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A Support Program for First-Year University Biology That Improves Course Performance Among At-Risk Students

Sara Kayvani, Sophia Yu, Niki Sharan

Abstract: ***First-year students often struggle with the transition to university learning, which can lead to lower grades, higher dropout rates, and poorer overall well-being. We evaluated a low-cost, scalable program to support students at academic risk in an introductory biology course at Western University (London, Ontario, Canada). Each fall (September–December), the Department of Biology offers Biology 1001A, the first half of a foundational first-year course. More than 2,000 students enrol annually. The course is a prerequisite for progression to second-year classes in biology, medical sciences, and health sciences. At-risk students identified by poor midterm exam performance were offered four weekly, one-hour sessions that provided tutoring, test-taking strategies, and mental health support from upper-year student mentors and a faculty instructor. Attendance was encouraged but optional. The three-hour final exam consisted of 45 multiple-choice and five short-answer questions. Grade improvement (%) was calculated as the final exam grade (%) - midterm exam grade (%). We found that attendees improved from the midterm to final exam by 5.3 percentage points more than non-attendees (95% CI 3.5 to 7.1; $p < 0.001$). Attendees also reported greater satisfaction with their final exam performance, fewer personal concerns and stronger perceived support from the instructional team. From midterm to final, attendees also reported greater familiarity with multiple-choice testing, lower test-taking anxiety, and fewer concerns about insufficient study time. These findings suggest that targeted support to at-risk students in a large class can improve both academic outcomes and the student experience. In future communication materials for this support program, we will share that attendees demonstrated improved academic performance, which may encourage greater participation.***

Keywords: Biology Education, Student Support, Performance.

Nomenclature:
STEM: Science, Technology, Engineering, and Mathematics

I. INTRODUCTION

Transitioning from high school to university-level science often requires substantial academic and social adjustment, particularly in large-enrollment foundational courses. The success of this transition is shaped by multiple interacting factors, including variation in incoming preparation and prior learning experiences, ineffective study habits and time management, course and instructor characteristics, and students' degree of academic and social integration within the university environment [1-3]

Early experiences in foundational science, technology, engineering, and mathematics (STEM) courses are associated with academic performance, persistence, anxiety, and emotional well-being. Poor performance in foundational STEM courses is strongly associated with lower persistence in STEM majors [4]. In the United States, national data indicate that only about 55% of students who enter college in a STEM major complete a STEM credential, while others either complete a non-STEM degree or leave without a degree [5,6].

Although demand for STEM workers continues to rise, sustaining a sufficient number of STEM graduates remains a challenge, particularly given recent declines in associate and bachelor level degrees in science and engineering [7]. At some Canadian universities, students who do not meet minimum grade thresholds may be placed on academic probation and, if their performance does not improve, suspended or required to withdraw. These academic stressors can contribute to psychological distress and concerns about the future [8,9].

To address these challenges, universities offer a range of academic and peer-support programs, including tutoring, mentoring, study-skills or self-regulated-learning workshops, and peer-led learning initiatives such as study groups and other peer-assisted learning models [10]. Effects vary by context, but students who engage with structured supports generally perform better. We focus on three approaches.

Peer-led tutoring. Upper-year students review course concepts with early-year peers, providing discipline-specific guidance in student-friendly language while easing faculty workload. In an introductory biology course, optional peer tutoring improved exam scores and increased course persistence among consistent attendees [11].

Peer mentoring. Beyond direct course content, peer mentors can help first-year students build effective study strategies and navigate university systems. In a first-year biology mentorship program comprising 10 50-minute sessions, participants adopted more effective academic habits, earned higher grades in a foundational chemistry course, and showed improved short-term retention [12]. A recent systematic review similarly found that peer mentoring in the

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transition to higher education is associated with benefits in social and academic integration, emotional well-being, university-life balance, soft skills, sense of belonging, and career development [13].

Instructor engagement beyond the lecture hall. Meaningful interactions with faculty outside the classroom are associated with greater student satisfaction and persistence into the second year of studies. Targeted, personalized feedback from professors can also improve subsequent academic performance, particularly among first-generation students [14,15].

Despite broad recognition of their value, student-support programs can be difficult to scale. More effective coaching interventions often rely on sustained, in-person support from trained professionals, whereas lower-intensity web- and phone-based approaches tend to have lower uptake. Even when supports are available, student engagement may remain limited by low awareness of services and competing time demands [16,17].

