

Term Duration: Comparing Student Success in College Science

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ABSTRACT

This study examines the impact of varying anatomy and physiology (A&P) course durations—16-week, 8-week, and 5-week terms—on student success at a Southern Texas college. Utilizing cognitive load theory, the investigation included 7 years of data of 31,656 students completing A&P I or II courses. Contrary to the literature, the study found that cognitive load does not influence success across different course lengths. Students performed better in the 5-week course compared to longer durations, challenging assumptions about reduced course durations and cognitive load. This finding is important for healthcare education decision-makers. Colleges can confidently offer shorter A&P courses without compromising grades and passage rates.

Keywords: cognitive load, compressed courses, anatomy and physiology (A&P)

INTRODUCTION

Anatomy and Physiology (A&P) courses serve as crucial entry points into various medical careers, shaping pathways in health sciences, nursing, physiotherapy, radiology, and medicine (Gultice et al., 2015). The success of students in these courses is vital for entering healthcare professions, and their completion is a prerequisite for a broad spectrum of healthcare jobs (Vitali et al., 2020). Notably, the duration of A&P courses varies, with some colleges adopting traditional 16-week semesters, while other colleges employ compressed formats with shorter completion times. Amid the growing popularity of compressed courses, conflicting findings in existing literature necessitate a closer examination. While some studies suggest enhanced focus and performance in compressed formats, others raise concerns about potential drawbacks, particularly in courses with extensive laboratory components like A&P (Paul, (2017); Picardo, (2016); Sheldon & Durdella, (2010); Walsh et al., (2019).

This study addresses this void by examining the relevance of course length to student success in A&P at a college in South Texas. Guided by two key research questions focused on grades and passage rates, the investigation is framed within Cognitive Load Theory (CLT). CLT offers a theoretical foundation for understanding how different course lengths impact students' cognitive demands and academic outcomes.

The research recognizes the unique challenges of A&P courses, requiring comprehensive understanding and retention due to their dual emphasis on anatomy and physiology. The study explores whether the duration of A&P course delivery influences student success, considering the intricate content and structure of A&P curricula.

Gateway science courses pose potential barriers for students aspiring to enter the competitive and essential healthcare workforce (Conley, 2020). With healthcare workforce demands escalating, investigating the relationship between course length and student outcomes is essential for optimizing educational practices and meeting industry needs.

RESEARCH QUESTIONS

RQ1: Is there a difference in grades among students who took a 16-week fall or spring, an 8-week fall or spring, and a 5-week summer course in Anatomy and Physiology I and II at a community college in the Southern region of Texas during the period 2016-2022?

RQ2: Is there a difference in passage or failure among students who took a 16-week fall or spring semester, 8-week fall or spring, and 5-week summer course in Anatomy and Physiology I and II at a community college in the Southern region of Texas during the period 2016-2022?

LITERATURE REVIEW

In a study exploring student success in Anatomy and Physiology (A&P) courses without laboratory components, the importance of instructional methods, student characteristics, class length, and earned grades was emphasized (Hull et al., 2016). A&P courses demand substantial

intellectual efforts, requiring time to comprehend extensive information and various structures (Vitali et al., 2020). Johnson (2019) highlighted the limited understanding of context-dependent cognitive processes in A&P education, employing a constructivist and relativist theoretical perspective.

Reviewing literature related to cognitive load theory, 10 studies were analyzed and listed below, three specifically linked to A&P courses. These three studies are summarized first and then studies of other fields which used cognitive load theory (CLT) are presented. Richards (1984) found significant relationships between cognitive development, cognitive style, reading ability, and academic success. Johnson's (2019) qualitative case study identified limited variances in cognitive processes among students in A&P courses. Talip et al. (2021) related CLT to instructional design, emphasizing the challenges of learning anatomy.

In physics courses, Saw (2017) applied CLT with worked examples for distance learners, highlighting the importance of sequencing in reducing cognitive burden. Zu (2017) employed various measures to study different types of cognitive load, indicating the importance of instructional settings and learner characteristics. Applying CLT to accounting courses, Canaday (2018) found that students in classes implementing CLT outperformed those in traditional lecture formats. Sewell et al. (2019) linked CLT to health professions education, emphasizing the negative correlation between cognitive load and performance.

