Retrived from https://www.statmodel.com.

Nelson-Le Gall, S. (1981). Help-seeking: An understudied problem-solving skill in children. *Developmental Review, 1*(3), 224-246.

Nelson-Le Gall, S. A. (1987). Necessary and unnecessary help-seeking in children. *The Journal of Genetic Psychology, 148*(1), 53-62.

Newman, R. S. (1994). Adaptive help seeking: A strategy of self-regulated learning. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 283-301). Hillsdale, NJ: Lawrence Erlbaum Associates.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Palomares, N. A. (2014). The goal construct in interpersonal communication. In C. R. Berger (Ed.), *Interpersonal communication* (pp. 77-99). Berlin/Boston: Walter de Gruyter.

Paris, S. G., & Winograd, P. (1990). How metacognition can promote academic learning and instruction. *Dimensions of Thinking and Cognitive Instruction, 1*, 15-51.

Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research, 31*(6), 459-470.

Potvin, P., & Hasni, A. (2014). Analysis of the decline in interest towards school science and technology from grades 5 through 11. *Journal of Science Education and Technology, 23*(6), 784-802.

Rønsen, A. K. (2013). What teachers say and what students perceive interpretations of feedback in teacher-student assessment dialogues. *Education Inquiry, 4*(3).

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68.

Seidel, T., Rimmele, R., & Prenzel, M. (2005). Clarity and coherence of lesson goals as a scaffold for student learning. *Learning and Instruction, 15*(6), 539-556. doi:http://dx.doi.org/10.1016/j.learninstruc.2005.08.004

Shah, J. (2003). Automatic for the people: How representations of significant others implicitly affect goal pursuit. *Journal of Personality and Social Psychology, 84*(4), 661.

Shi, Z., Lin-Siegler, X., & Wei, R. (In press). Student-teacher goal alignment: Conceptualizing, measuring, and determining its effect on interaction and motivation. *The Journal of the Chinese Language Teachers Association Monographs, V*.

Shi, Z., Lin-Siegler, X., & Xu, J. (2016). The importance of students and teachers having congruent goals for Chinese language learning. *Studies in Chinese Learning and Teaching*(2), 1-28.

Shteynberg, G., & Galinsky, A. D. (2011). Implicit coordination: Sharing goals with similar others intensifies goal pursuit. *Journal of Experimental Social Psychology, 47*(6), 1291-1294. doi:http://dx.doi.org/10.1016/j.jesp.2011.04.012

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95*(6), 323-332.

Son, L. K., & Metcalfe, J. (2000). Metacognitive and control strategies in study-time allocation. *Journal of Experimental Psychology-Learning Memory and Cognition, 26*(1), 204-221.

Spera, C., & Wentzel, K. R. (2003). Congruence between students' and teachers' goals: Implications for social and academic motivation. *International Journal of Educational Research, 39*(4–5), 395-413. doi:http://dx.doi.org/10.1016/j.ijer.2004.06.006

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences, 28*(05), 675-691.

Vansteenkiste, M., Lens, W., & Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation. *Educational Psychologist, 41*(1), 19-31.

Vedder-Weiss, D., & Fortus, D. (2011). Adolescents' declining motivation to learn science: Inevitable or not? *Journal of Research in Science Teaching, 48*(2), 199-216.

Volet, S., & Lawrence, J. (1989). Goals in the adaptive learning of university students. In H. Mandl, E. de Corte, N. Bennett, & H. F. Friedrich, (Eds.) *Learning and instruction: European researchin an international context.* Pergamon: An Imprint of Elsevier Science, Oxford, UK, pp. 497-516.

Vrugt, A., & Oort, F. J. (2008). Metacognition, achievement goals, study strategies and academic achievement: Pathways to achievement. *Metacognition and Learning, 3*(2), 123-146.

Walton, G. M. (2014). The new science of wise psychological interventions. *Current Directions in Psychological Science, 23*(1), 73-82.

Wei, F. F., Wang, Y. K., & Klausner, M. (2012). Rethinking college students' self-regulation and sustained attention: Does text messaging during class influence cognitive learning? *Communication Education, 61*(3), 185-204.

Wentzel, K. R. (1989). Adolescent classroom goals, standards for performance, and academic achievement: An interactionist perspective. *Journal of Educational Psychology, 81*(2), 131.

Wentzel, K. R. (1998). Social relationships and motivation in middle school: The role of parents, teachers, and peers. *Journal of Educational Psychology, 90*(2), 202.

Wentzel, K. R., Baker, S. A., & Russell, S. L. (2012). Young adolescents' perceptions of teachers' and peers' goals as predictors of social and academic goal pursuit. *Applied Psychology, 61*(4), 605-633.

Zohar, A., & Barzilai, S. (2013). A review of research on metacognition in science education: Current and future directions. *Studies in Science Education, 49*(2), 121-169.

APPENDIX A: Pre-intervention Survey

The purpose of this survey is to better understand what college students think about STEM courses, as well as to identify effective strategies they can use in the future. Your responses will be kept confidential, and your professor will not see the responses. In addition to this survey, there will be another questionnaire for you to fill out by the end of the semester. Your completion of the two surveys will earn you extra credits toward your final grade.

