Early Identification and Intervention Influences the Success of First-year "At Risk" Science Students

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Abstract - Many students face a difficult transition when they move from high school to university. Universities are providing ever-increasing resources to help first-year students succeed in this transition. Several institutions have adopted an early-alert program to identify students who are "at risk" of not passing their course(s). Often, these early-alert programs are coupled with intervention programs. Unfortunately, little is known about the effectiveness of early-alert and intervention programs. Here we describe a study that used mid-term grades to identify students who are "at risk" (midterm grades <60%) in their science, mathematics, and computer science courses. All "at risk" students were asked to meet with upper-year volunteer student mentors to develop intervention plans. "At risk" students who met with a student mentor were significantly more likely to pass their course(s) than "at risk" students who ignored their letters. These findings suggest that when early-alert programs are coupled with student volunteer intervention programs, first-year students can make a more successful transition from high school to university.

Introduction

Many students are faced with increased academic demands when they enter university, including greater responsibilities, more difficult courses, more assignments, and longer study hours. Because these increased demands are often coupled with increased personal freedom and the luxury to miss class without penalty, many students find the transition from high school to university to be a very difficult one (Nist and Holschuh, 2002). Universities are providing ever-increasing resources to help first-year students make their transition a successful one. Resources are often available to help students learn effective study and time management skills, and to help them become fully engaged with the institution. Universities are increasing these resources with the overall goal of improving graduation rates.

Many institutions have adopted an early-alert system to help students successfully transition from high school to university. These early-alert systems help identify students who are "at risk" of not passing one or more of their courses (Perez, 1998). Early-alert systems are "formal, proactive, feedback system[s] through which students and advisors are alerted to early red flags" (Joe Cuseo, Marymount College, Palos Verde, CA). When early-alert systems are coupled with an intervention program that assists identified students, the "at-risk" students can be helped to successfully pass their courses (Lewis & Lewis, 2007; Legg et al., 2001; Wagner et al., 2002; Perez, 1998; Beatty-Guenter, 1994).

To date, however, little data have been published on the effectiveness of early-alert and intervention programs. Further, the data that have been published are discouraging. As a case in point, Irvine Valley College performed a two-year experiment to quantify the effectiveness of their early-alert and intervention system (Rudmann 1992). They randomly subdivided students into one of three groups: letter group, advisor group, and control group. Students were then identified as "at risk" or "succeeding" by their course instructors during week seven of a twelve-week semester. In week nine, "at risk" students in the letter group received a letter of concern that

informed them of their status and described campus support services, study skill services, and basic skill services offered by the college. "At risk" students in the advisor group were informed of their status and encouraged to make an appointment with a university advisor to talk about the issues and learn about the support services offered by the college. "At risk" students in the control group were not contacted. Rudmann (1992) found no significant difference across the three treatment groups, suggesting that neither of the intervention strategies (letter or advisor) were successful at increasing the "at risk" students' cumulative grade point average, pass rate, final grade, or retention rate, over the non-intervention control group.

Given the number of resources universities are putting into early-alert and intervention programs, it is imperative we ascertain whether these programs are effective at helping "at risk" students successfully complete their first-year courses. Here we describe a new study that quantifies the effectiveness of an early intervention program at helping students successfully complete their courses. Our study focused on students taking first-year science, mathematics, and computer science courses. Theoretically, these students spend 24-27 hours a week attending classes, laboratories, tutorials, and discussion groups. Along with class attendance, day-to-day studying, midterm tests and final exams, these students regularly have to take pre-laboratory quizzes, and complete laboratory and tutorial assignments. This heavy course-load can make time management a significant challenge for a first-year student. To complicate matters, first-year science, mathematics, and computer science students who are unable to master one or more of their courses are often prevented from continuing into other areas of science and technology until they master their missing courses, effectively forcing students who fail or drop a course to lag even further behind their peers (Lewis & Lewis, 2007).

