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Improving student performance in organic chemistry: Help seeking behaviors and prior chemistry aptitude

Gail Horowitz[1], Laura A. Rabin[2], and Donald L. Brodale[3]

Abstract: Organic Chemistry is perceived to be one of the most challenging of undergraduate science courses, and attrition from this course may impact decisions about pursuing a professional or academic career in the biomedical and related sciences. Research suggests that chemistry students who are strategic help seekers may outperform those students who avoid seeking help, and that encouraging self-regulated learning behaviors can benefit academically at-risk students. In the current study we present the results of action research conducted in an Organic Chemistry classroom at a large, urban, public university over the course of three semesters. Results suggest that encouraging academic help seeking, a type of self-regulated learning, improves student outcomes. Implications for other science courses and for similar student populations (underrepresented minorities and first generation to attend college) are discussed.

Keywords: organic chemistry, student learning, help seeking behavior, higher education, underrepresented students

I. Introduction.

While many students enter college with the intention to major in science or mathematics, a large percentage exits these disciplines during the early college years (Barr, Gonzalez, & Wanat, 2008; Eaton, 2004; Seymour & Hewitt, 1997). Moreover, attrition rates of female and ethnic/racial minority students from these disciplines have been disproportionately high relative to that of White males (Barr et al., 2008; Seymour & Hewitt, 1997; Tsui, 2007). Surprisingly, research has indicated that students leaving science and mathematics fields are not necessarily weaker academically; rather, a disproportionately "able" or academically successful group of students leaves these disciplines (Barr et al., 2008; Seymour & Hewitt, 1997).

Various factors are known to contribute to what has been termed the "leaky pipeline" (Rosser, 1997) of science and mathematics undergraduates, including a competitive classroom atmosphere (Tobias, 1990) and poor quality teaching (Seymour & Hewitt, 1997). In some cases, loss of interest and subsequent attrition may be related to negative academic experiences, such as earning poor grades, negative experiences with teaching assistants or lab instructors, and minimal or poor contact with professors (Barr et al., 2008). Of particular interest, however, are how negative experiences with Chemistry courses, especially Organic Chemistry, play a key role in discouraging students from persisting in premedical studies (Barr et al., 2008; Lovechhio & Dundes, 2002). Beliefs students hold about their own intelligence (Dweck & Leggett, 1988) lead some who perform poorly in Organic Chemistry toward self-blame due to a belief that their

[1] Department of Chemistry, Brooklyn College of the City University of New York, 2900 Bedford Avenue, Brooklyn, NY 11210, ghorowitz@brooklyn.cuny.edu
[2] Department of Psychology, Brooklyn College of the City University of New York, lrabin@brooklyn.cuny.edu
[3] Department of Sociology, Brooklyn College of the City University of New York, sociology@brodale.net

failure stems from a lack of ability (entity beliefs about intelligence) rather than a limited background in science (incremental beliefs about intelligence) (Horowitz, 2011).

A number of reform efforts have arisen in response to the high attrition rates of students in STEM (science, technology, engineering, and mathematics) fields. Two well-known efforts of the National Science Foundation (NSF) are Process Oriented Guided Inquiry Learning (POGIL) and Peer-Led Team Learning (PLTL) (Gosser & Roth, 1998; Farrell, Moog, & Spencer, 1999). Both POGIL and PLTL focus on changing traditional science classrooms into more student-centered environments. POGIL replaces traditional lectures with student-focused, problem solving activities, while PLTL utilizes undergraduate peer tutors to run supplementary problem solving sessions for small groups of students. Both POGIL and PLTL have resulted in significant improvements in student retention and performance in a variety of classroom settings (e.g., public universities and private colleges) and across science disciplines (Gosser, 2011; Eberlein et al., 2008). Institutional finances, however, can impact the duration and scope of POGIL and PLTL programs because these programs may impose class size limits or require the hiring and training of peer tutors (Gosser, 2010). For example, although preliminary results with POGIL and PLTL at the authors' institution were promising (Contel, 2009), cost considerations led to the curtailment of these programs.