In this paper, we describe our design of a low-cost, scalable, sustainable support program for students at academic risk in a large first-year biology course. We also assessed its effect on academic outcomes.

II. METHODS

A. Setting

Western University is a large public research institution in London, Ontario, Canada. Each fall (September–December), the Department of Biology offers Biology 1001A, the first half of a foundational first-year course. More than 2,000 students enrol annually. The course is a prerequisite for progression to second-year classes in biology, medical sciences, and health sciences.

Biology 1001A is organised into 11 weekly modules, led by two faculty instructors and a lab coordinator. Instruction includes weekly in-person lectures, bi-weekly skill-development laboratories, and complementary online materials. Supplementary supports include instructor office hours, moderated discussion forums, the course textbook, digital simulations, and practice examinations. Assessment comprises weekly online quizzes (12%), the laboratory component (20%), one midterm exam (33%), and a final exam (35%).

Running for over a decade, a student-run biology mentorship program is also available to all first-year students; participation is voluntary, and about 20% take part. Upper-year volunteers who have completed Biology 1001A/1002B deliver the program, which includes about 40 mentors, 10 to 15 vice presidents, and two co-presidents. Offerings include weekly lecture-aligned workshops with guided practice, biweekly study sessions, exam review sessions, a moderated Discord channel for course questions, and cycle infographics on Instagram. The team also offers skill-building sessions on second-year course selection, guidance on navigating research opportunities and study strategies. In collaboration with the course instructors, it offers mock exams and comprehensive final reviews.

B. Our New Support Program for At-Risk First-Year Biology Students

The 2-hour midterm exam consisted of 40 multiple-choice questions. Following the midterm, we offered at-risk students four one-hour weekend support sessions to prepare them for the final. The structure of this program is described below.

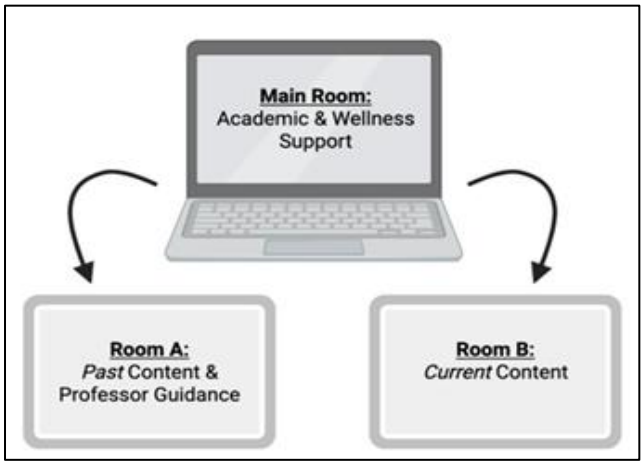
The course midterm average was 63%, just above the 60% program-withdrawal threshold. Students scoring ≤63% were classified as at risk (n = 1,074); they had not yet triggered academic consequences but were likely to do so without improvement on subsequent assessments. These students were invited to the weekend support sessions via a mass email that outlined the offerings and included embedded Google sign-up links.

i. Structure of the Support Sessions

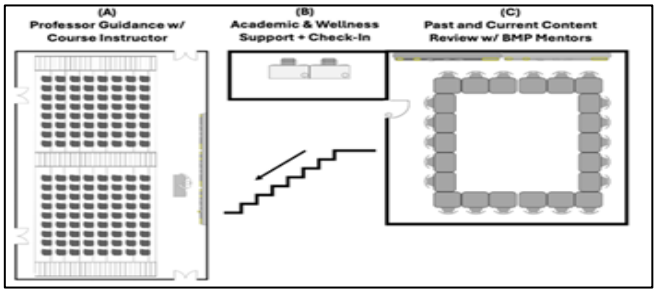
Four one-hour weekend support sessions were co-led by a course instructor and volunteers from the biology mentorship program. The first two sessions were delivered via Zoom with breakout rooms, while the final two were held in person on campus.

Each session used three rotating stations (Figures 1 and 2): (1) instructor guidance, offering direct answers to questions and clarification of concepts, and a preview of upcoming material in a low-pressure setting; (2) content review, where three to four mentors led structured reviews, addressed common misconceptions, and facilitated practice problems; and (3) academic and wellness support, where two mentors provided study strategies, time-management advice, and transition-to-university tips.