In our study, we identified students as "succeeding" if they received a mid-term grade of 60% or better, and "at risk" if they received a mid-term average of <60%. We then invited all "at risk" students to visit the Science Student Success Centre for a one-on-one help session with an upper-year volunteer science student mentor. We assessed the impact our identification and intervention program had on students' final grades in the course(s) in which they were originally "at risk". Our study provides support for the effectiveness of early intervention programs in first year science, mathematics, and computer science courses.

Methods

Identifying Students "At Risk"

Instructors teaching first-year science seminar, biology, chemistry, physics, algebra, calculus, earth science, and computer science courses submitted midterm grades by the end of week seven of each twelve-week term. Instructors supplied midterm data for a total of 49 science and mathematics courses over the first two years this program was implemented. In the first-year, data were received for 18 courses (8 in the fall 2008 semester and 10 in the winter 2009 semester); in the second year, data were received for 31 courses (16 in fall 2009 and 15 in winter 2010).

Students who received a mid-term grade of less than 60% were classified as "at risk" in that course. We set the "at risk" cutoff point at 60% because students who continue on that grade trajectory would typically either end up with a "D" grade (50-59%) or would fail the course (<50%). "At risk" students were emailed a letter, which strongly encouraged them to meet with an upper-year science student mentor for help. Emails were sent out to "at risk" students during week eight of the twelve-week term. Each email was encouraging and included an electronic link to allow students to easily and immediately book their appointments. Students who sought help were able to obtain appointments as early as the next day and always within the week. If the student booked an appointment for later in the week, the student was sent a reminder of their upcoming appointment 24 hours in advance. Students who happened to be on campus during

regular business hours when they received the email also had the option of 'dropping in' to the Science Student Success Centre and meeting with a mentor immediately.

Mentoring Process

The mentoring team consisted of eighteen volunteer science students. Volunteer mentors were second, third, and fourth year science students who had previously demonstrated academic success in the Faculty of Science. Volunteers applied for these mentoring positions and underwent a rigorous interview process. Selected volunteer mentors were trained in a one-day workshop (early September 2009) and then in two-hour sessions that occurred fortnightly from September 2009 to March 2010. This training schedule ensured that volunteer mentors received at least eighteen hours of training prior to meeting with their first "at risk" student.

Volunteer mentors attempted to establish a healthy helping relationship with the "at risk" students by supporting them while simultaneously encouraging them to take responsibility for their academic and professional development. Volunteers were thus trained in how to ask open-ended questions to enable each "at risk" student to identify and explain the difficulties they were facing, and in how to carefully listen to "at risk" students during their one-on-one mentoring sessions. Volunteers were also trained in how to mentor students to develop personalized study plans, time management skills, note taking skills, lab writing skills, studying skills, and exam taking skills. Importantly, volunteers were taught how to recognize less apparent signs of student distress by interpreting both verbal and non-verbal signs. They connected "at risk" students in need of help with other resources available on campus, and in most cases followed up with students after they used those services. Each volunteer was required to demonstrate strong knowledge of the personal, academic and professional services and resources available to students at the university prior to meeting with "at risk" students.

Each intake mentoring session was one-on-one (with just the student and the mentor in attendance) and lasted 30-60 minutes in duration. During each session, the mentor listened while the student identified the key issue(s) he or she was facing. The mentor then assisted the student in developing an intervention plan that was specific to the student's needs. Intervention plans included having the "at risk" student attend workshops to develop the skill-sets necessary to succeed, connecting the student to other on-campus resources, and/or helping the "at risk" student develop a customized study plan. The mentors were careful to ensure that they did not act as problem solvers, but instead focused on teaching the "at risk" students the tools they could use to identify and then solve their own problems. One or two weeks after the intake mentoring session, the mentor often met with the "at risk" student again to find out whether the strategies they discussed were working or if other issues had arisen. If there were additional challenges, the "at risk" student was given subsequent appointments for follow-up session(s). While most "at risk" students only saw their mentor once or twice, some continued to meet with them on multiple occasions.