Cooperative learning theory underpins both POGIL and PLTL (Slavin, 1980). However, *self-regulated learning theory* is also highly relevant to student success in STEM. Self-regulated learning, a sociocognitive theory, posits that individuals can monitor their own learning processes, employ strategies to meet their goals, and modify behaviors in response to feedback, toward better learning outcomes (Zimmerman, 1990). Self-regulated learners attain success by exerting control over important aspects of their learning environments. A significant feature of self-regulated learning is that it can be developed through practice and self- reflection at any stage in the educational process; thus, it is not conceptualized as or static trait related to underlying intellectual abilities or personality traits (Pintrich, 1995). The adoption of self-regulated learning strategies is particularly appropriate for college students who typically are able to exert control over many aspects of their learning environments including planning academic schedules, regulating physical and social environments, monitoring short and long-term performance outcomes, and seeking help when necessary (Pintrich, 1995; Zimmerman & Risemberg, 1997).

Help seeking is one of a number of self-regulated learning strategies postulated by Zimmerman and others (Newman, 1994; Zimmerman & Martinez-Pons, 1986). While several studies have examined self-regulated learning and academic help seeking among college students, relatively few have examined these behaviors in science or mathematics contexts. One study by Dibenedetto and Bembenutty (2011) demonstrated a positive association between the use of self-regulated learning strategies and science achievement. A study by Nandagopal (2006) found a relationship between the frequency of use of self-regulated learning strategies and science achievement; self-regulated learning strategies accounted for almost as much variance in academic performance as prior grade point average. An intervention study involving remedial math students at a technical college (Zimmerman, Moylan, Hudesman, White, & Flugman, 2011) revealed that training students in self-regulated learning strategies, specifically to review and correct their own quizzes, resulted in treatment students outperforming control students by 25% on a national "gateway" examination.

With regard to help seeking behaviors among chemistry students, Karabenick (2003) found that General and Organic Chemistry students who were *strategic* help seekers performed

better than students who avoided seeking help. (Strategic help seekers were those who sought appropriate help to maximize learning as opposed to those who asked for shortcuts to quickly find solutions to problems). Szu and colleagues (2011) found that higher achieving Organic Chemistry students engaged in help seeking behavior earlier in the semester than lower achieving students. They also found that although student performance in Organic Chemistry was strongly correlated with prior grade point average, study behaviors and concept mapping made a much larger relative contribution to course performance.

Barriers to help seeking may include time constraints, lack of knowledge about available sources of assistance, low perceived need for help, or threat of being regarded as less capable than other students (Ryan & Pintrich, 1997; Ryan, Pintrich, & Midgley, 2001). Low-achieving students, in particular, may perceive a need for help as indicative of their cognitive or academic failures. These students may have lower self-efficacy (Bandura, 1997; Ryan & Shin, 2011), feel too embarrassed to admit failings (Newman, 1994; Shapiro, 1983), or possess less awareness of a need for help (Wood & Wood, 1999). As Marchand and Skinner (2007) suggest, help seeking may have the net result of being most helpful to those who are least in need of help—the strongest students—a phenomenon wherein the "rich … become richer."

Academic help seeking may be a particularly difficult undertaking for students who do not share the cultural experiences of the majority of college students. Although there is a paucity of empirical data on racial, ethnic, and cultural differences in academic help seeking behavior, research has identified a tendency to prefer culturally similar versus dissimilar helpers, likely reflecting an in-group bias (Kashima, 2001). Furthermore, students whose parents are less familiar with the American educational process (e.g., immigrants, those not college educated), sometimes report receiving a message that they "just need to study harder" Horo(Horowitz, 2011) According to author GH, the parents of these students may lack a clear picture of what it takes to succeed in pre-medical courses because sometimes it is not about "studying harder," but rather "studying smarter" by being more strategic about one's organizational skills and study habits. Newman (2000), for example, showed that parental and mentor socialization of students influences help seeking behavior. And Zimmerman (1990) pointed out that weaker students, who are not self-regulated, talk about working harder rather than talking about the strategies they will utilize to try to improve.

The research cited above suggests, not only that students who are strategic help seekers may outperform students who avoid seeking help, but also that encouraging self-regulated learning behaviors can benefit academically at-risk students. Given the potential significance of students' outcomes in Organic Chemistry to their educational and professional trajectories, the goal of the present study was to examine whether or not help seeking could significantly improve the course performance of Organic Chemistry students.

II. Method.

A. Participants and General Procedure.

Over the course of three semesters (Fall 2010, Spring 2011, and Spring 2012), an IRB approved, action research study investigated the benefits of academic help seeking in an Organic Chemistry I classroom at a large, public university located in the Northeastern U.S. Author GH was the lecture instructor for all three semesters of this 5-credit, 15-week long course that consisted of three hours of lecture, one hour of recitation, and four hours of laboratory each week.