Attendance was recorded by matching Zoom display names for virtual sessions and by Google Sheets check-in for in-person sessions. Students were invited to all four sessions, and some content was intentionally repeated to accommodate varying attendance.



[Fig.1: Schematic of the Support Sessions provided by Zoom, showing the main room and two breakout rooms]



[Fig.2: Floor plan of the in-person Support Sessions. Room A is located on the building's lower level, while Rooms B and C occupy the upper level]

C. Educational Outcomes

i. Exam Grades

The three-hour final consisted of 45 multiple-choice and five short-answer questions. Grade improvement (%) was calculated as the final exam grade (%) - midterm exam grade (%).

ii. Student Surveys

All biology students, irrespective of risk status, were invited to complete two voluntary online surveys administered after the midterm (Survey 1) and final exam (Survey 2). Students who completed both received a 1% bonus toward their final course grade. Full instruments are provided in the Appendix. Items assessed responses to statements about satisfaction with exam performance, perceived barriers, and awareness/use of available supports. Responses were recorded on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree).

D. Statistical Analysis

All analyses were conducted in RStudio version 2025.09.2+418 (Posit Software, PBC, Boston, MA, USA). Records with a score of zero on the midterm or final were excluded because they likely indicated withdrawal or a missed exam. A p-value < 0.05 was considered statistically significant.

Students were classified into three groups: not at risk, at-risk attendees, and at-risk non-attendees. Among at-risk students, an independent-samples t-test was used to compare the percentage of grade improvement (final exam grade − midterm exam grade) between attendees and non-attendees. A one-way ANOVA was used to compare mean midterm and final exam scores across the three groups, followed by Tukey's honest significant difference test for post hoc pairwise comparisons. Results are presented as mean ± standard error.

To assess for differences in students' opinions, attitudes, and perceptions following the midterm and final exams across the three groups, ten selected Likert-scale (1–5) survey statements were analyzed using Kruskal-Wallis H tests (also called one-way ANOVA on ranks), followed by post-hoc Dunn's tests for pairwise comparisons.

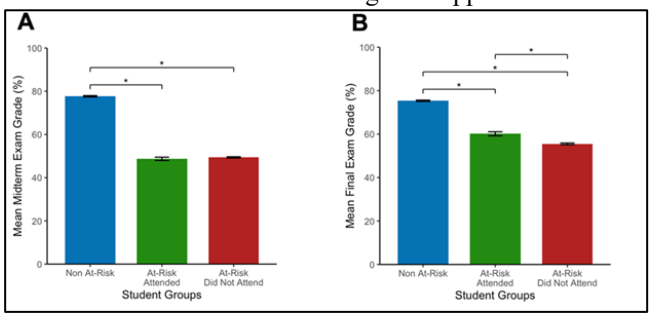
III. RESULTS

A. Attendance

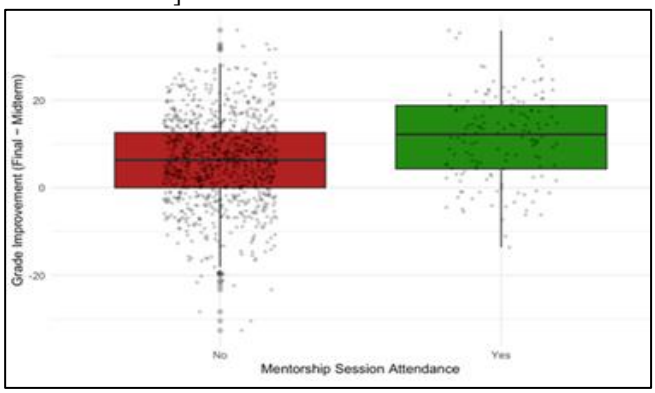
Of 2,073 students, 999 were not at risk. Of the 1,074 at-risk students, 145 attended the targeted support sessions, and 929 did not.

B. Exam Grades

Figure 3 shows the midterm and final exam grades by the three student groups. Figure 4 shows the mean percentage-point improvement in grades for at-risk students who attended and did not attend the targeted support sessions.



