

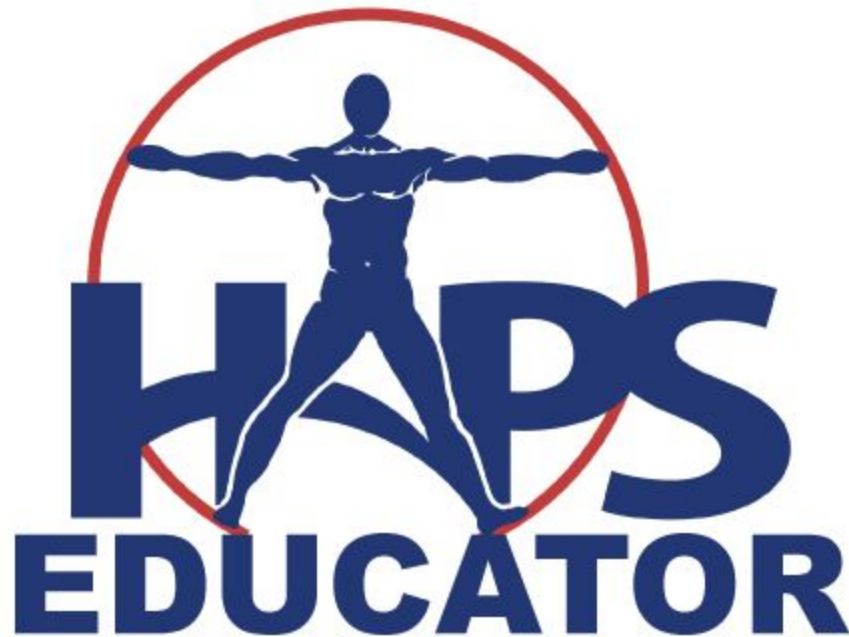
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The Impact of Face-to-Face Exam Viewing on Future Exam Performance in a First Term Anatomy and Physiology Course

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Abstract

The purpose of this investigation was to determine if attending a face-to-face midterm exam review with the instructor predicts final exam performance in an Anatomy and Physiology I course. Students were invited to attend office hours in small groups to review their midterm exams. Multiple linear regression was used to test whether attendance at an exam review appointment, midterm exam score, and/or high school grade point average (GPA) significantly predicted the final exam score. Alpha levels were set *a priori* to $p < .05$. Attendance at an exam review appointment and high school GPA significantly predicted final exam grades (Beta = .081, $p = .042$; Beta = .126, $p = .002$, respectively) but midterm exam scores explained most of the model variance in final exam scores (Beta = .736, $p < .000$). Taken together, the three predictors in the model explained 58% of the variance in final exam scores (adjusted $R^2 = .58$). The results of this study suggest that exam review appointments should be continued but enhanced to include a more structured analysis of the midterm exam. Follow up with students on the implementation of new study strategies should occur prior to the final exam. <https://doi.org/10.21692/haps.2018.020>

Key words: anatomy, physiology, examinations, face-to-face exam review, evaluation

Introduction

Anatomy and Physiology is a foundational course series for most health-related professions. A number of researchers have attempted to identify factors that predict performance in Anatomy and Physiology courses. High school grade point average (GPA) has been a consistent predictor of grades in Anatomy and Physiology (Anderton *et al.* 2016, Gultice *et al.* 2015, Rompolski *et al.* 2016, Sturges *et al.* 2016). However, success in high school biology and chemistry courses may be even more predictive of success in Anatomy and Physiology than high school GPA (Gultice *et al.* 2015). The number of credit hours carried at the time of entry into anatomy and physiology has also been positively associated with performance in anatomy and physiology (Gultice *et al.* 2015, Russel *et al.* 2016). Performance may also be influenced by the age and maturity of students and whether or not they have previously taken other college science courses such as biology or chemistry (Rompolski *et al.* 2016, Russel *et al.* 2016). Finally, a student's chosen major predicts final grades in anatomy and physiology (Anderton *et al.* 2016, Rompolski *et al.* 2016, Schutte 2016).