Historically, the Organic Chemistry I course at this institution has had a high failure plus withdrawal rate (approximately 40%). This was of concern to the authors because of the high degree of diversity of the student population at our institution: approximately 50% of students are ethnic/racial minorities, approximately 40% are from groups underrepresented in STEM disciplines, approximately 60% are from households with annual incomes of less than $30,000, and approximately 33% of students speak English as a second or third language. Additionally, many students are the first in their families to attend college.

We employed two methods of data collection. The first was an anonymous, online questionnaire, developed by author GH and administered to students immediately following the return of the first midterm exam (at approximately week 7 of the semester). This questionnaire inquired about various aspects of student behaviors and attitudes including help seeking behaviors, perceived need for help, and midterm grade. The second method of data collection entailed objectively tracking student attendance at instructor problem sessions and office hours, noting each instance of student attendance, later summed into a single "total help seeking" score. In addition, the authors collected information regarding the grades students received in General Chemistry II—an immediate prerequisite course for Organic Chemistry I—as a control variable in the analyses. However, students who took General Chemistry II at outside institutions were excluded from analysis because of institutional variability in course content and grading standards.

B. Specific Procedures and Analyses.

Fall 2010: Setting the Stage

Prior to beginning the Fall 2010 semester, GH developed a course website and syllabus in which she highlighted and emphasized the availability of a variety of help seeking resources for students such as supplementary problem sessions (held on Saturday evenings before quizzes and exams), office hours, free tutoring, online tutorials, etc.

Analysis 1—*Help seeking and midterm performance.* Based on data collected from the anonymous, online questionnaire, we investigated whether the odds of achieving a higher degree of midterm performance varied significantly for different levels of *help seeking behaviors* and *perceived need for help*. Perceived need for help was included as a variable to account for the fact that the strongest students might not seek help simply because they did not need it.

Analysis 2—*Help seeking and overall course performance.* Based on objective tracking of student attendance at problem sessions and office hours, we investigated the impact of *help seeking behavior* on final class grade, while using students' prior General Chemistry II grade (expressed as grade point equivalents, e.g. 3.0, 2.67) as a control variable. General Chemistry II grades were observed to be strongly correlated with students' final numerical grades obtained in Organic Chemistry I. The simple Pearson correlation coefficient for this relationship was 0.70 ($p < 0.001$) for the Fall 2010 semester. In other words, approximately half the variability in Organic I grades directly related to how students performed in their previous General Chemistry II class. This finding provided a strong rationale for use of General Chemistry II grades as a control variable.

Spring 2011 and Spring 2012: Fine-tuning

Based on student feedback and her own observations of student behavior, beginning in Spring 2011, GH offered a greater number of supplementary problem sessions. And instead of holding problem sessions solely before quizzes and exams, she held two problem sessions per week, one during the day (during club hour when no classes meet) and one on a weeknight in the early evening. GH also decided, partly due to personal time constraints, to shorten the problem session lengths from two hours to one hour. Based on student feedback, she also recruited peer tutors to assist during the problem sessions. GH located a number of willing, former students so that, at a minimum, 2-3 people were available to answer student questions. All of the changes implemented in Spring 2011 were maintained in Spring 2012.

Analysis 3—*Help seeking and midterm performance.* As before, based on data collected from the anonymous, online questionnaire, we investigated whether the odds of achieving a higher degree of midterm performance varied significantly for different levels *help seeking behaviors* and *perceived need for help*. Notably, the survey was modified slightly from Fall 2010 to include a question about students' performance in General Chemistry II. This variable was then used as a control variable in Analysis 3.

Analysis 4—*Help seeking and overall course performance*. As in Fall 2010, GH collected her own observational data of student attendance at each of her problem sessions and office hours over the course of the semester. The authors subsequently investigated the impact of *help seeking behavior* on final class grade, while using students' prior General Chemistry II grade as a control variable.

Table 1. Overview of analyses conducted.

Fall 2010	N	*Spring 2011 & Spring 2012*	N
Total Enrolled	214	Total Enrolled	274
Completed Midterm Survey	137	Completed Midterm Survey	140
Included in Analysis 1	111*	Included in Analysis 3	97***
Withdrew from Course	25	Withdrew from Course	25
Included in Analysis 2	157 **	Included in Analysis 4	204**

* Students with incomplete survey data were excluded.
** Students who withdrew (and who therefore had no numerical course grade at the end of the semester) were excluded, as were students who received incompletes or who did not take General Chemistry II at the home institution.
*** Students with incomplete survey data or who did not take General Chemistry II at the home institution were excluded.