Statistical Analyses

Data were analyzed using JMP 8 statistical software (SAS Institute Inc., 100 SAS Campus Drive, Cary, U.S.A.). We used linear regressions to quantify how well midterm grades predicted final grades. We used a logistic fit model to explore how well our "at risk" classification (midterm grade of less than sixty percent) predicted passing the course versus failing or withdrawing from it.

Results

First-year course instructors provided midterm grade data for 4428 students over the two-year study. In the first semester (fall 2008), midterm data were received for 951 students. This nearly doubled to 1871 students in the second semester (winter 2009). Data were received for

2181 students in the third semester (fall 2009) and 1643 students in the fourth semester (winter 2010).

We received midterm data for 2.26 +/- 0.03 courses per student on average. Of the 4428 students who had midterm grades reported, 2335 (53%) were identified as "succeeding" in all their science courses, 1318 (30%) were identified as "at risk" in one course, 445 (10%) were identified as "at risk" in two courses, and 330 (7%) were identified as "at risk" in three or more courses. Thus, of the students identified as "at risk", the majority was only "at risk" in one course; they tended to be succeeding in their other courses.

Midterm Grades Predictability

Midterm grades strongly predicted final grades, explaining 45% of the variation across all courses (regression: t=84.44, P<0.0001, DF=1,8669, R^2_{adj}=0.45). Explanatory power was not dependent on subject (ANOVA: F=1.0199, p=0.4311, DF=1,21, R^2_{adj}=0.00), average class size (regression: t=0.05, p=0.9642, DF=1,25, R^2_{adj}=0.04), or proportion of the course grade in the midterm average (regression: t=0.28, p=0.7846, DF=1,30, R^2_{adj}=0.03).

When we analyzed the midterm data on a course-by-course basis, an average of 32% of the students were identified as "at risk" in each course. Ninety-five percent of the students identified as succeeding at mid-term subsequently passed the course. In contrast, only 56% of the students identified as "at risk" at mid-term subsequently passed the course. Overall, the probability of not passing a course was significantly higher if the student was identified as "at risk" than if they were identified as succeeding in the course (Figure 1; Chi-square: Pearson=2134.74; P<0.0001, DF=1,9122, R^2_{adj}=0.24).