In a study by Gultice *et al.* (2015), a regression model was created to predict success in Anatomy and Physiology I. The model included age, total credit hours earned in college, current credit load for the semester and high school GPA (Gultice *et al.* 2015). This model explained 81% of the variance in the final grade in Anatomy and Physiology I. Identifying students at risk for not receiving passing grades in anatomy

and physiology courses is worthwhile. However, a plan of action to assist the students who are likely to struggle is needed and is understudied. Students often underestimate the effort that learning anatomy and physiology will require and overestimate the grades they expect to achieve (Eagleton 2015, Schutte 2016, Sturges *et al.* 2016). In anatomy and physiology courses that offer only two examinations, such as a midterm exam and a final exam, students may not have a reasonable or clear understanding of where they stand in the course until the coursework is over 50% complete.

The first exam in anatomy and physiology, possibly the midterm exam, can provide an opportunity for students to reflect on their learning strategies and make adjustments. This can be accomplished during exam review sessions with the instructor. Research examining the frequency, structure, and outcomes of reviewing examinations with students is limited. This suggests that the decision of if, or how, to review exams with students is largely at the discretion and preference of each instructor. Some instructors may hand exams back to students, but this may increase the possibility of exams being disseminated to future students or require faculty to consistently make new exams. The exam can be reviewed in class, but this may take up necessary class time. Without reviewing exams, students who performed poorly may move forward with the same strategies and receive the same results (Wiles, 2015).

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Students may choose to attend office hours or request an appointment with the instructor to discuss their performance on an exam. However, research suggests that office hours are very poorly utilized by students (Griffin *et al.* 2014, Guerrero and Rod 2013). Griffin *et al.* (2014) sought to find out why students do not attend office hours, and if any of these reasons were within the instructor's control. Six hundred twenty-five students were surveyed across all four years of their academic study. Sixty-six percent of students surveyed reported never using office hours; and, only 8% reported using them for two or more sessions. The perceived convenience of office hours was found to be the biggest barrier to office hour use. Approachability of the instructor did not predict office hour use, and the only instructor-specific variable that predicted office hour use was the perceived usefulness of the feedback students expected to receive. In another exploratory study, Chung and Hsu (2016) compared the use of office hours with attendance of open course session for students in large physics and symbolic logic courses. Students were welcome to come-and-go and could observe other students asking questions or working with the instructor or teaching assistants. Sixty-seven percent of the students reported preferring the open course center. Students reported that they felt somewhat pressured to have specific questions to ask if they attended office hours but did not feel pressured in the open course session. Accordingly, if students do not know what questions to ask their instructors during office hours, the potential for them to receive help prior to an exam, or receive useful feedback after an examination, is limited.

When considering the impact of office hour attendance on grade outcomes, Guerrero and Rod (2013) found that office hours "have a real, and substantial effect on academic performance" (p. 403) in a political science course at their university. In the Guerrero and Rod (2013) study, the instructors examined 406 undergraduate students over four years of undergraduate study. After controlling for age, gender, college GPA, class standing, family income, and academic major, each office hour visit corresponded to a 0.72% increase in a student's final grade. However, the authors mentioned that these courses have a significant subjective grading component; therefore, greater interaction between the student and the instructor may have influenced grading. Similar to other studies, 54% of the students in these courses never attended office hours and 29% reported attending once or twice. Thirty-six percent of students surveyed claimed that the office hours did not fit into their schedule, which is consistent with the findings of Griffin (2014). Twenty-seven percent claimed they forgot to attend, 24% claimed they did not need help, and 13% claimed they were too hesitant to ask for help (Guerrero and Rod 2013).

In the present study, Health Sciences (HSCI) and Nursing (NURS) students at a large Mid-Atlantic private university were required to take three consecutive anatomy and physiology courses over three academic quarters as part of their undergraduate curriculum. Each of these courses had the same grading format: a midterm examination and a non-cumulative final examination, each worth 30% of the overall grade. Due to the time limitations of a 10-week quarter, and the potential for exams to be copied and shared with future students, students were not "handed back" their exams, and exams were not reviewed in class. Other assessments included five laboratory quizzes (4% of final the grade each), and a weekly quiz (2% of the final grade each). The weekly quizzes were open book and they were due prior to the lecture session on the material.