III. Results.

A. Fall 2010 (Analysis 1).

Help seeking and midterm performance. The overall response rate for the voluntary survey was 58% (i.e., 137 students at all levels of class performance participated). The majority of respondents reported that they had sought some form of help before the first midterm exam: 58% had attended at least one extra problem session, 52% had attended office hours at least once,

56% had participated in some form of tutoring, and 32% had visited the campus learning center. Midterm grade was self-reported on an ordinal scale (i.e., <25%, 25-45%, 46-65%, 66-85%, or >85%).

We employed logit ordinal regression (O'Connell, 2006) on 111 students with complete data to determine whether the odds of achieving a higher degree of midterm performance varied significantly for different levels of the independent variables of *help seeking behaviors* (i.e., self-reported attendance at problem solving sessions and office hours, categorized as 0 times, 1-4 times, 5-8 times, or more than 8 times) and the control variable of *perceived need for help* (i.e., dichotomized as "agree" or "disagree" with the following statement: "I often feel that I need help understanding the class material"). Odds were expressed as a single cumulative odds ratio for each level of each variable, providing a measure of representation of each group relative to its given reference category. Presentation of a single odds ratio rests on the assumption that regression parameters themselves do not vary for each successive level of performance on the midterm examination, an assumption met upon inspection of the test of parallel lines. Tests of model fitness were also satisfied, and the Nagelkerke pseudo-R^2 value, a measure of predictive improvement in the proposed fitted model relative to a null model, was 13.3%.

With regard to office hours, the odds ratios revealed a statistically nonsignificant pattern of positive association of increased office hours visitation with greater likelihood of improved midterm performance (Table 2). As for the impact of problem solving, there was no clear trend despite positive association at all levels (i.e., compared to those who do not attend at all, those who attended at any level had a greater likelihood of a higher level of midterm performance). The only level that showed measurable statistical significance was among those who attended 1-4 times. Compared to those who do not attend at all, such students were approximately 2.5 times more likely to see improved midterm performance. With regard to perceived need for help, there was a positive effect noted that did not achieve statistical significance.

B. Fall 2010 (Analysis 2).

Help seeking and overall course performance. The authors investigated the impact of *help seeking behavior* (i.e., sum of student visits to problem solving sessions and office hours) on final class grade (a continuous variable ranging from 0 to 100), while using students' prior General Chemistry II grade (expressed as grade point equivalents, e.g. 3.0, 2.67) as a control variable. A multiple regression analysis utilizing simultaneous entry of predictors (Cohen, Cohen, West, & Aiken, 2003) was conducted to estimate the model that best predicted final class grade based on two factors: help seeking and prior performance in General Chemistry II. Final class grade was significantly negatively skewed. In order to meet the test assumption of normality for this criterion, a square root transformation appropriate to the raw data was conducted prior to analysis (Tabachnick & Fidell, 2007). All other test assumptions were met satisfactorily. Results revealed that a regression model incorporating as factors help seeking and General Chemistry II performance was statistically significant ($F = 84.853$, $p < 0.001$) accounting for 52.4% of variance in final class grade overall ($R = 0.724$). As shown in Table 3, both factors were positively correlated and independently significant, though prior General Chemistry II performance ($\beta = -0.687$, $p < 0.001$) more so than help seeking behavior ($\beta = -0.115$, $p = 0.047$) in terms of both impact and significance.

Table 2. Regression analysis for prediction of midterm performance by help seeking behaviors and perceived need for help. (N = 111)

Variable	*Parameter*	*B*	*SE*	*Odds Ratio*	*95% Confidence Interval*
Office Hours (reference = 0 visits)	>8 5-8 1-4	1.541 0.433 0.078	0.803 1.150 0.389	4.669 1.542 1.081	0.969 – 22.511 0.162 – 14.702 0.505 – 2.316
Problem Solving (reference = 0 visits)	>8 5-8 1-4	1.061 1.407 0.901	1.182 0.979 0.398	2.889 4.084 2.462*	0.285 – 29.283 0.599 – 27.799 1.129 – 5.376
Perceived Need for Help (reference = agree)	disagree	0.380	0.402	1.462	0.668 – 3.212

