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Learning style versus time spent studying and career choice: Which is associated with success in a combined undergraduate anatomy and physiology course?

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Abstract

The VARK learning style is a pedagogical focus in health care education. This study examines relationships of course performance vs. VARK learning preference, study time, and career plan among students enrolled in an undergraduate anatomy and physiology course at a large urban university. Students ($n = 492$) from the fall semester course completed a survey consisting of the VARK questionnaire, gender, academic year, career plans, and estimated hours spent per week in combined classroom and study time. Seventy-eight percent of students reported spending 15 or fewer hours per week studying. Study time and overall course score correlated significantly for the class as a whole ($r = 0.111$, $P = 0.013$), which was mainly due to lecture ($r = 0.118$, $P = 0.009$) performance. No significant differences were found among students grouped by learning styles. When corrected for academic year, overall course scores (mean $\pm$ SEM) for students planning to enter “medicines” ($79.89 \pm 0.88\%$) were significantly higher than those of students planning to enter physical/occupational therapies ($74.53 \pm 1.15\%$; $P = 0.033$), as well as nurse/physician assistant programs ($73.60 \pm 1.3\%$; $P = 0.040$). Time spent studying was not significantly associated with either learning style or career choice. Our findings suggest that specific career goals and study time, not learning preferences, are associated with better performance among a diverse group of students in an undergraduate anatomy/physiology course. However, the extent to which prior academic preparation, cultural norms, and socioeconomic factors influenced these results requires further investigation.

Keywords

gross anatomy education; undergraduate education; anatomy and physiology course; A&P; VARK; undergraduate education; science education; time management; learning styles

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INTRODUCTION

Examination of student learning styles with respect to the learning environment continues to be a pedagogical focus among educators. Learning styles, or learning preferences, defined by Kocinski (1984) are an individual's preferred way to learn and the way that the individual learns best. Sewall (1986) further defines learning style as a hypothetical construct that is intended to help explain the learning process; it is an individual's unique way of interacting with the environment.

Since the publication of these early works, methods of assessment of learning styles have expanded dramatically. The use of learning styles spans the entire field of education – from kindergarten through graduate and professional programs. This extensive emphasis on learning styles, however, is not without controversy. Coffield et al. (2004) concludes that many of the most popular learning style assessment tools rate poorly with respect to internal consistency, test-retest reliability, and construct and predictive validity. Paschler et al. (2009) concludes that although adults and children exhibit learning preferences, there is little experimental evidence to support that specifically matching a student's learning style, or preference, with a method of teaching will result in improved academic performance.

Despite the concerns raised in these reviews, evaluation of students' learning styles continues. In higher education, the shift away from "teacher centered" to "student centered" learning may be promoting continued use of these evaluations (Kharb et al., 2013; Matthies and Jensen, 2014; Prithishkumar and Michael, 2014). In student-centered classrooms, it is reasonable to assume that instructors benefit from understanding how their students' learning styles differ from their own (de Raadt and Simon, 2011). Indeed, among students enrolled in pre-health/health care curricula, learning style assessments have revealed gender differences (Breckler et al., 2009; Nuzhat et al., 2013), cultural and demographic differences (James et al., 2011; Mustafa et al., 2013), and differences among students pursuing different health care specialties subspecialties (Murphy et al., 2004; Meehan-Andrews, 2009). Students' learning styles may change as they progress and are exposed to different curricular demands (Kell and van Deursen, 2002; Alkhasawneh, 2013). Furthermore, some evidence suggests that an association exists between students' specific learning style and psychological well-being, which could affect academic performance (Burger and Scholz, 2014). Therefore, the use of learning styles to assess students' varied styles may be beneficial with respect to optimizing the learning environment.

One learning preference that is not specifically addressed in either of the extensive reviews by Coffield et al. (2004) or Pashler et al. (2009) is the VARK learning preference questionnaire (Fleming and Mills, 1992). The acronym VARK refers to visual (V, prefer graphics or pictures), aural (A, listening and discussing), read/write (R, prefer reading and writing), and kinesthetic (K, physically handle) categories. The reason for this exclusion is unclear, although the Coffield, et al. (2004) review does reference the modalities of visual, auditory, kinesthetic, and tactile as part of a constitutionally based (fixed or genetic) family of learning styles. The VARK preferences are related to these sensory modalities. It is easy to administer and freely accessible on the internet. When administered online, results can be obtained immediately after completion (Fleming, 2011). Within the past decade this

questionnaire has been used extensively to evaluate students' learning preferences in pre-health/health care curricula (Murphy, 2004; Lujan and DiCarlo, 2006; Breckler et al., 2009; Meehan-Andrews, 2009; Dobson, 2010; Skinder-Meredith, 2010; Koch et al., 2011; Bareither et al., 2013).