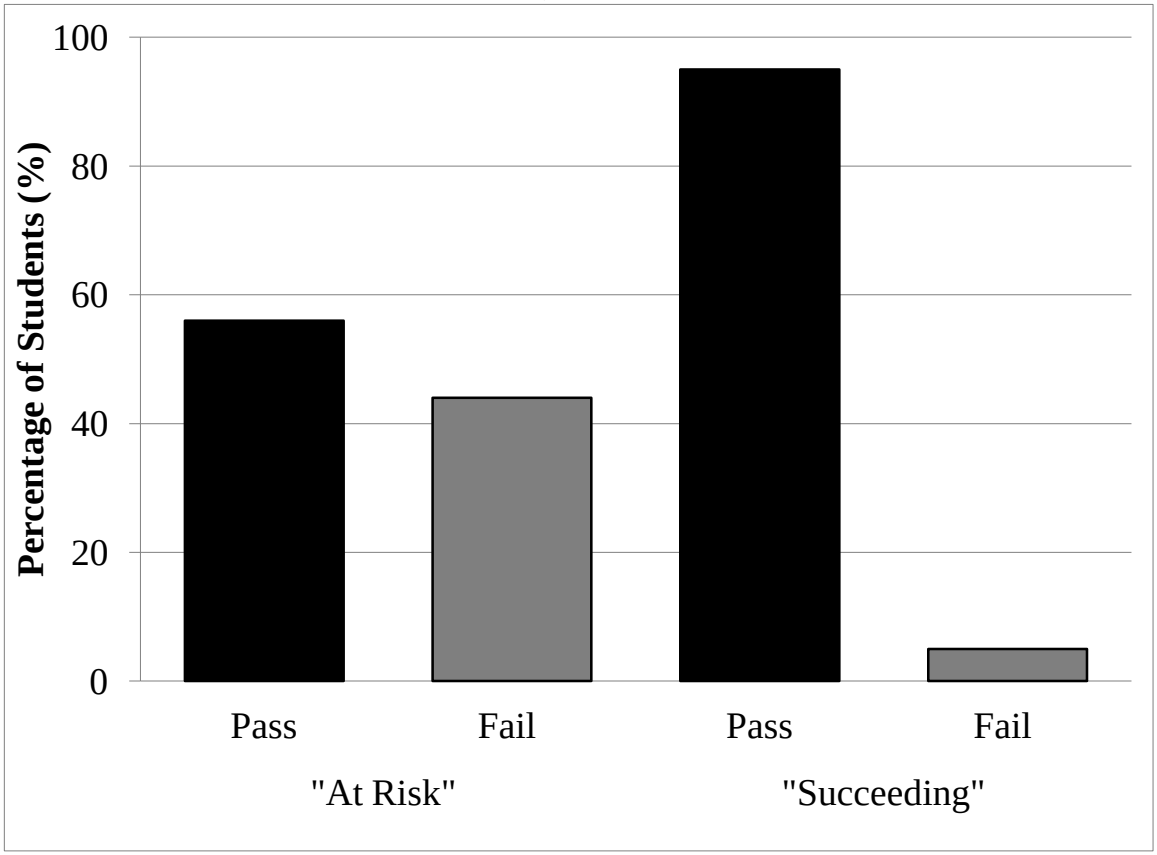

Figure 1. Likelihood of passing or failing the course. Students identified as "at risk" at midterm were more likely to fail or withdraw than students who were identified as "succeeding".

Midterm grade was a strong predictor of whether a student would subsequently pass the course (Logistic Regression: ChiSquare=2586.71, P<0.0001, R^2_{adj}=0.30, DF=1,9122). Students with a midterm average of 60% had a 16% chance of either failing or withdrawing from their course. The chance of failing or withdrawing increased dramatically with declining midterm grades (25% with a midterm grade of 50%; 50% with a midterm grade of 40%; Figure 2). Conversely, the chance of passing increased dramatically with higher midterm grades (6% with a midterm grade of 75%; 2% with a midterm grade of 90%; Figure 2).