* $p < 0.05$

Table 3. Regression analysis for prediction of final class grade by General Chemistry II grade and help seeking behavior. (N = 157)

Factor	*B*	*SE*	*B*	*t*
General Chemistry II	-1.129	0.094	-0.687	-11.974***
Help Seeking	-0.043	0.021	-0.115	-2.006*

Note. Positive factors possess negative signage due to transformation of the dependent variable.
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

C. Spring 2011 and Spring 2012 (Analysis 3).

Help seeking and midterm performance. Survey data from the respondents (45% of those who completed the first midterm) indicated that over 90% surveyed had sought at least one form of help before the first midterm exam. Seventy percent had attended at least one extra problem session, and 50% had attended office hours at least once. Notably, students at all levels of class performance participated in the survey. However, only students who completed General Chemistry II at the authors' university were included in the analysis.

For Spring 2011 and 2012, midterm grade was reported on the following ordinal scale: <25%, 25-39%, 40-54%, 55-69%, 70-85%, or >85%. As before, an ordinal regression of the 97 student cases with complete data was employed to determine whether the odds of achieving a higher degree of midterm performance varied significantly for different levels of the independent variable of *help seeking behaviors* (i.e., self-reported attendance at problem solving sessions and office hours, categorized as 0 times, 1-4 times, 5-8 times, or more than 8 times) and the control variables of *perceived need for help* (i.e., dichotomized as "agree" or "disagree" with the following statement: "I often feel that I need help understanding the class material.") and

General Chemistry II grade (entered in the form of a continuous grade point equivalent). Odds were expressed as a single cumulative odds ratio for each level of each variable, providing a measure of representation of each group relative to its given reference category. Presentation of a single odds ratio rests on the assumption that regression parameters themselves do not vary for each successive level of performance on the midterm examination, an assumption met upon inspection of the test of parallel lines. Tests of model fitness were met, and the Nagelkerke pseudo-R^2 value was 29.7%, representing an noteworthy improvement in modeling over the Fall 2010 analysis.

As shown in Table 4, higher General Chemistry II scores were associated with improved midterm performance—each one-point grade increase improved the odds ratio by a factor of 2.6. As an example, students who earned a grade of "A" as compared to a grade of "C" in General Chemistry II were roughly seven times more likely to achieve a higher level of performance on the Organic Chemistry I midterm. As with Fall 2010, there were no statistically significant findings for office hours. Attendance at problem solving sessions showed a positive, statistically significant association at all levels with a trend of increased likelihood of improvement in midterm performance with increased attendance at problem solving sessions. Perceived need for help was a statistically significant factor; students who disagreed with the statement that they needed help understanding class material had an approximately 3 times greater likelihood of achieving a higher level of performance on the midterm.

D. Spring 2011 and Spring 2012 (Analysis 4).

Help seeking and overall course performance. The authors investigated the impact of *help seeking* (i.e., sum of student visits to problem solving sessions and office hours) on final class grade, while using students' prior General Chemistry II grades as a control variable. A multiple regression analysis (N=204) was conducted to estimate the model that best predicted final class grade based on two factors: help seeking behavior and prior performance in General Chemistry II. Final class grade was significantly and negatively skewed, and a square root transformation was applied. All test assumptions were met satisfactorily. Results revealed that a regression model incorporating as factors help seeking and General Chemistry II was statistically significant ($F = 89.514$, $p < 0.001$) accounting for 47.1% of variance in final class grade overall ($R = 0.686$). As shown in Table 5, both factors were positively correlated and independently significant, though prior General Chemistry II performance ($\beta = -0.582$, $p < 0.001$) more so than help seeking behavior ($\beta = -0.275$, $p < 0.001$) in terms of substantive impact. Of note, we reran this analysis with individual semester of enrollment (i.e., Spring 2011 or Spring 2012) as an additional factor and found its contribution to the model to be insignificant; its inclusion did not alter the pattern of findings.

IV. Discussion.

Overall, the Fall 2010 data demonstrated that both help seeking and General Chemistry II grades related to Organic Chemistry I course performance, though prior grade showed a stronger effect. Results obtained in Spring 2011 and Spring 2012 were encouraging in terms of their consistency with Fall 2010 results, but also in terms of the noticeable improvement in the measured contribution of help seeking to overall class performance. Specifically, the restructuring and

rescheduling of problem sessions may have resulted in greater student attendance at these sessions.