The Anatomy and Physiology I course covered cell biology, tissues, the muscular and skeletal systems. Anatomy and Physiology II covered the nervous, digestive and endocrine systems. Anatomy and Physiology III covered the immune, cardiovascular, respiratory, urinary and reproductive systems. The HSCI students started the anatomy and physiology series during their sophomore year, while the NURS curriculum scheduled the anatomy and physiology series during the freshman year. There is very high enrollment in these courses. As enrollment in these courses grow, it will be more important than ever to identify the most effective method of exam review that will lead to better performance. Whether attending face-to-face exam reviews with the instructor will have a positive impact on future exam performance is currently unknown. Therefore, the purpose of this investigation was to determine if attending a face-to-face midterm exam review with the instructor predicts final exam performance in an anatomy and physiology I course.

Methods

The Drexel University Institutional Review Board approved this retrospective examination in March 2018, IRB Protocol #: 1801006007. In the Fall of 2017, 292 students were enrolled in Anatomy and Physiology I. The same instructor taught all students. Class year and high school GPA were obtained from the University. The instructor obtained grades on the midterm and final examination from the Blackboard Learn system.

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Exam Review Sessions

All students who were enrolled at the time of the midterm exam were invited to attend office hours to review their midterm exams in small groups. Students were sent a link via a Doodle poll to choose a 30-minute time slot that was convenient for their schedule. The script of the email invitation follows:

"Hi everyone! Below is the link for the doodle poll. Carefully follow the instructions. You may only choose one appointment. Please write down the day and time, and location, as you will not be able to log back in to view it again. Whatever you choose is your appointment time. Please reserve discussion about your exam until during, or after your appointment. It is helpful to see where you went wrong during the test before discussing better studying strategies!"

When students followed the link to the poll, they could see that these sessions would be in small groups of three to four students. The rationale for group sessions was to serve as many students as possible, reduce the time burden on the instructor, and to help students feel a sense of community and support in learning (Chung and Hsu 2016, Tinnon 2018). Sessions were scheduled throughout

the week to minimize the potential for time conflicts. Students were told to email the instructor if none of these times worked for them.

Exam review sessions were held in either the instructor's office or a reserved conference room. During the exam review sessions, students were required to identify at least two strategies for exam improvement suggested by the instructor. The suggested strategies are outlined in Table 1. Before leaving the exam review session, students were asked to complete an anonymous survey via Survey Monkey about the perceptions and outcomes of the exam review sessions. Forty of the 71 students (56.3%) who attended the exam review appointments responded to the survey. For question 1 of the survey, the instructor asked the following questions:

1. "If the professor had not invited you to view your exam, would you have requested to do so?"
2. "After this appointment, will you change the way you prepare for the final exam?"
3. "After this appointment, what changes will you make to your studying?" Students were allowed to choose all that applied.

Table 1. Suggested Strategies During Appointment Meetings to Improve Exam Performance

Before Exam	During Exam
Reading summaries	Process of elimination
Quizzing by a friend or peer	Careful reading of question
Drawing and concept mapping	Recall what knowledge is known to make connections with question content
Minimize distractions	Change answers only when new information is gained
Hand written note taking	

Statistical Analyses

Students were excluded from the analysis if they did not take both exams or were repeating the course, which brought the final sample from 292 to 273 students. A preliminary power analysis was performed with G*Power (Faul *et al.* 2007), version 3.1, to detect a medium effect size of .15 with 80% power. We determined that a sample size of 77 would yield this power threshold given the effect size expected with three predictors. Our sample of 273 students was therefore sufficient and adequately powered to perform the current investigation. The instructor removed all student personal information from

the data file prior to statistical analysis. To determine whether midterm exam scores, high school GPA and appointment (dummy coded: 1 = attended; 0 = not attended) significantly predicted final exam scores, we performed a multiple linear stepwise regression procedure. Students were excluded from the statistical analysis if they did not take both exams. Data were screened for normality and homogeneity of variances. All statistical analyses were performed using IBM SPSS software, version 24 with alpha levels set *a priori* to $p < .05$.