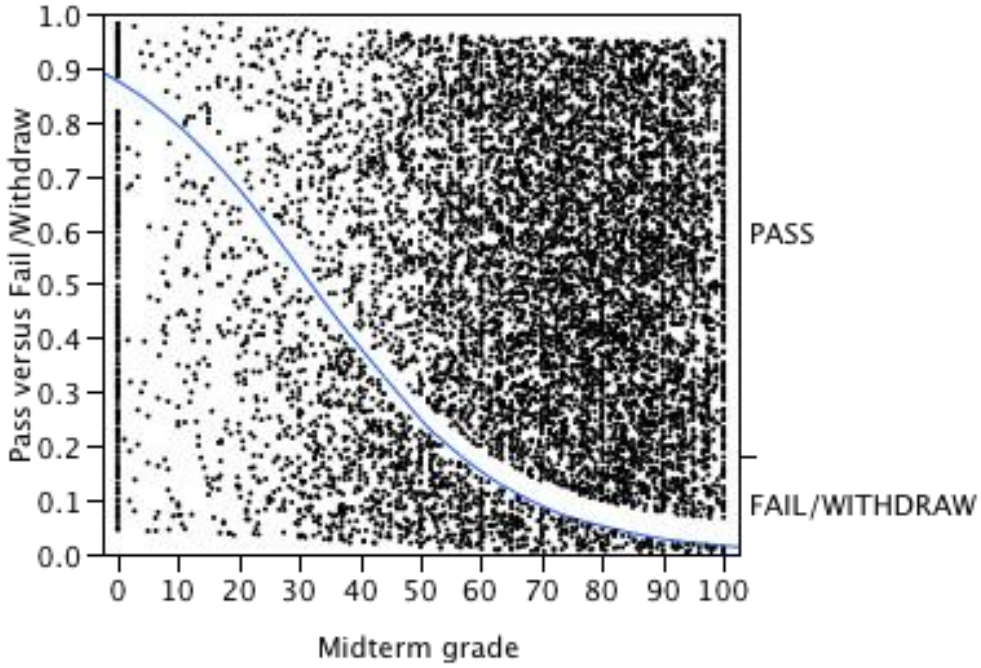

Figure 2. Midterm grade was a strong predictor of whether the student subsequently passed, failed/withdrew from the course.

Success of the Early-Alert and Intervention Program

Of the 2093 students who were identified as "at risk" in one or more courses and then sent an invitation to make an appointment at the Science Student Success Centre, 445 sought help (21.3%). Students "at risk" in multiple courses were slightly more likely to seek help than students who were "at risk" in only one course, however only 3% of the variance in whether or not they sought help was explained by the number of courses they were "at risk" in (Logistic Fit, ChiSquare = 66.68, P<0.0001, DF=1,3061, R^2_{adj}=0.03).

"At risk" students who met with a volunteer science mentor were significantly more likely to pass the course they were "at risk" in than if they did not heed to the advice in the letter and seek help. When students who withdrew from the course were included in the analysis, 62% of the students who participated in the mentoring program passed the course; this number dropped to 55% for students who did not seek help (Pearson ChiSquare = 7.40, P=0.0065, DF=1,3061, R^2_{adj}=0.001). If we only focus on "at risk" students who continued in the course (did not withdraw from it), 70% of the "at risk" students who participated in the Science Student Success Centre's mentoring program passed the course; this dropped to 65% for "at risk" students who did not seek help from the Science Student Success Centre (Figure 3; Pearson ChiSquare=4.49, P=0.0341, DF=1,2594, R^2_{adj}=0.001).