Table 4. Regression analysis for prediction of midterm performance by General Chemistry II grades, help seeking behaviors, and perceived need for help. (N = 97)

Variable	*Parameter*	*B*	*SE*	*Odds Ratio*	*95% Confidence Interval*
General Chemistry II	grade points	0.950	0.240	2.586***	1.614 – 4.141
Office Hours (reference = 0 visits)	>8 5-8 1-4	1.278 -0.554 0.254	1.332 1.127 0.398	3.589 0.575 1.289	0.263 – 48.862 0.063 – 5.233 0.590 – 2.812
Problem Solving (reference = 0 visits)	>8 5-8 1-4	1.852 1.957 1.125	0.573 0.618 0.544	6.373** 7.078** 3.080*	2.071 – 19.590 2.106 – 23.784 1.061 – 8.944
Perceived Need for Help (reference = agree)	disagree	1.091	0.505	2.977*	1.106 – 8.020

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

Table 5. Regression analysis for prediction of final class grade by General Chemistry II grade and help seeking behavior. (N = 204)

Factor	*B*	*SE*	*β*	*t*
General Chemistry II	-0.979	0.088	-0.582	-11.174***
Help Seeking	-0.055	0.010	-0.275	-5.278***

Note. Positive factors possess negative signage due to transformation of the dependent variable.
*** $p < 0.001$

Our results indicated that when a diverse group of undergraduate students participates in help seeking, performance in a challenging, gatekeeping course like Organic Chemistry I can improve. However, our data also revealed that some students sought help infrequently, or not at all. Descriptive survey data provided some rationale for why this was the case. For example, in Spring 2011, although the vast majority of respondents indicated comfort in seeking help from recitation and lecture instructors, 50% indicated that the times available to obtain help did not match their personal schedules. Among the schedule constraints respondents faced, 80%

indicated managing a full course load, 60% indicated family responsibilities, and 56% indicated work responsibilities.

Other factors unrelated to scheduling may also have discouraged certain students from seeking help. For example, GH observed that students who present as more self-confident seem more comfortable seeking help while poorly performing students seem ashamed of their lack of knowledge or afraid that asking questions will bother or annoy the instructor. These student behaviors may be related, in part, to SES and parents' levels of education. GH speculates that students who grow up in wealthier households may take steps to ensure that their academic needs are met, as compared to students from less privileged backgrounds. It also seems that some students (perhaps because their parents are college educated) are savvier about how to succeed in college, whereas other students are not as proactive about getting help when they needed it. These possibilities are supported by the ethnographic work of Annette Lareau (2011), who found that children raised by college educated parents grow up feeling more entitled and more comfortable asserting their needs in school settings.

The degree to which students' self-regulated behaviors are learned from parents or influenced by the beliefs students hold about their own intelligence and self-efficacy remains to be determined. Preliminary data from our research (not presented above) suggests that better midterm performance is correlated with knowing where to go for advice or information and knowing which questions to ask when one feels "stuck." Better midterm performance was also associated with feeling comfortable letting instructors and peers know that one is struggling with the class material. These findings have implications for the development of interventions to encourage help seeking behavior in those less inclined to seek out such services on their own. For example, instructors could be trained to teach students to adopt behaviors that stronger students seem to demonstrate already (e.g. picking up and reviewing graded materials, making lists of questions they need help with, or creating flash cards). Before intervening, it would be instructive to explore students' help seeking orientations (e.g., whether one is an "instrumental" or "executive" help seeker) (Karabenick & Dembo, 2011), their beliefs about their ability to exert control over their learning environments, and their basic ability to communicate needs to a peer or instructional tutor. By understanding the unique needs of students, focused interventions could be developed that target specific barriers to effective help seeking. Ultimately, that of greatest benefit to students remains not merely the receipt of help but the receipt of the right type of help for their particular struggles.

Every semester GH observes that some Organic Chemistry I students exhibit worrisome behaviors that seem contrary to the mode of self-regulated learning. For example, some students avoid seeking help while others avoid obtaining feedback (e.g., fail to retrieve exams and quizzes); still others avoid meeting with the instructor or even attending class (where the instructor provides suggestions about what to focus on and how to study). When these students perform poorly, they may resort to self-blaming, believing that their failures are due to a lack of ability (entity beliefs about intelligence), rather than due to lack of a strong science background (incremental beliefs about intelligence) (Dweck & Leggett, 1988). Clearly there is a role here for education around issues of ability and intellect, which could be incorporated into the academic helping relationship.

