Evaluation of Supplemental Instruction in Human Anatomy and Physiology I Using Predicted Grades

Gilbert R. Pitts, PhD, Amy L. Thompson, PhD MT (ASCP), Michelle Rogers, MS, James F. Thompson, PhD MT (ASCP), Joseph R. Schiller, PhD

Austin Peay State University, Clarksville, TN, USA

Corresponding author: pittsg@apsu.edu

Abstract

Human Anatomy and Physiology courses are "gateway" courses that students must pass with high grades in order to proceed through their program of study. However, student pass rates are often low, resulting in students attempting the course multiple times and delaying their graduation. Supplemental instruction performed by peer leaders is one mechanism that has been used to increase student success. The goal of this study was to evaluate the effectiveness of peer-led supplemental instruction by comparing predicted and actual course grades. We learned that students predicted to earn a C achieved higher grades when they utilized supplemental instruction. While those students performed better than predicted, supplemental instruction did not improve ABC rates for the class. We conclude that supplemental instruction can be of benefit for some students. https://doi.org/10.21692/haps.2024.003

Key words: supplemental instruction, predicted grades, anatomy and physiology

Introduction

Human Anatomy and Physiology (HAP) courses are "gateway" courses at many colleges and universities in the United States that students must pass in order to proceed through their program of study. It has been reported that 450,000 students enroll in these courses annually (Human Anatomy & Physiology Society, 2020). These challenging courses are often taken during the freshman year; for example, Austin Peay State University (APSU) encourages pre-nursing students to take HAP 1 during their first semester of college. Several studies have presented evidence of the difficulties students face in HAP. One study reported that only 38% of students enrolled in HAP 1 received a score of C or better while another reported that 58.6% of first generation students earned at least a C (Hopper, 2011; Russell et al., 2016). HAP courses are unusual in that students may be in either STEM (science, technology, engineering and mathematics) or non-STEM programs. In general, the attrition rates in the non-STEM health sciences are quite high (57%) in comparison to those of the STEM biological sciences (45%) and the average for all STEM disciplines (48%) (Chen, 2013). The different attrition rates suggest that students enrolled in specific programs may need additional help to succeed in HAP.

Students often do not seem to be aware of the difficulties associated with gateway courses such as HAP. This was illustrated in a study of 1,210 students in which 19% earned less than a C but very few students predicted they would fall into this category (Sturges et al., 2016).

Several factors have been shown to be associated with student success in HAP. These include increased age, not taking a developmental reading, math, or writing course, and not repeating prior courses (Russell et al., 2016). Another study showed that the year taken (freshman or sophomore), high school GPA as well as math and verbal SAT scores were important predictors of HAP success (Rompolski et al., 2016). The wide variety of these factors and their interactions preclude the effective use of prerequisites for many gateway courses.

Peer-led supplemental learning (SI) workshops have been effective in increasing student performance in courses as diverse as introductory computer science (Biggers et al., 2009) and introductory accounting (Etter et al., 2000; Jones, 2013). One study reported the use of SI in several STEM subjects including introductory biology, general chemistry, organic chemistry, and precalculus (Peterfreund et al., 2008). A one credit supplemental section of HAP at the University of Southern Indiana resulted in 63% of the students earning a C or better, while only 38% of students without supplemental instruction earned a C or better (Hopper, 2011).

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The goal of this study was to determine if supplemental instruction increased student performance in HAP at our institution, APSU. Our study is unique in that we compared the predicted and actual grades of students enrolled in supplemental and traditional instruction. Supplemental instruction carries the risk that students perceive it to be a form of remedial education; hence, they consider SI to be stigmatized. Therefore, supplemental instruction sections were renamed as "Success" sections. Enrollment in these sections was completely voluntary in order to reduce any stigma that might be associated with the course and to develop a learning community comprised of students with different amounts of preparedness.

Materials and Methods

Experimental Groups

Traditional and Success sections were created for three instructors. Each instructor taught at least two sections of HAP I: a Traditional and a Success section. The students enrolled in the Success sections attended the same lectures as those enrolled in the Traditional sections, resulting in combined courses containing up to 99 students. Each Success section consisted of no more than 24 self-selected students. Academic advisors were told that the SI sections were geared towards developing learning communities within HAP with the goal of increasing student success. Furthermore, they were told that we wanted students to take the class if they were concerned about HAP prior to registration so that students would understand the function of the Success sections. Since students enrolled in the Success sections prior to the start of class, they were already aware of the schedule and could ensure that they did not have any scheduling conflicts that would prevent them from attending the Success sections. Students in Traditional and Success sections were told that lecture attendance was mandatory; however, they were not penalized for missing class.