In radiology courses, Louw (2021) investigated CLT's application to simulations, finding that critical thinking demands significant cognitive resources. Stachel (2011) applied CLT to introductory computer programming courses, revealing the effectiveness of scaffolding tools in reducing cognitive load. Puma et al. (2018) used the time-based resource sharing model to explore cognitive load in instructional design, emphasizing the impact of information presentation pace on working memory. The accelerated pace in science laboratory courses and extensive A&P courses may hinder learning outcomes (Schmidt-Weigand et al., 2010).

In summary the literature review emphasized the importance of instructional methods, student characteristics, class duration, and grades in Anatomy and Physiology (A&P) courses. It was noted that there is limited understanding of cognitive processes in A&P education and that connecting cognitive load theory (CLT) to challenges in designing effective instruction for learning anatomy is paramount. Studies across various disciplines were researched, such as physics, accounting, health professions, radiology, and computer programming that highlighted the effectiveness of CLT in diverse educational contexts. Puma et al. (2018) explored cognitive load in instructional design, emphasizing the impact of information presentation pace on working memory, cautioning that an accelerated pace may impede learning outcomes in science laboratory and extensive A&P courses (Schmidt-Weigand et al., 2010).

METHODS

This study adopted a comparative ex post facto quantitative design to assess differences in student grades and passage or failure rates based on different term course durations. This quantitative study compared differences in student grades and passage or failure in A&P I and II courses at a college in the Southern region of Texas from 2016 to 2022. A careful sample

selection of data was observed with student grades from the population of extant archival data. Objective measurements were utilized to collect data, which was then evaluated using computer approaches to acquire numerical data and observe the occurrence.

The dependent variable (grades) was measured at the ordinal level; The independent variable consisted of three groups of different term lengths; Observations of each grade were independent and represented one student for any given term (Laerd Statistics, 2015). There was one independent variable with three nominal categories grouped as 16-week fall or spring, 8-week fall or spring, and 5-week summer course durations. The dependent variable was dichotomous. Students were coded as having either failed (coded 0) or passed (coded as 1) A & P I and II (16-week fall or spring, 8-week fall or spring, and 5-week summer courses).

Population and Sample

The study encompassed a population of 31,656 students who completed Anatomy and Physiology I and II courses over 7 years (2016-2022) at a Southern Texas Hispanic-Serving Institution (HSI) with over 95% Hispanic students. With five campuses serving more than 45,000 students, the college qualifies as an HSI, and more than 60% of its traditional student population consists of first-time college attendees. Class sizes average approximately 22 students per faculty member. Pre-existing archival data of student academic records, was collected for A&P I and II courses over three terms from the Institutional Effectiveness Office. Approval from the Institutional Review Board (IRB) was secured for data access, and subsequent analysis was performed using IBM SPSS (version 29), focusing on variables related to course durations, student grades, and passage or failure rates.

RESULTS

For research question #1, a Kruskal Wallance H test was used to determine if there were differences in grades among students who took courses for three-term durations. There was a statistically significant difference in grades ($H_{(2, 31,656)} = 925.08, p = .001$) among groups. Though the null hypothesis was rejected for RQ1, differences were small ($\eta^2 = .03$): About 3% of differences in grades were explained by course duration. Meaning that the null hypothesis (H_0) suggests that there is no difference in grades among students who took A&P courses with varying durations at a Southern Texas college. Conversely, the alternative hypothesis (H_A) suggests that there is a difference in grades among students in these courses, emphasizing potential variations based on course duration. Table 1 presented the grade comparison for the three term course durations (Appendix). The highest percentage of students passed a 5-week course at 36.3%, 34.5% of students passed an 8-week course, and 20.4% of students passed a 16-week course. In other words, more students passed a 5-week course in comparison of the two other longer subsequent course duration (Appendix). Table 2 compared the findings for all three course lengths (Appendix). Additionally, table 2 also showed that the mean grade for each course term was noteworthy, with students taking a 5-week course receiving the highest mean grade of 2.58.

A post-hoc Mann-Whitney U test was used to compare differences between combinations of groups using mean ranks (MR). A Bonferroni correction was used as the adjusted significance

for two-group comparisons (Morgan et al., 2020). The level of significance (.05) was divided by 3 because three two-group comparisons were calculated. The adjusted level of significance for deciding to retain or reject the null hypotheses for multiple group differences was $\leq .017$. The differences in mean rank were used as a measure of effect (Rovai et al., 2014) as was Pearson Correlation Coefficient (Morgan et al., 2020). Table 4 presents the results of the post hoc two-group comparisons (Appendix).