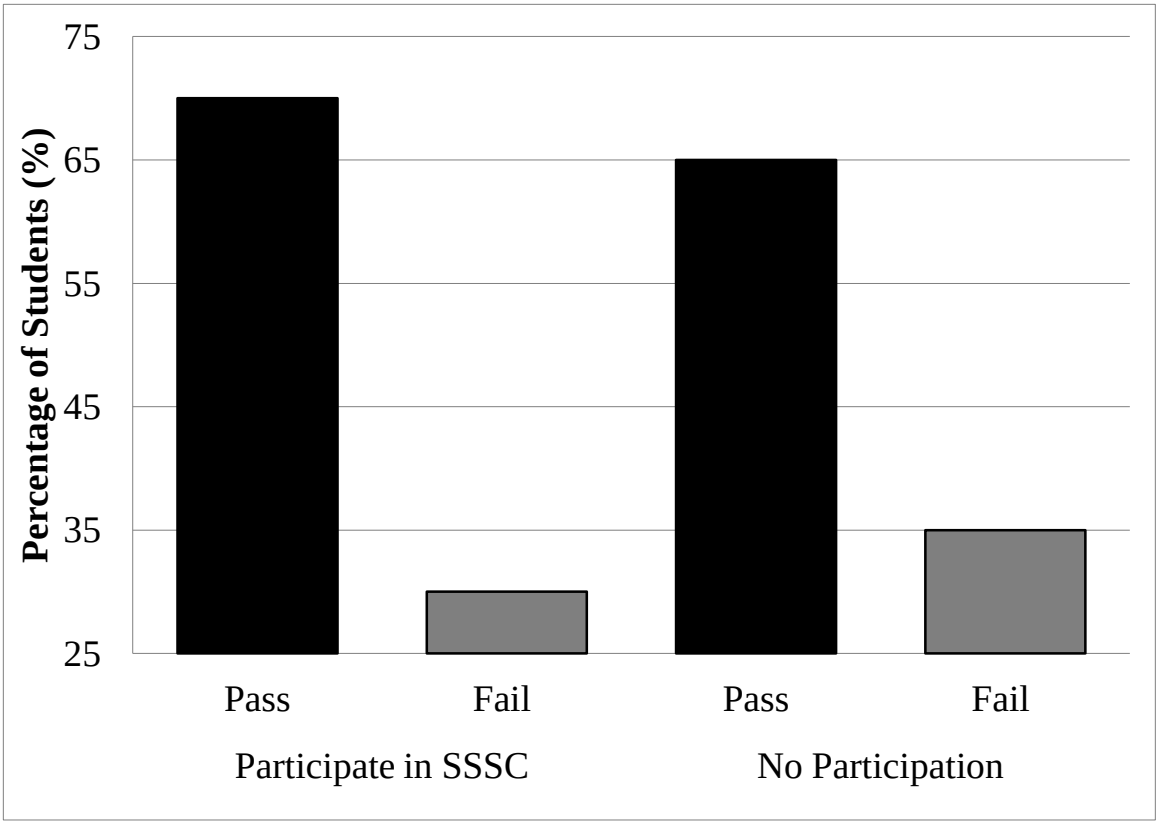

Figure 3. "At risk" students who participated in the Science Student Success Centre's (SSSC) mentoring activities had a significantly higher chance of passing their course (70%) compared to students who did not participate (65%).

Discussion

Our findings suggest that early identification and intervention of "at risk" students increased the probability that the "at risk" students would successfully complete their first-year science, mathematics, and computer science courses. Students who sought help after receiving a letter informing them of their midterm grades and encouraging them to speak with a mentor had significantly higher pass rates (6% higher) compared to students who choose not to seek help after receiving their "at risk" letter. These findings suggest that our mentoring program increases students' ability to pass a course they are not performing well in, provided the students seek help soon after they are informed there is a problem.

Identifying "At Risk" Students

Approximately 60% of North American postsecondary intuitions use mid-term grades to provide early feedback to first-year students about their academic performance (Barefoot, 2001). Academic institutions vary in the cut-off grades they use to identify students "at risk" (e.g., Drexel uses <70%, Duke uses <60%, and Sacred Heart uses <50%). Our 60% grade cut-off to identify "at risk" students seemed to be an appropriate one because only 56% of our students successfully completed the course they were "at risk" in. In comparison, 95% of students who were not classified as "at risk" successfully completed the course. While 56% is an unfortunately low success rate, it is similar to other academic institutions. For example, "at risk" first-year students (<50% midterm grades) at Kent State University have only a 50% chance of persisting to second year. In comparison, students who are not "at risk" have a 76% chance of persisting (Barefoot, 2001). These data reveal the problem that most universities face regarding student

retention and the overwhelming need to implement intervention programs to enhance student success.

Using mid-term grades to identify "at risk" students has inherent pros and cons. On the positive side, there are few false-positives as most students who are identified as "at risk" really are experiencing difficulties. Further, assessing mid-term grades can allow mentors to focus on course-specific issues. We have found that students are often much more amenable to obtaining help if they think it focuses on the one course they are having difficulties with. Students can, if they wish, then apply what they learn in these help sessions to all their courses. On the negative side, using mid-term grades to identify "at risk" students requires buy-in from faculty members, as data are needed to evaluate how the students are performing. Further, mid-term grade data must be made available early enough in the semester to give the students time to take corrective actions. Ensuring that faculty comply can be difficult. Mid-term grade data also requires a central facility to collect the data from the faculty members, analyze it, send out "at risk" letters, and ensure the volunteer mentors are trained and ready to go when the "at risk" students start responding. This is do-able with a small team, provided the university has students who are willing to be trained and mentor students all while working as volunteers.