A notable finding in this study was the strong association between General Chemistry II and Organic Chemistry I grades. This finding initially surprised the authors, given the limited content overlap between these courses. It appears, however, that the General Chemistry II grade likely taps into not just General Chemistry knowledge, but also prior overall science background

and science study skills. Students at our university with strong high school science backgrounds often anecdotally report that General Chemistry is not difficult for them. By contrast, students with weak high school backgrounds tend to report the opposite. This supports our hypothesis that skill at seeking help can impact Organic Chemistry I performance. It also supports the notion that training weaker students to adopt appropriate help seeking behaviors can improve their performance.

Limitations. The study was limited in terms of the types of data available to the researchers. We did not possess demographic data (e.g. gender, race/ethnicity, parental educational achievement) that could have improved the explanatory power of our models. In addition, because we altered the survey between the Fall 2010 and Spring 2011 and 2012 semesters, we were unable to compare findings directly between these semesters.

This study also excluded transfer students, which limits the generalizability of our findings, since a number of students in Organic Chemistry I were transfers. This exclusion is of concern because it has been observed (Kobrak, 2010) that transfer students who take General Chemistry II outside of our university encounter particular trouble when they take Organic Chemistry I at our institution.

Another limitation is that in our final course grade analyses (Analyses 2 and 4), all students who withdrew (who did not complete the course) had to be excluded. This is of concern because it is likely that the majority of these students withdrew because they were performing poorly in the course.

V. Conclusions.

While a number of studies discuss self-regulated learning and academic help seeking among college students, relatively few have examined these behaviors in science or mathematics contexts. Over the course of several semesters at a large, urban, public university, the current study explored the potential impact upon performance in Organic Chemistry I of several variables including student participation in academic help seeking activities, such as attendance at problem sessions and office hours. While results indicated that prior demonstration of aptitude through General Chemistry II grade was the best predictor of current performance in Organic Chemistry I, other variables had a significant impact including engaging in help seeking (particularly attendance at problem solving sessions) and a lower self-perceived need for help (perhaps indicating greater confidence in one's potential to master course material). This study has important implications for others who teach introductory science courses, especially for those who teach underrepresented students, because it supports the findings of Zimmerman et al. (2011) that encouraging students to engage in self-regulated learning behaviors may benefit underrepresented and at-risk students.

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References

Horowitz, G. (2011, November). *Encouraging academic help seeking: Improving student performance through action research.* Presented at the Center for Teaching, Authors' Institution, City, State.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Barr, D. A., Gonzalez, M. E., & Wanat, S. F. (2008). The leaky pipeline: Factors associated with early decline in interest in premedical studies among underrepresented minority undergraduate students. *Academic Medicine, 83*(5), 503-511.

Cohen, J., Cohen P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences.* (3rd ed.) Hillsdale, NJ: Lawrence Erlbaum Associates.

Contel, M. (2009, May). *Experiences with POGIL and PLTL in Organic Chemistry I.* Presented at the 13th Annual Faculty Day Conference, Brooklyn College - CUNY, Brooklyn, NY.

DiBenedetto, M. K., & Bembenutty, H. (2013). Within the pipeline: Self-regulated learning, self-efficacy, and socialization among college students in science courses. *Learning and Individual Differences, 23*, 218-224.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256-273.

Eberlein, T., Kampmeier, J. A., Minderhout, V., Moog, R. S., Platt, T., Varma-Nelson, P., et al. (2008). Pedagogies of engagement in science: A comparison of PBL, POGIL, and PLTL. *Biochemistry and Molecular Biology Education, 38*(4), 262-273.

Eaton, R. L. J. (2004). Teaching for diversity in undergraduate science. In D. W. Sunal, E. Wright, & J. B. Day (Eds.), *Reform in undergraduate science teaching for the 21st century* (pp. 153-166). Greenwich, CT: Information Age Publishing.

Farrell, J. J., Moog, R. S., & Spencer, J. N. (1999). A guided inquiry General Chemistry course. *Journal of Chemical Education, 76*(4), 570-574.

Gosser, D. K. (2010, April). *Peer-Led Team Learning.* Presented at Science Education for the 21st Century, The Graduate Center, City University of New York, New York, NY.

Gosser, D. K. (2011). The PLTL boost: A critical review of research. *Progressions, 14* (1).