In table 3 a Two-Group Analysis of Grades by Course Duration revealed differences between the 5-week and 16-week course as well as the 8-week and 16-week courses (Appendix). Nonsignificant differences were noted between 5-week and 8-week course durations. There were no statistically significant differences between the 5-week and 8-week course durations. The mean grade in 5-week courses was 2.58 (SD = 1.47) and the mean grade for 8-week courses was 2.50 (SD = 1.50), a difference of .08. Statistically significant differences were found between 5-week and 16-week course durations. The mean grade in 5-week courses was 2.58 (SD = 1.47) and the mean grade for 16-week courses was 1.90 (SD = 1.56), a difference of .68. The mean rank difference was 2236.02 and r was $-.11$, a small effect (Morgan et al., 2020). Statistically significant differences were found between 8-week and 16-week course durations. The mean grade in 8-week courses was 2.50 (SD = 1.50) and the mean grade for 16-week courses was 1.90 (SD = 1.56), a difference of .60. The mean rank difference was 1816.45 and r was $-.08$, a small effect (Morgan et al., 2020). Noted from the data set, was that no differences existed between a 5 and 8-week course, however differences were found between the 5 and 16-week; likewise, the 8 and 16-week courses, yet effects were small.

For research question #2 a Pearson's chi-square test of homogeneity was used to test for statistically significant differences in passage or failure by three-course durations. Cohen's w was used to measure the effect size if differences were statistically significant (Cohen, 1988). There was a statistically significant difference between passage or failure among students who took a 16-week fall or spring, an 8-week fall or spring, and a 5-week summer course in Anatomy and Physiology I and II at a community college in the southern region of Texas during the period 2016-2022. As noted in Table 4, 81.9% of students who took a 5-week course passed compared to 79.9% who took an 8-week course and 66.7% who took a 16-week course (Appendix). That is, 15.2% more students passed the 5-week course compared to the 16-week course. At 2%, the percent difference between 5-week and 8-week courses was much smaller. The effect size was small at .13.

In summary, the study used statistical tests, including Kruskal Wallace H and post-hoc Mann-Whitney U, to examine the impact of course duration on grades in A&P courses. While statistically significant differences were found between 5-week and 16-week courses, as well as 8-week and 16-week courses, no significant distinctions were observed between 5-week and 8-week courses. Additionally, a Pearson's chi-square test revealed significant differences in passage or failure rates, with a small effect size, indicating higher pass rates in shorter duration courses.

RECOMMENDATIONS

This paper offers practical recommendations for educators and administrators in a higher educational setting based on a review of factors influencing student success, particularly focusing on Anatomy and Physiology (A&P) courses. For example, tracking specific student groups leading to nursing program success with a longitudinal study tracking academic performance, experiences, and motivations of specific student groups. Insights gained from this study can inform curriculum development and instructional strategies to ensure consistency in learning outcomes across different course durations. Equally important is drawing from research on course rigor, instructor methods, and their impact on student outcomes, this paper may provide actionable insights to improve curriculum design, instructional practices, and support mechanisms to help students achieve an opportunity for future acceptance to healthcare education programs.

Recommendations for practice include aligning curriculum and assessment across different durations that may ensure consistency in learning outcomes and assessments across A&P courses with varying durations. Implementing targeted support mechanisms for at-risk student groups by identify specific student groups at risk of academic challenges based on demographic factors or prior academic performance may help improve student success in science courses. Additionally, developing tailored support programs, such as tutoring, mentorship, or academic advising, to address individual student needs and promote success in future healthcare programs. Equally important is providing faculty development opportunities to align course content, rigor, and assessments to enhance student preparation for subsequent coursework allowing consistent learning opportunities. By implementing these practical recommendations and considering their implications for practice, educators and administrators can enhance student success in science courses leading future success in healthcare education. More importantly, fostering collaboration, providing targeted support, and integrating licensure exam preparation, institutions can better prepare students for the challenges and responsibilities of healthcare professions, ultimately contributing to improved patient care and outcomes.