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Results

Two hundred and seventy-three students completed Anatomy and Physiology I in the Fall of 2017. The sample included 191 nursing (NURS) and 58 health science (HSCI) students. The majors of the remaining 24 students varied and included nutrition and food sciences, biology, physics, chemistry, behavioral health counseling, public health, dance, provisional studies, electrical engineering, general business, study abroad, and first year exploratory studies. Of the 273 students who completed Anatomy and Physiology I, 71 students responded to the poll and attended the midterm review sessions. Freshman NURS majors made up the majority of the attendees (42 out of 71). The average score on the midterm exam for the entire

cohort was 75.7%. There were no significant differences in midterm exam scores among students who attended review appointments (Appt-attend: $M = 76.63$, $SD = 13.19$) and those who did not attend (Appt-not: $M = 74.8$, $SD = 14.03$), $F(1,271) = .944$, $p = .332$. However, there were significant differences in final exam scores between the groups: Appt-attend: $M = 76.86$, $SD = 14.23$ and Appt-not: $M = 72.64$, $SD = 15.12$, $F(1,271) = 4.21$, $p = .04$. The difference in final exam scores between the groups (Table 2) resulted in a small to medium effect size, adjusted for the difference in students between groups ($g = .29$, CI: .02 - .56). Cohen (1988) provided effect size interpretation general guidelines: .20 is considered a small effect, .50 a medium effect, and .80 a large effect.

Table 2. Exam scores (means ± standard deviation) by review session attendance

	Attend (n = 71)	Not Attend (n = 202)
Midterm Exam Scores	76.6 ± 13.2	74.8 ± 14.0
Final Exam Scores	76.9 ± 14.3	72.6 ± 15.1

The regression model (Table 4) indicated that 58% of the variance in final exam scores were predicted by midterm exam scores, high school GPA and appointment (adjusted $R^2 = .58$, $F(3, 269) = 125.99$, $p < .000$). Adding exam

review meeting attendance as a predictor to the model accounted for an additional 0.6% of the variance in final exam scores (Beta = .081, $t(269) = 2.05$, $p = .042$).

Table 3. Regression Model variable correlations

	1	2	3
1. Final Exam			
2. Midterm Exam	.75*		
3. High School GPA	.177*	0.070	
4. =1 if Exam Appt attended	.124*	0.059	-0.002

*Sig. (1-tailed)

Table 4. Regression Model for A&P 101 Final Exam Scores

	β	SE	Beta	t	P
<i>Adjusted R² = .58</i>					
Midterm Exam Scores	.799	.04	.736	18.65	.000
High School GPA	1.73	.542	.126	3.19	.002
Exam review appointment attended	2.75	1.34	.081	2.05	.042

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Student Survey Responses

The results of the student survey are presented in Figures 1, 2 and 3. Twenty-nine of the 41 (70.7%) respondents chose responses that indicated that they would not have come for an exam review session without the invitation by the instructor (Figure 1). Thirty-one (75.6%) of the respondents indicated that they would change the way they study for the next exam. Only two students (4.9%)

indicated that they would not change anything and were satisfied with their grade. The choices, “test myself more frequently” and “focus more on understanding and applying, rather than memorizing” were most commonly chosen, followed by “studying every week rather than a few days before the exam.” The least chosen preparation approach was “post in the discussion board more frequently or meet with professor.”