Instructor A taught 9 courses between Fall semester of 2013 and Fall Semester of 2018. Instructor B taught one course Fall semester of 2014. Instructor C taught one course Fall semester of 2016. In total, 422 students were enrolled in the Traditional course and 285 were enrolled in the Success course.

Students in all sections taught by a given instructor were graded using the same tests in an identical manner, regardless of whether the student was enrolled in a Success section or not. Instructors administered five tests covering specific sections of the course material and one comprehensive test. Tests consisted of multiple-choice questions and, in some sections, short answer questions. Tests were completed within the class period. Students in the Success sections received additional instruction by an undergraduate structured learning assistant (SLA).

SLA Selection & Training

The SLAs were selected by the course instructors and were required to have grade point averages of at least 3.0. Instructors selected SLAs from a pool of students who recently successfully completed HAP I and II. In general, these students had earned A's during both semesters of these courses. In addition, it was important to utilize SLAs who improved over the course of the semester in which they were enrolled in HAP. This was thought to identify SLAs with more empathy and experience in grade improvement. Essentially, they could describe the changes that they made to improve their performance in HAP. The SLAs were then invited to meet with the instructor for an interview. The interviews were performed to examine the following factors that were used to select the SLA.

1. Motivation to be an SLA
2. Concern/empathy of the SLA for the HAP students
3. Ability of the SLA to interact with a diverse student population
4. Whether the SLA's schedule fit with the HAP course schedule
5. Whether the SLA understood the importance of HAP to career goals
6. Whether the SLA was able to recall information about HAP

Once hired, the SLAs received two days of training in classroom management, communication skills, cultural awareness, ethics, and safety, as well as how to serve students with disabilities from the Student Learning Resource Center at APSU. The SLAs also met with the course instructors to learn about expectations and to discuss how the Success sections would be conducted. SLAs were required to attend each lecture session so that they knew what topics were being covered in class and how the material was presented.

Students enrolled in the Success sections were charged a fee of $75. This fee was used to pay the salary of the SLAs. The starting pay of the SLAs was $15/hour. They were paid for attending lectures, preparing for each SLA course, meeting with the instructor, and teaching their courses.

Success Section Course Design

Each Success section met once each week for 55 minutes. The SLA was responsible for SI class planning. However, there were few differences in course design amongst the SLAs because they utilized course materials provided by the previous SLA. Therefore, the biggest difference from one SLA to another was found in presentation/speaking style. Preliminary attempts at conducting Success sections clearly demonstrated the importance of Success section attendance. Therefore, students enrolled in the Success sections were required to attend

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each meeting. Any student that missed three Success section meetings was told that they would be awarded an absence-related failure (FA) for the final course grade.

At the beginning of the course, SLAs described the methods that they themselves used to successfully pass the course. This included discussion of study and test-taking strategies. Later, the SLAs reviewed course materials, answered student questions, and worked to engage students in small group discussions. SLAs were encouraged to keep the students engaged by asking them questions to encourage participation. Sometimes, the SLAs divided the class into groups and played online HAP quizzes. Each success section met two to three times between successive exams. After each exam, the SLA would discuss the exam and explain the answers to commonly missed questions.

Statistical Analysis

Predicted grades were computed for all students using Degree Compass (Denley, 2012; Whitten et al., 2013). Unfortunately, Degree Compass is proprietary software and the specific criteria and algorithm that it uses to predict grades have not been made available. It has been stated that Degree Compass uses a model that "combines hundreds of thousands of past students' grades with each particular student's transcript to make individualized recommendations for current students" and that it "uses predictive analytics techniques based on grade and enrollment data" (Denley, 2012). Degree Compass is currently packaged within Desire2Learn. The Desire2Learn features guide states that it utilizes "two elements: a degree audit for current students and academic histories of the school's students, including transcripts and test scores over the past 10 years" (Desire2Learn, 2013). I have been led to understand that the academic history includes High School GPA, ACT scores, and historic grades.