Gosser, D. K., & Roth, V. (1998). The workshop chemistry project: Peer-led team learning. *Journal of Chemical Education, 75*(2), 185-187.

Karabenick, S. A. (2003). Seeking help in large college classes: A person-centered approach. *Contemporary Educational Psychology, 28*(1), 37-58.

Karabenick, S. A., & Dembo, M. H. (2011). Understanding and facilitating self-regulated help seeking. *New Directions for Teaching and Learning, 126*, 33-43.

Kashima, Y. (2001). Culture and social cognition: Towards a social psychology of cultural dynamics. In D. Matsumoto (Ed.), *The handbook of cultural and psychology* (pp. 325-360). New York, NY: Oxford University Press.

Kobrak, M. (personal communication, July 20, 2010). Discussed problems transfer students have when they take Organic Chemistry at Authors' Institution.

Lareau, A. (2011). *Unequal childhoods: Class, race, and family life* (2nd ed.). Berkeley, CA: University of California Press.

Lovecchio, K., & Dundes, L. (2002). Premed survival: Understanding the culling process in premedical undergraduate education. *Academic Medicine, 77*(7), 719-724.

Marchand, G., & Skinner, E. A. (2007). Why do some students avoid asking for help? An examination of the interplay among students' academic efficacy, teachers' social-emotional role, and the classroom goal structure. *Journal of Educational Psychology, 99*(1), 65-82.

Nandagopal, K. (2006). *An expert performance approach to examining individual differences in study strategies.* Florida State University, Tallahassee, FL.

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

Newman, R. S. (2000). Social influences on the development of children's adaptive help seeking: The role of parents, teachers, and peers. *Developmental Review, 20*, 350-404.

O'Connell, A. A. (2006). *Logistic regression models for ordinal response variables*. Thousand Oaks, CA: SAGE Publications.

Pintrich, P. R. (1995). Understanding self-regulated learning. In P. R. Pintrich (Ed.), *Understanding self- regulated learning* (pp. 3-12). San Francisco, CA: Jossey-Bass.

Rosser, S. V. (1997). *Re-engineering female friendly science*. New York, NY: Teachers College Press.

Ryan, A. M., & Pintrich, P. R. (1997). Should I ask for help? The role of motivation and attitudes in adolescents' help seeking in math class. *Journal of Educational* Psychology, *89*, 329-341.

Ryan, A., Pintrich, P., & Midgley, C. (2001). Avoiding seeking help in the classroom: Who and why? *Educational Psychology Review, 13,* 93-114.

Ryan, A. M., & Shin, H. (2011). Help-seeking tendencies during early adolescence: An examination of motivational correlates and consequences for achievement. *Learning and Instruction, 21*, 247-256.

Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.

Shapiro, E. G. (1983). Embarrassment and help-seeking. In B. M. DePaulo, A. Nadler, & J. D. Fisher (Eds.), *New directions in help seeking* (Vol. 2, pp. 143-163). New York, NY: Academic Press.

Slavin, R. E. (1980). Cooperative learning. *Review of Educational Research, 50*(3), 315-342.

Szu, E., Nandagopal, K., Shavelson, R. J., Lopez, E. J., Penn, J. H., Scharberg, M., et al. (2011). Understanding academic performance in Organic Chemistry. *Journal of Chemical Education, 88*(5), 1238-1242.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariarate statistics* (5th ed.). Boston, MA: Pearson Publications.

Tobias, S. (1990). *They're not dumb, they're different: Stalking the second tier*. Tucson, AZ: Research Corporation.

Tsui, L. (2007). Effective strategies to increase diversity in STEM fields: A review of the research literature. *The Journal of Negro Education, 76*(4), 555-581.

Wood, H., & Wood, D. (1999). Help seeking, learning and contingent tutoring. *Computers and Education, 33*, 153-169.

Zimmerman, B. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist, 25*(1), 3-17.

Zimmerman, B. J., & Martinez-Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal, 23*(4), 614-628.

Zimmerman, B., Moylan, A., Hudesman, J., White, N., & Flugman, B. (2011). Enhancing self-reflection and mathematics achievement of at-risk urban technical college students. *Psychological Test and Assessment Modeling, 53*(1), 141-160.

Zimmerman, B. J., & Risemberg R. (1997). Self-regulatory dimensions of academic learning and motivation. In G. D. Phye (Ed.), *Handbook of academic learning: Construction of knowledge* (pp. 105-125). San Diego, CA: Academic Press.