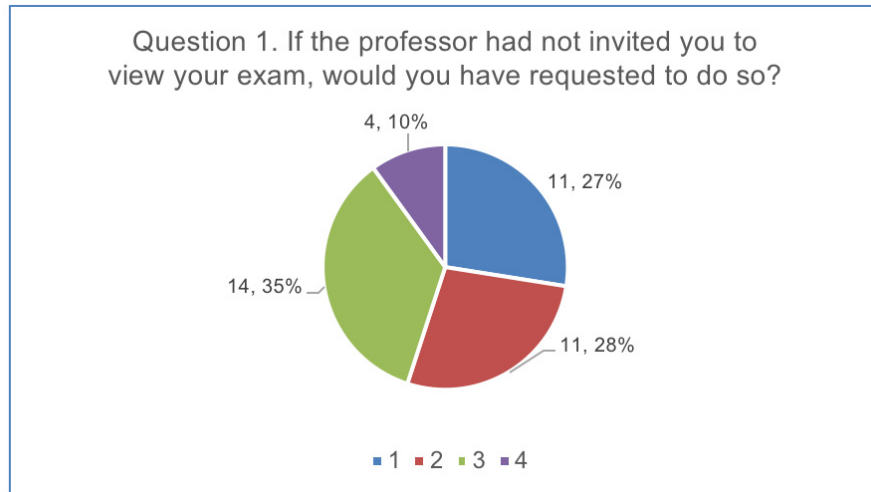


Figure 1. Responses to survey question 1

- 1 - I would have emailed the professor anyway to set up an appointment.
- 2 - I would not have emailed the professor to set up an appointment.
- 3 - I wouldn't have known that I was allowed to come view my exam.
- 4 - I would have been too embarrassed to reach out to the professor to discuss my exam.

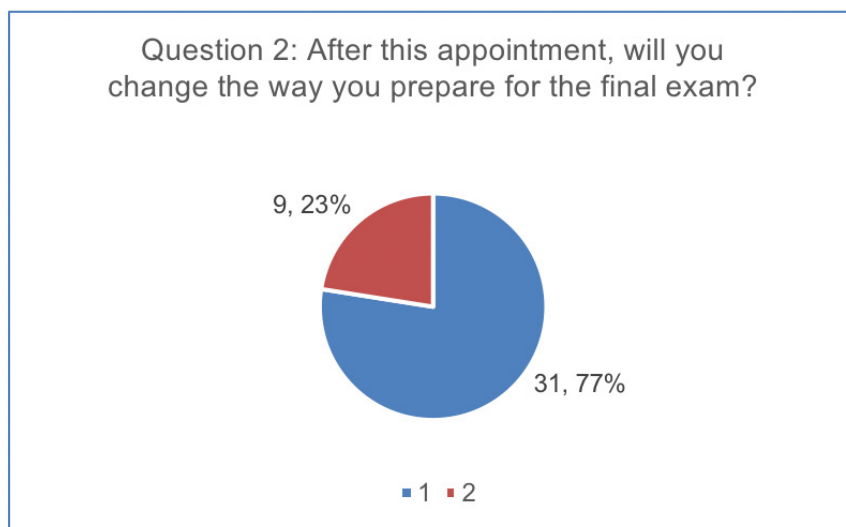


Figure 2. Responses to survey question 2

- 1 - I will change the way I study for the next exam.
- 2 - I will continue what I did before, as I am happy with my results.

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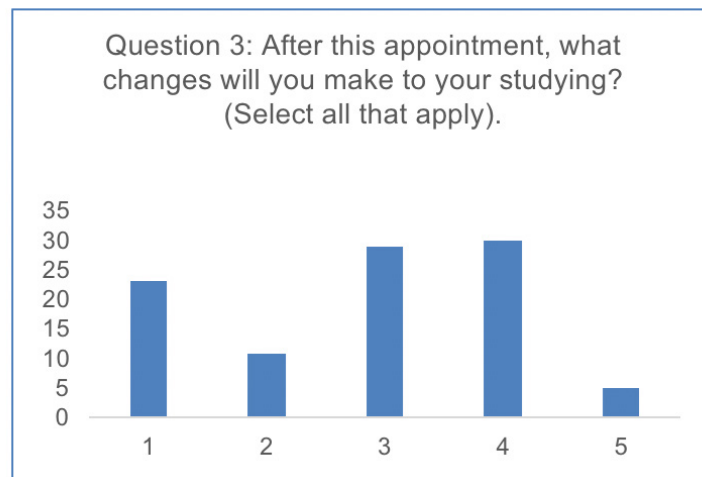