APSU utilizes an A, B, C, D, F grading system with no provision for +/-grading. Furthermore, the predicted grades obtained from Degree Compass did not estimate +/- grades. Predicted and actual grades were coded by numbers with F=0, D=1, C=2, B=3, and A=4. The difference between the predicted and actual grades was also calculated (actual grade – predicted grade). Hence, a difference of -1 would mean that their actual grade was one letter grade lower than the predicted grade. All statistical tests were performed using the General Linear Models (GLM) procedure of the SAS/STAT software package, version 9.4 (SAS Institute Inc, 2013). When needed, multiple means were compared using Duncan's tests (Duncan, 1955).

This project was approved by the Institutional Review Board of APSU (#17:017).

Results

We began by examining whether the students enrolled in the Success and Traditional courses were different; that is, whether students enrolled in the Success sections were predicted to achieve lower success than those in the Traditional sections. The average predicted scores of students enrolled in Traditional and Success courses were 2.386 ± 0.038, n=422 and 2.316 ± 0.043, n=285, respectively, and were not significantly different between the two student populations. The distribution of predicted grades of students enrolled in the Traditional and Success courses is presented in Figure 1. The number of students predicted to earn A's in the Traditional and Success courses was significantly different ($p<0.05$); however, there were no other differences amongst the distributions. Therefore, the students enrolled in the Success and Traditional courses were predicted to perform similarly.

In order to determine if participation in Success classes impacted course grades, an analysis was performed on the difference between final and predicted course grades (final grade – predicted grade; Fig. 2). A difference of -1 would mean that the student's actual letter grade was one less than their predicted letter grade. Students enrolled in both Traditional and Success sections received grades that were lower than predicted (Traditional: -0.543 ± 0.049, n=422; Success: -0.326 ± 0.0597, n=285). However, students enrolled in the Success sections had a smaller difference than those enrolled in Traditional sections ($p<0.05$), showing that the Success sections were related to student performance. The effect of instructor was also significant ($p<0.05$).

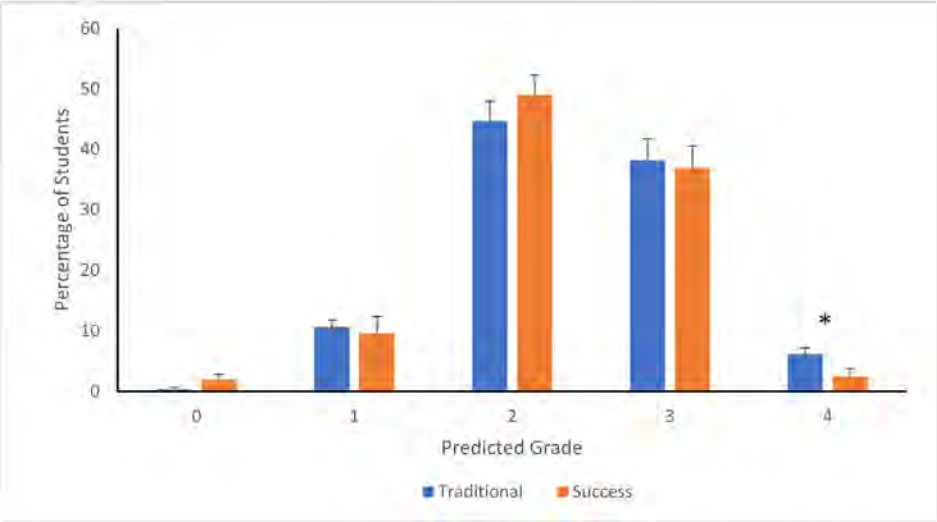

Figure 1. *Distribution of predicted scores of students enrolled in Traditional and Success courses. Data are presented as mean ± standard error. The asterisk denotes a statistically significant difference (p<0.05).*

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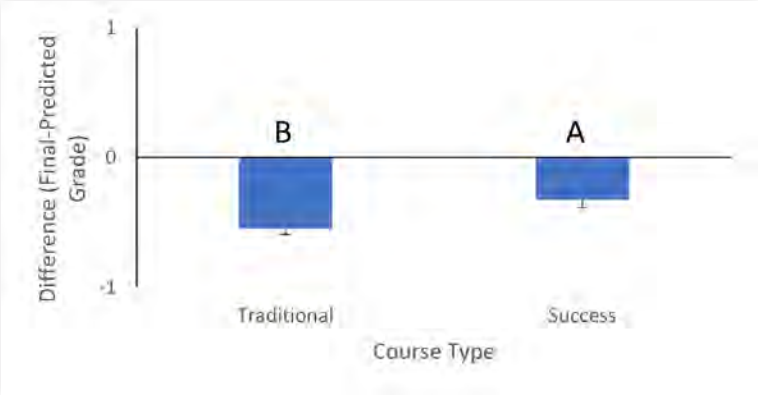