[Fig.3: Mean midterm (A) and final (B) exam grades (%) for non-at-risk students (n=999), at-risk students who attended targeted support sessions (n=145) and at-risk students who did not attend (n=929). One-way ANOVA was performed for both the midterm ($F(2,2070) = 2408.3$, $p < 0.001$) and final ($F(2,2070) = 843.6$, $p<0.001$) exam performance, followed by Tukey's HSD post-hoc test. Asterisks denote significance ($p < 0.001$); error bars represent ± standard error]



[Fig.4: Mean grade improvement (final – midterm) between at-risk students who attended the targeted support session (n=145) and at-risk students who did not attend (n=929). An independent two-sample t-test was performed: $t(1072) = 5.98$, $p < 0.001$]

The three groups of students showed significant differences in their results for both the midterm ($F(2,2070) = 2408.3$, $p < 0.001$) and final exams ($F(2,2070) = 843.6$, $p < 0.001$). As expected, not-at-risk students scored higher on the midterm (77.7±0.3%) than at-risk attendees (48.7±0.7%, $p<0.001$) and at-risk non-attendees (49.4±0.3%, $p<0.001$); however, the two at-risk groups did not differ in their midterm results ($p=0.7$).

On the final, not-at-risk students again outperformed all at-risk students (75.3 ± 0.3%, $p < 0.001$). Among at-risk students, attendees scored higher than non-attendees (60.2±0.9% vs 55.5±0.4%, $p < 0.001$) and achieved a larger midterm-to-final gain (11.4 vs 6.1; difference of 5.3 percentage points, 95% CI 3.5 to 7.1; $p < 0.001$).

C. Survey Responses

Figure 5 summarises post-midterm and post-final survey responses, comparing not-at-risk students with at-risk students who attended the targeted support sessions and those who did not. Of 2,073

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students, 831 who did not complete both surveys were excluded from the survey analyses.

A.

	Pairwise Comparison Between Student Groups					
	Non-At-Risk vs. At-Risk (Attended)		Non-At-Risk vs. At-Risk (Did Not Attend)		At-Risk (Attended) vs. At-Risk (Did Not Attend)	
Post-Midterm Examination Survey Statements	Z-Score	P-Value	Z-Score	P-Value	Z-Score	P-Value
I am satisfied with my performance on the exam	12.7	< 0.0001	19.75	< 0.0001	-1.68	0.0936
Inexperience with University multiple-choice testing negatively influenced my performance on the exam	-7.00	< 0.0001	-7.61	< 0.0001	2.72	< 0.01
Test-taking anxiety negatively influenced my performance on the exam	-7.79	< 0.0001	-9.50	< 0.0001	2.46	0.0137
Personal concerns outside of academic activities negatively influenced my performance on the exam	-5.12	< 0.0001	-8.77	< 0.0001	0.24	0.808
There was not enough time to study for the exam	-5.01	< 0.0001	-5.00	< 0.0001	2.20	0.0279
I felt supported by the teaching team and BMP mentors when studying and preparing for the exam.	3.69	< 0.001	5.37	< 0.0001	-0.69	0.489

B.

	Pairwise Comparison Between Student Groups					
	Non-At-Risk vs. At-Risk (Attended)		Non-At-Risk vs. At-Risk (Did Not Attend)		At-Risk (Attended) vs. At-Risk (Did Not Attend)	
Post-Final Examination Survey Statements	Z-Score	P-Value	Z-Score	P-Value	Z-Score	P-Value
I am satisfied with my performance on the exam	-0.84	0.402	2.86	0.0128	2.37	0.0353
Inexperience with University multiple-choice testing negatively influenced my performance on the exam	-6.04	< 0.0001	-11.41	< 0.0001	-0.22	0.823
Test-taking anxiety negatively influenced my performance on the exam	-4.32	< 0.0001	-11.06	< 0.0001	-1.72	0.0857
Personal concerns outside of academic activities negatively influenced my performance on the exam	-1.26	0.209	-7.12	< 0.0001	-2.61	0.0179
There was not enough time to study for the exam	-1.56	0.236	-2.32	0.0616	0.29	0.775
I felt supported by the teaching team and BMP mentors when studying and preparing for the exam.	-3.49	< 0.001	0.23	0.815	3.56	< 0.01

[Fig.5: Post-hoc pairwise comparisons of student groups on post-midterm (**A**) and post-final exam (**B**) survey statements (Dunn's test; Holm-adjusted p-values). Z statistics quantify the direction and magnitude of rank differences: $Z > 0$ indicates that the first group listed has higher Likert responses (greater agreement). In contrast, $Z < 0$ indicates that the second group listed has higher Likert responses (greater agreement).]