Figure 3. Responses to survey question 3

- 1 - Study every week, rather than the few days before the exam
- 2 - Ask for help more often in the discussion board, or meet with professor
- 3 - Test myself more frequently with the quizzes, a friend or other resources
- 4 - Focus more on understanding and applying, rather than memorizing
- 5 - No changes; I am satisfied with my grade

Discussion

Instructors teaching Anatomy and Physiology need to know which strategies are most effective in helping their students learn from their mistakes and improve their grades. Attending an appointment to review the midterm exam in a small group of student peers significantly predicted future exam performance in an Anatomy and Physiology I course in this study. High school GPA also predicted midterm and final exam scores. Finally, midterm exam scores significantly predicted final exam scores. Although the exam review appointment predictor explained a small percentage of the variance in final exam scores, the mean difference on the final exam between attendees and non-attendees was 4.3 points, which has practical significance and may determine whether a student passes or fails the course. This study contributes to previous findings that have found that attending an exam review with the instructor can positively impact future exam performance.

In a recent study of a critical care nursing course, Wiles (2015) examined the impact of exam review appointments with the addition of a developed testing grid. The intent of this grid was to analyze gaps in information or preparation strategies. Students who failed the first exam were strongly encouraged to meet with the instructor to review the exam. Students who met with the instructor to review the exam and complete the test grid analysis improved their score on the second exam by an average of 9.6 points (range -1 to

21), versus students who did not attend these face-to-face meetings (3.1 points, range -5 to 10). Some of the students in this course waited until failing their second or third exam to meet with the instructor, but a number of these students still failed the course despite improvements on the final exam. Fourteen of the students never came to review any exams and eleven of them failed the course (Wiles 2015). The author suggested that the improved scores on the exam were the result of more focused studying on areas identified as “gaps” in the test analysis grid (Wiles 2015). Since the students in the Wiles study were seniors in an advanced critical care nursing course, research is needed to determine if such a structured feedback process will produce similar dramatic improvements for anatomy and physiology students.

The timing of exam review appointments may be particularly important if student expectations of their grades are not aligned with their outcomes. In a study by Eagleton (2015) on learning satisfaction in anatomy and physiology, 56% of students surveyed underestimated the level of preparation that was expected for studying anatomy and physiology and only 57% felt that their grades reflected their effort. Similarly, researchers in a 2016 study examining intrinsic and extrinsic motivation of anatomy and physiology students found that 66% of the students overestimated their final grade (Sturges *et al.* 2016). If students are aware that their expectations for course performance are not realistic before, or at the point of the midterm examination, they may make changes in

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their academic behaviors. These changes may mean that the students can continue on to the next anatomy and physiology course with their cohort and avoid the feelings of failure associated with repeating a course.

Tinnon (2018) reported findings related to the use of a novel test review process utilized in three cohorts of nursing students. In this investigation, students who failed the first exam were required to attend a test review session, which could either be done one-on-one with the instructor, or with another student. The author observed that the students who chose to meet in pairs benefited from hearing the thought processes of fellow students. At these sessions, students were required to reflect on each of their missed exam items and provide a rationale to the instructor for the correct answer. Test-taking strategies, such as process of elimination, reading questions carefully and searching for key words were also discussed. Finally, the instructor also discussed learning styles and study skills with the students.

Students were required to end the test review session by writing down what they learned from the review session and set goals for improvement. While no data on student outcomes was included in this article, the author reported that retention in the course increased significantly in the courses in which the test review was used, and 84% of the students who were failing after the second exam improved their grades and passed the course (Tinnon 2018). The author added that students often returned to tell faculty that the strategies they learned during test reviews were helpful in their subsequent coursework (Tinnon 2018). Although the specific classes and the content of these classes was not provided by the author, the process of test review outlined in this article is similar to our current investigation and provides support to continue the exam review process.