Figure 2. *The differences between predicted and actual grades of students enrolled in Traditional and Success sections. A difference of -1 indicates that a student's actual grade was one letter grade lower than the predicted grade. Data are presented as mean ± standard error. Bars with different letters are statistically different ($p<0.05$).*

Since there was a significant effect of course type on the difference between predicted and actual grades, we decided to examine the difference between actual and predicted grades for each predicted grade (Fig. 3). The difference between the predicted and final grades significantly differed among students who were predicted to earn a C in the course ($p<0.05$). The difference in grade was -0.529 ± 0.081 for students enrolled in Success sections while it was -0.796 ± 0.075 for students enrolled in Traditional sections. The impact of Success sections was not significant for students that were predicted to earn A's, B's, or D's.

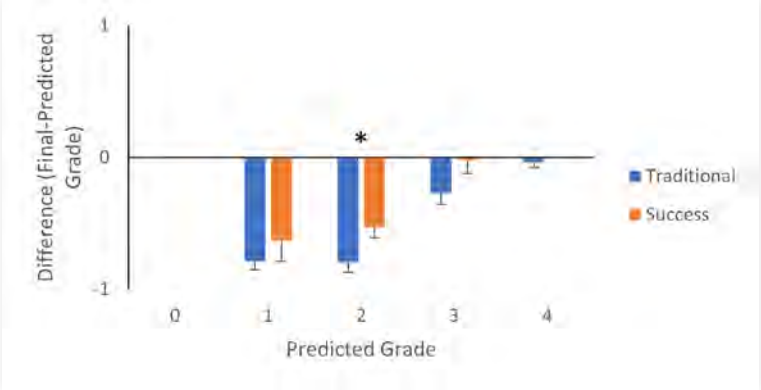

Figure 3. *The difference between predicted and actual grades at each predicted grade. A difference of -1 indicates that the student's actual grade was one letter grade lower than the predicted grade. Data are presented as mean ± standard error. The asterisk denotes a statistically significant difference between the Traditional and Success sections ($p<0.05$).*

Figure 4 depicts the actual final grade distribution of students predicted to earn a C. An important point about Figure 4 is that it provides some information regarding the ability of Degree Compass to predict grades. Specifically, it shows that if a student is enrolled in a traditional course and is predicted to earn a C, it is very likely that the student will earn a grade of C or lower. It is highly unlikely that they will earn an A or B.

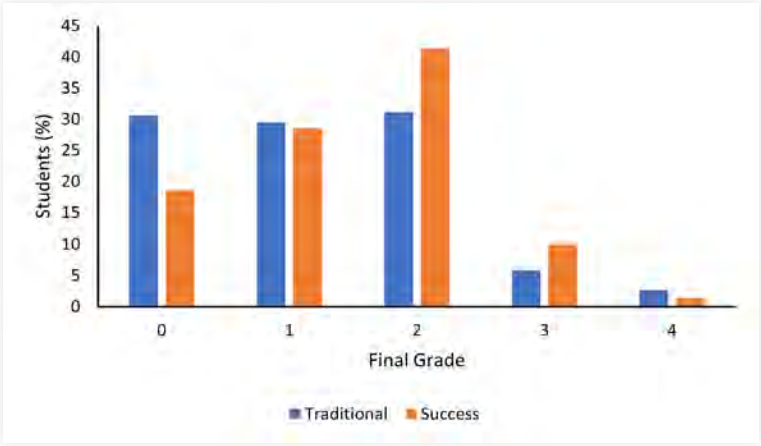

Figure 4. *The final grade distribution of students enrolled in Traditional and Success sections who were predicted to earn a C. Data are presented as mean ± standard error.*

Many colleges and universities use DFW or ABC rates as a metric to quantify course success. DFW is an abbreviation for the number of students who drop (D), fail (F), or withdraw (W) from the course. Figure 5 shows that there were no significant differences between the DFW and ABC rates of Traditional and Success courses ($p>0.05$). The DFW rates of Traditional and Success courses were 41.2 ± 2.4% and 36 ± 3.0%, respectively. ABC rates were 58.8 ± 2.4% and 63.8 ± 3.0% for Traditional and Success courses, respectively. These results show that implementation of success sections did not significantly impact the overall ABC or DFW rates.