Newton and Moore (2009) and Behrendt et al. (2020), recognized that success in a difficult science course like anatomy and physiology is indicative of college performance in allied health and nursing programs. However, Mitchell (2012) pointed out that minimal literature explored how prepared students perform in pre-nursing college entry-level courses. Ultimately, few studies exist that have been directed toward understanding the cognitive processes used, much less the importance of the learning context of A&P education that undergraduate students need when seeking healthcare-related programs (Magolda, 2009).

LIMITATIONS

Grades were used as a measure of success and may potentially serve as a threat to construct validity because the sole use of grades was to measure success. Other measures were available but not used in this study. External validity was threatened because only one community college in South Texas was used in this study. The results of this study may or may not be used in similar environments or equally generalized. Internal validity was threatened

because no factors such as instructor, pre-existing knowledge, environment, or other factors were controlled in this investigation. The threats to this study's validity were acknowledged but did not limit the effectiveness of this study because interpretations do not go beyond the findings. Ultimately, the results of this study may serve as the basis for future studies.

Another limitation recognized during the conduct of this study is that traditional-length courses met only once a week versus compressed courses that met more than once a week during the term duration in which more distractions could occur. Furthermore, differences based on instructor were not examined such as instructional design and delivery angle. Variation exists among faculty who taught courses included in the study. No accounting for these variations was made. Carman and Bartsch (2017) recognized the importance of different instructional methods on the results of a course-level analysis.

Additionally, this study was limited to students who took the Anatomy and Physiology I and II courses. Findings may be different among students studying other subjects. A further limitation is that students may have taken the course more than once (course repeaters) may have been included in the data more than once. Findings reflect any multiple attempts made by students who took A&P I and II for different course durations. Preexisting knowledge was not accounted for in this study and so findings are limited to grade and passage or failure outcomes without controlling for preexisting knowledge as a confounding variable. Lastly, a limitation that needs to be pointed out, is that the study included courses taken by students during the COVID-19 pandemic. Any elements which may have impacted students and their grades were not taken into account.

CONCLUSION

Although at various course term durations there existed small differences, the largest differences existed between the 5-week and the 16-week course duration. This investigation found that A&P I and II courses are congruent with that of previous studies. CL did not represent a contributing factor to the reduced course time frame. As noted from the results, students performed better in a 5-week, as opposed to an 8-week or a 16-week course. These findings do not affirm cognitive load theory when only course duration, and no other possible confounding factors, are considered.

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APPENDIX**Table 1**

Grades by Course Duration Crosstabulation

	Weeks						Total N
	5		8		16		
Grade	N	%	N	%	N	%	N
0	751	18.1%	459	20.1%	8411	33.3%	9621
1	212	5.1%	114	5.0%	1889	7.5%	2215
2	553	13.3%	337	14.8%	3952	15.7%	4842
3	1127	27.2%	579	25.4%	5825	23.1%	7531
4	1503	36.3%	791	34.7%	5153	20.4%	7447
Total	4146	100.0%	2280	100.0%	25230	100.0%	31656

Table 2

Analysis of Grades by Course Duration (n = 31,656)

	MR	M	SD	Mdn	n
5-week	19005.23	2.58	1.47	3.00	4146
8-week	18494.83	2.50	1.50	3.00	2280
16-week	15065.52	1.90	1.56	2.00	25230
	MRD				
5-weeks to 8-weeks	510.40				
5-weeks to 16-weeks	3939.71				
8-weeks to 16 weeks	3429.31				

Table 3

Post Hoc Two-Group Analysis of Grades by Course Duration (n = 31,656)

	n	MR	MRD	Asymp. Sig.	Adj. p	Decision
5-week to	4146	3236.50	64.83	.048	.017	retain
8-week	2280	3171.67				
5-week to	4146	16608.94	2236.02	< .001	.017	reject
16-week	25230	14372.92				
8-week to	2280	15421.40	1816.45	< .001	.017	reject
16-week	25230	13604.95				

Table 4

Pass Fail by Weeks Crosstabulation (N = 31,656)

		Weeks						Total N
		5		8		16		
		N	%	N	%	N	%	
Fail	0	751	18.1%	459	20.1%	8411	33.3%	9621
Pass	1	3395	81.9%	1821	79.9%	16819	66.7%	22035
Total		4146	100.0%	2280	100.0%	25230	100.0%	31656