There are several other ways in which students could be identified as being "at risk". Unfortunately, all have inherent difficulties. For example, high absence rates can be used as "at risk" indicators (Mendoza & Corzo, 1996; Betty-Guenter, 1994). However, absence rate data requires regular assessment of class attendance. This is not a simple task when the class sizes are large and attendance is not regularly quantified. A second way of identifying "at risk" students is to collect pre-entrance data. Pre-entrance data on social factors such as personal finances, employment status, proximity to campus, child-care needs, and maturity status data can all be indicators of success (Feiger, 1996; Flint, 2000; Bonham & Luckie, 1993; Conklin, 1993; Geddes & Golbetz, 1992). Unfortunately, this broad sweep approach often results in many false positives: students who are labeled as "at risk" but who succeed without intervention. A third way of identifying "at risk" students is through pre-entrance tests. Students who do not pass the tests can then be counseled and/or placed into developmental programs to help them gain the skills they need to succeed (Rouche & Rouche, 1994). However, when students are not allowed to attempt to earn the credits they require for their degree they can become discouraged and leave the institution (Bach, Bernstein & Vaughters, 1992). For all the aforementioned reasons, the use of mid-term grades seems to be the most direct way to identify students who are "at risk" while not alienating those who are succeeding.

Low Student Response

It is concerning that many students failed to obtain help after they were informed of their "at risk" status. We are presently working on ways to increase response rates of our "at risk" students by ensuring first-year students meet and interact with volunteer mentors during academic orientation days. Our hope is that familiarity with the mentors will put students more at ease and incite them to seek help if they need it. We are also working with our faculty members to encourage students who are not doing well in their class to seek our help. We believe student response rate will increase if they receive encouragement to seek help from both their professor and from the email we send out.

Utilizing Volunteer Student Mentors

There were numerous benefits to using volunteer upper-year students to mentor "at risk" first-year students. First, "at risk" students tended to identify with the upper-year volunteers as these volunteers had successfully passed the course the "at risk" students were struggling with. Second, the upper-year volunteers reported that mentoring helped them improve their own time management skills and study skills. Third, the upper-year volunteers reported that mentoring was personally rewarding. Mentoring was also recognized on the volunteer's official transcript (co-

curricular record), which quantifies student community service activities. Fourth, the volunteers developed such strong bonds with each other that their engagement with the Faculty of Science increased dramatically. Fifth, operating costs for running the mentoring program were minimized.

One of the issues we were most concerned about with utilizing volunteer student mentors was mentor attrition. However, we only had one volunteer leave prior to the end of the academic year over our first two years running the program. This low attrition rate within the mentoring team might result from the fact that all of our volunteer mentors were hand selected after a rigorous application and interview process. Our volunteers are all highly motivated students who are involved with a number of activities both in and out of university. They carry heavy course loads, part-time jobs, and have extremely strong time-management skills.

Study Problems

We recognize the inherent difficulty of teasing apart motivation from success. We evaluated our program's success by comparing the participants to non-participants; therefore, "at risk" students who sought help were self-selected. As such, they might have been motivated to work harder than students who paid no heed to their "at risk" letter. An experimental design with a control group ("at risk" students who were not informed of their status) for comparison such as that used by Rudmann (1992) would have helped to more clearly quantify the effectiveness of our intervention program. However, our primary goal was to help as many students as we could succeed in their first-year courses. We were unwilling, therefore, to justify not informing a subset of the students about their "at risk" status for the sake of a balanced experimental design.

Conclusions

Students who sought help from volunteer undergraduate science mentors after being identified as "at risk" had a significantly higher chance of passing their course(s) compared to "at risk" students who chose to not seek help. These findings suggest that long term, our early identification and intervention program has the potential to improve retention rates, increase graduation rates, and decrease losses in tuition revenue that result from students who are unable to make a successful transition from high school to university. Our findings also suggest that using volunteer undergraduates as mentors is an effective way to assist first year students in making a successful transition from high school to university.

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