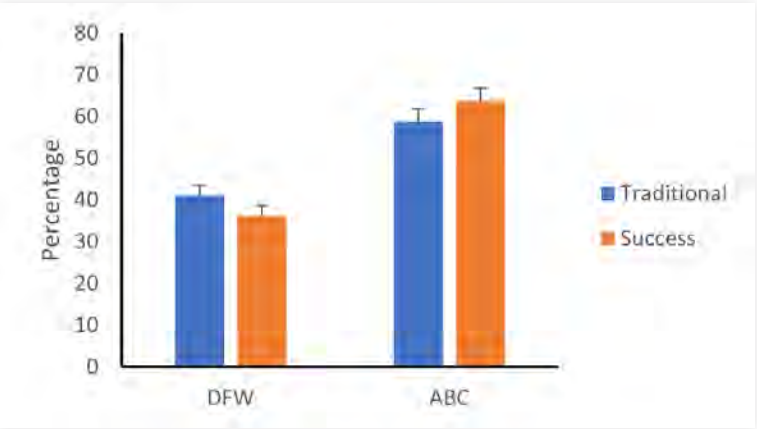

Figure 5. *DFW and ABC rates of students enrolled in Traditional and Success courses. There were no significant differences amongst DFW or ABC rates ($p>0.05$). Data are presented as mean ± standard error.*

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Although the overall ABC rates were not altered by the Success courses, we wondered what percentage of students might benefit from enrollment in the Success sections. To test this, we compared the percentages of students who increased, decreased or did not change their final grade in comparison to their predicted grades. These percentages are depicted in Figure 6. There was a significantly greater percentage of students who performed better than predicted in Success sections than in Traditional sections ($p<0.05$; Success: 20.6 ± 1.7%, Traditional: 13.7 ± 2.0%).

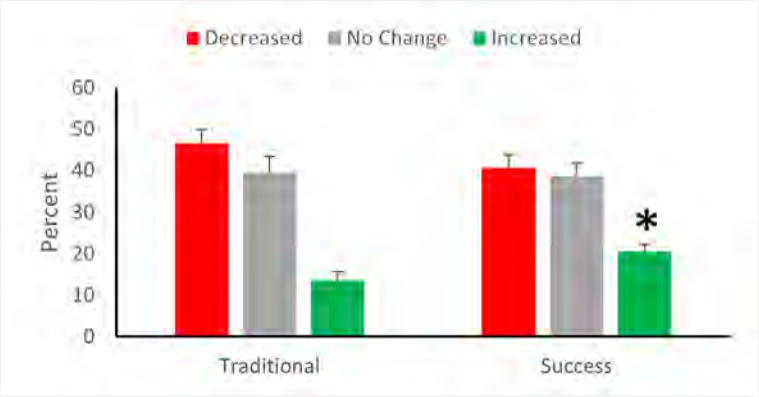

Figure 6. *The percentages of students who increased, did not change, or decreased their final grade from those of their predicted grades. Statistical comparisons were made between like groups and significant differences are marked with an asterisk (p<0.05). Data are presented as mean ± standard error.*

Next, we wanted to examine the accuracy of Degree Compass in predicting course grades. Therefore, we looked at the relationship between predicted grades and actual grades for students enrolled in both sections. The data for students enrolled in Traditional and Success courses are depicted in Figure 7. Twenty-seven students were predicted to earn an A in the Traditional courses; however, the average grade for these students was slightly lower (3.96 ± 0.037). Similarly, the 160 students predicted to earn a B earned slightly lower grades (2.73 ± 0.086). The actual grades of students predicted to earn a B was significantly lower than those predicted to earn a A ($p<0.05$). The actual grades of students predicted to earn a C were only 1.204 ± 0.075 (n=186) and those predicted to receive a D earned 0.213 ± 0.067 (n=47). The actual grades of students predicted to earn grades of C or D were significantly lower than those predicted to earn a B ($p<0.05$).