While grades may be positively influenced by faculty interactions and office hours, students may benefit in other ways from interaction with faculty while attending exam review sessions. Academic self-concept, the belief students have in their academic skills and abilities, can be influenced by faculty interactions (Reynolds 1988). Komarraju *et al.* (2010) studied the role of student faculty interactions to increase self-efficacy and engagement. In this study, students who perceived faculty as being less interested in their success reported feelings of discouragement and greater feelings of apathy about course outcomes (Komarraju *et al.* 2010). Conversely, students who perceived faculty as being approachable, respectful, and available for help, reported feeling more confident in their skills and motivated to succeed. Micari and Pazos (2012) set out to examine the impact of the student-faculty relationship in organic chemistry, a course they considered highly challenging. The authors hypothesized that a positive student-faculty relationship would be associated with better student

performance, greater confidence, and a sense of identity in the sciences.

A 12-item Likert scale was developed to assess the quality of the student faculty relationship and student confidence in the course. A stepwise linear regression model was created that included college GPA, gender, and minority status as covariates along with the student-faculty relationship score. Student-faculty relationship was a significant predictor of grade ($R^2 = .512$), with the items "looking up to the professor," "feeling comfortable approaching the professor," and "feeling the professor respects the students" as the strongest predictors. While this is meaningful, a stronger relationship existed between student-faculty relationship and student confidence in their ability to succeed than between student-faculty relationship and grades. For every unit increase in student-faculty relationship, the authors reported an expected .171 increase in the final grade in the course, but a .448 unit increase in student confidence (Micari and Pazos 2012). Since the anatomy and physiology course series is required for students in our undergraduate nursing and health sciences curriculum, more research on the impact of the faculty-student interaction on both grades and student confidence in anatomy and physiology courses is warranted.

Of the three predictors included in the regression model in the current investigation, midterm exam performance was the strongest predictor of final exam performance. Anecdotally, students often feel that their midterm exam performance is not indicative of their future exam performance and that their grade was not truly reflective of their understanding or ability. Sharing the message with students at the beginning of the course that grades on the midterm exam strongly predict grades on the final exam may be enlightening and motivate them to change their behaviors earlier in the course. However, this information should only be shared if effective strategies and support are available to the student following the midterm grade.

There are limitations to address in this study. First and foremost, while meeting with the faculty member to review the midterm exam significantly predicted performance on the final examination, we cannot know whether it was the influence of the instructor, or the actual exam review exercise, that predicted the final exam grade. Simply meeting with the instructor and feeling "seen" may have increased student confidence in their ability to succeed (Micari and Pazos 2012). Future research on exam review appointments could include a group that reviews exams with another faculty member or proctor not involved in the course or compare methods of exam review between review sessions. Students who are struggling in a course may still want to meet with the instructor and this additional meeting may serve as another variable to examine in regard to student performance.

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During the exam review sessions, students were required to identify two strategies for improvement. This provided structure to the exam review appointment and a goal for the session. However, these strategies were not monitored for the remainder of the course, so it is unknown whether the students followed the suggested strategies or if the strategies led to improvement on the final exam. Alternatively, students who were already motivated to improve their grades may have been the students who came to view their exams. It is possible that these students would have improved their grades by seeking out tutoring, studying more regularly, or testing themselves more frequently after seeing their midterm exam results. Without formal tracking of student behaviors and behavior change following the instructor meeting, the question of exactly *why* students who viewed their exams improved remains an area for future research. The results of the anonymous survey indicated that most students planned to change their studying approaches. Therefore, future research should include a method to track students after exam review sessions. Finally, information on high school anatomy and physiology courses, or other relevant coursework in high school that may have prepared students for anatomy and physiology, was not available.

Conclusions

Face-to-face exam review significantly predicted final exam grades in our large sample of HSCI and NURS students, but midterm exam scores explained most of the variance in final exam scores. Exam review appointments should be continued and enhanced to include a more structured analysis of the midterm exam. Follow up with students should include implementation of new studying strategies before the final exam. Anatomy and physiology instructors who are currently not reviewing examinations individually, or in small groups, may consider implementing an exam review plan that suits the course schedule.

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