i. Satisfaction with Exam Performance: Satisfaction with exam performance differed across groups at both time points (Kruskal–Wallis: midterm H (2) =456.10, p<0.0001; final H (2) =10.686, p<0.01). At midterm, the two at-risk groups did not differ (Dunn's test with Holm correction, p=0.09), indicating similar levels of satisfaction. After the final, at-risk attendees reported higher satisfaction than non-attendees (p=0.04).

ii. Perceived Barriers to Performance: Kruskal–Wallis tests showed group differences at both time points in ratings of four barriers: midterm— inexperience with multiple-choice testing H(2)=86.03, p<0.0001; test-taking anxiety H(2)=122.00, p<0.0001; personal concerns H(2)=86.38, p<0.0001; insufficient study time H(2)=40.28, p<0.0001; final— inexperience H(2)=141.49, p<0.0001; anxiety H(2)=125.26, p<0.0001; personal concerns H(2)=51.01, p<0.0001; insufficient study time H(2)=6.42, p=0.0403.

Dunn tests with Holm adjustment comparing the at-risk groups indicated that, after the midterm, attendees reported greater inexperience (p<0.01), higher anxiety (p=0.01), and less study time (p=0.03) than non-attendees, with no difference in personal concerns (p=0.8). After the final, differences in inexperience (p=0.8), anxiety (p=0.09), and study time (p=0.8) were no longer significant; attendees reported fewer personal concerns than non-attendees (p=0.02).

iii. Perceived Support from Teaching Team: Kruskal–Wallis tests indicated group differences in perceived support from the instructional team and mentors at both time points (midterm: H (2) =34.90, p<0.0001; final: H (2) =13.46, p<0.01). Post hoc Dunn tests with Holm adjustment showed no difference between at-risk attendees and non-attendees at midterm (p=0.50). After the final, at-risk attendees reported greater support than non-attendees (p<0.01).

IV. DISCUSSION

Low grades can erode motivation and increase the risk of dropping out of a course or even a STEM major. They are often accompanied by social isolation and reduced self-esteem, leaving students discouraged, embarrassed, and doubting their ability to succeed.

We developed a low-cost, scalable, and sustainable support program for academically at-risk students in a large first-year biology course, identified by low midterm performance. At-risk students were invited to four one-hour weekend sessions, co-led by a course instructor and volunteers from an existing upper-year student mentorship program. Compared with non-attendees, attendees scored higher on the final exam and showed greater improvement in their midterm-to-final scores. Attendees reported greater satisfaction with their exam performance, fewer personal concerns, and stronger perceived support from the instructional team. From midterm to final, attendees also reported greater familiarity with multiple-choice testing, lower test-taking anxiety, and fewer concerns about insufficient study time.

Our support program targeted at-risk first-year undergraduate students, with sessions that incorporated three academic strategies: peer-led tutoring, peer mentoring, and instructor engagement beyond the lecture hall. Leveraging the use of a volunteer group of upper-year mentors and using empty classrooms on weekends eliminated costs.

This evaluation has limitations. The observational design precludes causal inference: at-risk students were not randomized to receive support, and self-selection likely favoured more motivated attendees. Participation was modest (13%), and identifying barriers to uptake among non-attendees will be necessary to improve the program.

In our future communication materials, we will share that attendees demonstrated improved academic performance. This information may encourage greater participation. Our focus is to continue optimizing this program for biology and then share our experiences with other STEM courses at our university.

V. CONCLUSION

Our findings suggest that targeted support for at-risk first-year undergraduate biology students in large classes can improve both academic outcomes and the student experience.

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DECLARATION STATEMENT

As the article's author, I confirm the accuracy of the following information based on input from all authors.

- **Conflicts of Interest/ Competing Interests:** The authors declare that they have no conflicts of interest.
- **Funding Support:** This project was supported by a Parr Grant, funded through the Parr Centre for Thriving and administered by the Office of the Vice Provost (Students) at Western University. The opinions expressed are those of the authors.
- **Ethical Approval and Consent to Participate:** This study was conducted in accordance with institutional guidelines and was exempt from research ethics board review. All data were collected as part of routine educational practice, analyzed in aggregate, and contained no personally identifiable information.
- **Data Access Statement and Material Availability:** The data supporting the findings of this study are available from the corresponding author upon reasonable request through December 31, 2026.
- **Author's Contributions:** Sophia Yu and Sara Kayvani contributed equally and share first authorship. Niki Sharan served as the senior and corresponding author. All authors contributed to the study and approved the final manuscript.