Please respond to each of the following statements by choosing the answer that best describes you: (Note that the following questions were randomized when distributing to students)

Demographic:

Your name: _____

School ID: _____

Gender: ◎F ◎M

Age: _____

What is your classification in college?

◎freshman/1st year ◎sophomore/2nd year ◎junior/3rd year

◎senior/4th year ◎graduate student ◎other _____

How would you describe yourself?

◎Asian or Pacific Islander ◎Black or African-American

◎Hispanic or Latino ◎White/Caucasian (other than Hispanic)

◎Other _____

On average, how many hours per week have you spent on this Biology course OUTSIDE classroom, including doing readings, reviewing notes, writing papers, and any other course-related work?

◎less than 1 hour ◎1-3 hours a week ◎4-6 hours a week

◎7-9 hours a week ◎10-12 hours a week ◎more than 12 hours a week

Course interest.

I would describe the Microbiology class as interesting.

◎Strongly disagree ◎Disagree ◎Somewhat disagree

◎Somewhat agree ◎Agree ◎Strongly agree

I think that the Microbiology class is boring. (Reverse order)
◎Strongly disagree ◎Disagree ◎Somewhat disagree
◎Somewhat agree ◎Agree ◎Strongly agree

I enjoy the Microbiology class very much.
◎Strongly disagree ◎Disagree ◎Somewhat disagree
◎Somewhat agree ◎Agree ◎Strongly agree

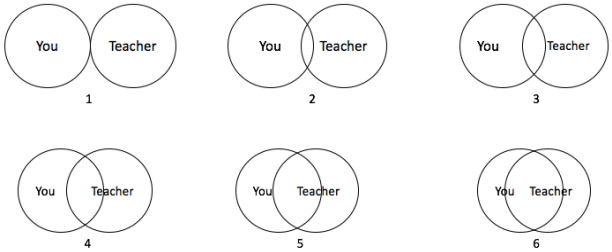
Course value.
The information presented in the Microbiology class is important for my future academic success.
◎Strongly disagree ◎Disagree ◎Somewhat disagree
◎Somewhat agree ◎Agree ◎Strongly agree

The information presented in the Microbiology class is important for my future career success.
◎Strongly disagree ◎Disagree ◎Somewhat disagree
◎Somewhat agree ◎Agree ◎Strongly agree

Teacher instrumentality.
I find my professor to be very helpful with my goals for the course.
◎Strongly disagree ◎Disagree ◎Somewhat disagree
◎Somewhat agree ◎Agree ◎Strongly agree

My professor is a real source of strength for me in pursing my goals for the class.
◎Strongly disagree ◎Disagree ◎Somewhat disagree
◎Somewhat agree ◎Agree ◎Strongly agree

Connectedness.
Which of the pairs of circles best represents you and your Microbiology professor? (The more the circles overlap, represents the closer you feel with your professor.)



Goal ranking:

Below are five goals laid out by your Microbiology course syllabus (the order was randomized). Now please prioritize them based on their importance to you. You can drag (using mouse or finger) to change their orders (1 = the most important, and 5=least important).

1		To learn about genetics of bacteria
2		To learn to handle microorganisms and some basic microbiological techniques in the lab
3		To learn about the structure and function of microbial cells
4		To learn about the growth and control of growth of microorganisms
5		To learn about metabolism of microbial cells

Video:

[Note: After the video, students in the GL condition were then shown the instructional goals as listed on their syllabus. Students in the GR and GRD conditions were then shown the instructional goals ranked by their professor.
At this point, the first survey and intervention were completed for students in the GL and the GR conditions.
Students in the GRD condition were additionally instructed to sign up for a 10-minute individual office session with their Microbiology professor within the following two weeks, see below.]

Within the following two weeks, you should schedule a 10 min office hours with your professor, to discuss the ranked instructional goals. She is available from 10:45 to 12:15 on Tuesdays and Thursdays, or by appointment. Now take a look at your calendar, and write down the date/time you want to visit.

APPENDIX B: End-of-semester Survey

Note: The End-of-semester survey included the same questions as the Pre-intervention survey but also included additional questions measuring the outcome variables that we were interested in, as follow.

Study-time allocation.

From the modules below, which were covered in your lectures, choose the three most important ones that you would like to further review for your final exam, and then list them by priority.

- o Module 1: Introduction to Microbial
- o Module 2: Microscope
- o Module 3: Cell Structure
- o Module 4: Macronutrients
- o Module 5: Metabolism
- o Module 6: Viruses/Viroids
- o Module 7: Genetics
- o Module 8: Human-microbe interaction

Self-assessment.

Within what range (10 points) do you expect your final exam grade to be? _____

Help-seeking tendency.

When you encounter difficulties in Biology class, who is the person you would like to ask for help? Why does this person come to mind first?

Office hours visit.

How often did you visit your professor's office hours in the past month?

◎Never ◎Seldom ◎Occasionally ◎Often ◎Very often