Eight students were predicted to earn an A in Success courses; these students all earned final grades of A (4.0 ± 0.). There were 107 students predicted to earn a B. The average grade earned in the course was slightly lower (2.98 ± 0.105). The actual grades of students predicted to earn a B were significantly lower than those predicted to earn an A ($p<0.05$). Of students predicted to earn a C, the earned grade average was only 1.471 ± 0.081 (n=140) and those predicted to receive a D earned an average 0.370 ± 0.161 (n=27). The actual grades of students predicted to earn grades of C or D were significantly lower than those predicted to earn a B ($p<0.05$).

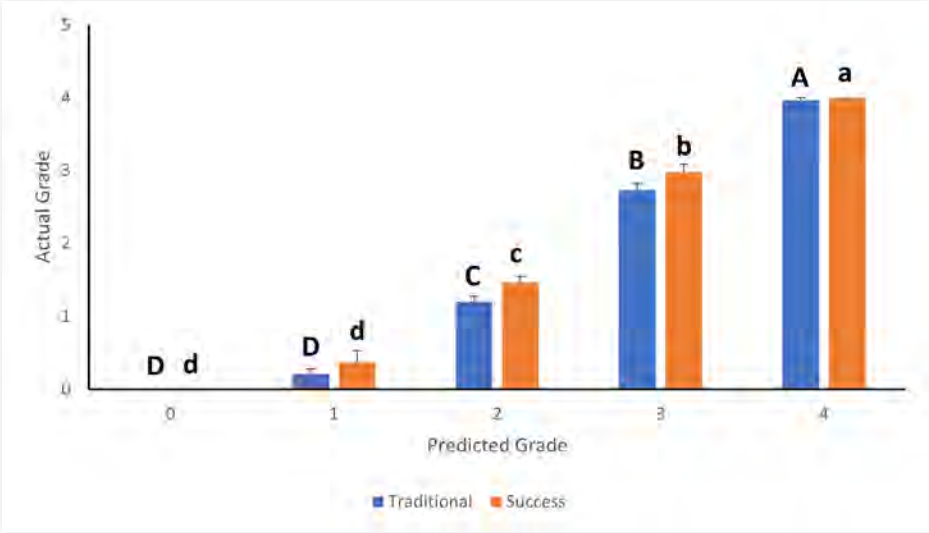

Figure 7. *The relationship between the predicted and the mean of actual grades of students enrolled in Traditional and Success courses. Bars with different letters are statistically different (p<0.05). Data are presented as mean ± standard error.*

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Discussion

Our results show that some students performed better when they were enrolled in Success sections even though ABC and DFW rates were not significantly altered. One factor that makes this study unique is that it utilized predicted grades for each student. Most experimental designs only show that one group of students performed better than another. The power of using predicted grades was that this method allowed us to examine the effect of Success sections on individual students. For example, we showed that students predicted to earn a C were aided by supplemental instruction. These students increased their grades by approximately one-half letter. The supplemental instruction used in the current study did not impact ABC or DFW rates. However, previous reports showed that SI was able to increase the number of students earning a C or higher (Rath et al., 2007). While our ABC rates were not affected by SI, our data clearly show that SI does alter the course outcome for the average (C level) student.

Since we utilized Course Compass to estimate predicted grades, we also examined its efficacy in predicting grades. Students predicted to earn A's and B's generally earned those scores. However, students predicted to earn C's and below often scored less than the predicted grade when enrolled in a traditional class. It was previously reported that Degree Compass is able to predict grades of at least a C within 0.56 of a letter grade; further, it correctly predicted who would earn at least a C 90% of the time (Denley, 2012).

At least one study found that SI instruction improved individual exam performance in both face-to-face and remote instruction courses (Rokusek et al., 2022). While we did not explicitly investigate the effect of SI on individual exams, we would expect to see a similar effect in this study because our course grades were only based on exam scores.

SI sections might be biased to have a larger impact on higher performing students (Jensen & Moore, 2009). However, a high performing student would already be predicted to earn an A or B. These students would be expected to already perform academic behaviors that allow them to do well in their classes (Moore & Jensen, 2007). In line with this reasoning, the current study showed that SI sections did not significantly increase the scores of students that were predicted do to well in the course. However, SI impacted the scores of students that were predicted to earn C's. This means that SI is able to make a difference for some students that need assistance such as review sections.