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AUTHOR'S PROFILE

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SUPPLEMENTAL DATA

APPENDIX

Survey 1 (After Midterm Exam)

The purpose of this survey is to support students in need and guide processes to improve the course. Please complete this survey only AFTER you have carefully reviewed the exam feedback file. Please answer all questions honestly so that we can better understand your specific needs. There is no time limit on this survey. Each response is voluntary, and you can leave any question you are not comfortable answering blank. (BMP, biology mentorship program)

Question: How Much do you agree with the Following Statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
My high school courses prepared me well to learn University-level material in Bio1001A.					
I had a good understanding of what to expect before taking the Bio1001A midterm exam.					
I put in my best effort studying for the Bio1001A midterm exam.					
I am satisfied with my performance on the Bio1001A midterm exam.					
Inexperience with multiple-choice testing at the University negatively affected my performance on the Bio1001A midterm exam.					
Test-taking anxiety negatively influenced my performance on the Bio1001A midterm exam.					
Personal concerns (outside of academic activities) negatively influenced my performance on the Bio1001A midterm exam.					
There was not enough time to study for the Bio1001A midterm exam.					
My best performance in midterm exams this semester was in Bio1001A.					
The Bio1001A instructional team provided enough help and support for students.					

Question: To Prepare for the Bio1001A Midterm Exam, How Much do You Agree with the Following Statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I attended the Bio1001A lectures in person.					
I watched the Bio1001A lecture recordings posted online.					
I attended the professor's office hours for any questions I had.					
I used and reviewed information about Bio1001A posted on the OWL forums.					
I studied the Bio1001A biology textbook.					
In addition to the practice midterm posted on OWL, I reviewed and studied prior year midterm exams.					
I used Simutext.					
I attended BMP workshops (Thursdays or Fridays).					
I attended BMP study sessions (biweekly on Tuesdays).					
I used the BMP Discord server.					
I reviewed material on the BMP Instagram Cycle Summaries.					
I completed the practice midterm.					
I watched the optional videos posted in the lecture cycle tabs.					

Survey 2 (After Final Exam)

The purpose of this survey is to support students in need and guide processes to improve the course. We really appreciate your time and effort in completing this survey (especially the short answers) and in helping us improve for B1002B next term and in future years. Our instructional team considers students as partners in our education! Please complete this survey only if you have written the final exam. Those of you writing the make-up final exam will receive a survey in Jan 2024. Please answer all questions honestly so that we can better understand your specific needs. There is no time limit on this survey. Each response is voluntary, and you can leave any question you are not comfortable answering blank.

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Question: How Much Do You Agree with the Following Statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I had a good understanding of what to expect before taking the B1001A final exam for Cycles 2, 3, 4, and 5.					
I had a good understanding of what to expect before taking the B1001A final exam for Cycles 1, 6, 8, and 9.					
I had a good understanding of what to expect before taking the B1001A final exam for Cycles 7, 10, and 11.					
I put more effort into studying for the final exam than for the midterm.					
Although I don't know my grade yet, I am satisfied with my performance on the B1001A final exam.					
Inexperience with multiple-choice testing at the University negatively affected my performance on the Bio1001A final exam.					
Test-taking anxiety negatively influenced my performance on the B1001A final exam.					
My experience writing the midterm exam helped me feel less anxious about the B1001A final exam.					
Personal concerns (outside of academic activities) negatively influenced my performance on the B1001A final exam.					
There was not enough time to study for the B1001A final exam.					

Question: To Prepare for the Biology 1001A Final Exam

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I attended the Bio1001A lectures in person.					
I watched the Bio1001A lecture recordings posted online.					
I attended the professor's office hours for any questions I had					
I used and reviewed information about Bio1001A posted on the OWL forums.					
I studied using the Bio1001A textbook.					
I reviewed and studied the practice final exam.					
I found the practice final exam to be useful.					
I used Simutext					
I attended BMP workshops (Thursdays or Fridays)					
I attended BMP study sessions (biweekly Tuesdays)					
I used the BMP Discord server.					
I reviewed material on the BMP Instagram Cycle Summaries.					