One may wonder if the students would be better served through the use of graduate student leaders. However, chemistry students recently rated trained undergraduate peer leaders higher than non-trained graduate student leaders (Philipp et al., 2016). Consistent with that finding, we try to utilize undergraduate SLAs rather than graduate students. Our graduate students work as graduate teaching assistants in lower level biology laboratories and are not involved in HAP lectures.

Student participation in supplemental instruction has been shown to be necessary to achieve a higher final course average (Hughes, 2011). For example, a calculus course with voluntary recitation attendance did not significantly reduce the DFW rate, while a mandatory course coupled with concept activities significantly reduced the DFW rate (Watt et al., 2014). Hopper (2011) showed that students who volunteered to attend SI in HAP outperformed their peers, but did not examine the impact of SI session attendance.

Prior to our study, we conducted two short-term trials (Pitts, personal observation). In the first trial, Success section attendance was voluntary during a summer semester course. Nevertheless, SI attendance was very high and there was a clear improvement in student performance. The model was repeated during the subsequent fall semester. Very few students attended the Success sections and there was no impact on student grades. Similar results have been reported in HAP courses, in which it was stated that students did not attend SI due to scheduling conflicts and to a lack of incentives (Hughes, 2018). Student attendance was later increased by providing extra credit for attendance and by scheduling the SI meetings early in the semester. Studies have also shown that supplemental instruction attendance increased Psychology 100 grades and that those with higher grades in that course were more likely to graduate (Paabo et al., 2021). In the present study, Success sections had an attendance policy that only allowed students to miss 3 meetings before an absence-related F was awarded for the course grade.

Student motivation is also important. Jensen and Moore (2009) revealed that students earning grades of D and F on their first exam rarely attended help sessions that were designed to prepare students for subsequent exams. They concluded that good students attended more help sessions, but that attendance did not turn students into good students. Our SLAs did their best to help with student motivation. However, student motivation and willingness to persevere in a course are probably more important than anything else that can be provided by the instructor or SI. It is possible that the students enrolled in the Success sections may have been more motivated than those in the Traditional sections, leading to volunteer bias. However, our data suggests that this was not the case since the predicted grades of students enrolled in the Success and Traditional sections did not differ.

SI has been shown to be particularly effective in assisting underrepresented groups. Rath et al. (2007) showed that SI increased the percentage of underrepresented students earning a grade of at least a C- more than for other traditional

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students. Similar effects were reported in other studies (Peterfreund et al., 2008; Thomas et al., 2019). SI instruction was found to be especially useful in improving the scores of male students (Peterfreund et al., 2008). The impact of Success sections on underrepresented groups was not examined in the current study as that type of demographic data was not collected.

This study focused on student performance. It did not examine student perceptions of SI. We did not request that students complete surveys of course satisfaction since the typical student would not be expected to describe their experience in a Traditional versus a Success course.

The results of this paper show that supplemental instruction increased the performance of students predicted to earn a C in HAP. This is very important to these students as they often seek admission into competitive programs such as Nursing that have high GPA admissions requirements. Further research needs to be performed to reveal methods that increase the performance of students predicted to earn less than a C in HAP.

About the Authors

Gilbert R. Pitts, PhD, is a Professor in the Department of Biology at APSU. He teaches Human Anatomy and Physiology I and II, Animal Physiology, Human Physiology, and Reproductive Physiology. His research is focused on the regulation of gonadotropin-releasing hormone secretion. Amy L. Thompson, PhD, MT (ASCP), is a Professor in the Department of Biology at APSU. She teaches Cellular & Molecular Biology, Anatomy & Physiology, and Introduction to Pharmacology. She researches the use of brown recluse spider venom as a pharmacological agent to kill cancer cells and the antimicrobial properties of plant products. Michelle Rogers, MS, is a Master Instructor in the Department of Biology at APSU. She received a master's degree in Science Education and has taught biology for over twenty years. James F. Thompson, PhD, MT (ASCP), is a retired Professor in the Department of Biology at APSU. He taught Human Anatomy and Physiology I and II, and Principles of Evolution. His research was focused on the intersection between laboratory medicine and nephrology. Joseph R. Schiller, PhD, is a retired Professor in the Department of Biology at APSU. He taught Human Anatomy and Physiology I and II, Conserving Biodiversity, Human Biology, and Zoological Diversity. His research interests include aquatic ecology and macroinvertebrates.

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