The VARK questionnaire has been validated for use in identifying student learning preferences, although caution has been advised regarding its use in research (Leite et al., 2010). However, a number of investigators have utilized the VARK questionnaire to explore relationships between VARK learning preferences and academic performance among health care students. Reported results are variable. For example, the kinesthetic learning preference was found to be a positive predictor of academic performance in a clinically based, hands-on training program for nursing students (Koch et al., 2011). In physiology courses, kinesthetic learners performed the poorest (Dobson, 2009; 2010) and aural learners performed the best, particularly when the courses had a heavy lecture component (Dobson, 2009). Aural learners performed the best in a dental biostatistics/research design course, where lecture attendance was required in order to take the final exam (El Tantawi, 2009). In a problem-based nursing course that utilized multiple learning modalities, multimodal learners (those preferring two or more preferences) scored the highest in the course (Alkhasawneh et al., 2008). These studies suggest that academic success may be greater for the students whose learning preference happens to match a significant or dominant component of the course. However, among medical students, no association was found between learning preference and overall GPA (Baykan and Nacar, 2007) or historic academic performance (Urval et al., 2014). Among pre-health care students, Bareither et al. (2013), found no significant differences in pre- and post-test scores among a small group of students of different learning preferences who studied anatomy supplemented with either kinesthetic or read-write modalities. Given these inconsistencies, it is possible that factors other than matching learning style with teaching methodology are contributing to academic success.

One would expect that the amount of time spent studying would affect student success. However, increased amount of time spent studying is only associated weakly with higher grades. The association is stronger if quality of study, class attendance, prior preparation, and motivation are also considered (Schuman et al., 1985; Plant et al., 2005; Credé and Kuncel 2008; Diseth et al., 2010). Motivation may be influenced by career plans. For example, student performance in a psychology course was better among students planning to continue psychology studies compared to those choosing different careers (Diseth et al., 2010). Given the stiff competition for acceptance into professional health care programs (AAMC, 2014; APTA, 2014; PAEA, 2014), it is reasonable to assume that motivation to invest time to study may be higher among students competing for spots in these programs. It is also reasonable to assume that students may invest more time studying if they enjoy their coursework. Providing course materials and learning environments that appeal to different VARK learning styles may make courses more enjoyable (Murphy et al., 2004), which could encourage additional study time and perhaps improve study quality for some. To date, however, it is unclear if a significant relationship exists between VARK learning style and the amount of time students spend studying, and whether or not this influences academic performance.

The purpose of this study was to determine the amount of time spent studying among students in an undergraduate anatomy and physiology course and to report the distribution of time spent studying among students categorized by different learning styles and career choices. Secondly, we wished to determine whether a significant relationship existed between course performance and one or more of the following: (1) reported time spent studying, (2) one or more career plans, and (3) one or more VARK learning preferences.

The authors hypothesized that: (1) for the class as a whole, students who spent the most time studying would perform the best; (2) career choice and VARK learning style preference would each be associated with differences in course performance, specifically, that these differences would be mediated by the amount of time each group of students spent studying; (3) students who were preparing to enter competitive health care programs with highly specific selection criteria would report the greatest amount of time spent studying, and would perform the best overall; and (4) students whose learning styles matched the course material with the greatest availability would study the most and perform the best overall.

METHODS

Students and course design

A total of 559 students enrolled in a five-credit undergraduate 200-level combined anatomy and physiology course were invited to participate. The study was approved by the Institutional Review Board of the University of Illinois at Chicago. Students ranged from sophomore through graduate status. Due to pre-requisite requirements, no freshmen were enrolled in the course. Students were given informed consent prior to voluntary participation.

The course consisted of combined lecture and laboratory taught during a 15-week semester. The lecture component consisted of a series of anatomy lectures followed by a series of physiology lectures delivered four days/week for 50 minutes per day in alternating blocks of related subject material. All lectures and discussions (described below) were recorded live through a lecture capture program that enabled students to view projected slides simultaneously with audio; the audio was also available through *iTunes* (Apple, Inc., Cupertino, CA). Lectures were of two types (1) new content delivery by the instructor to the student; (2) discussion or “tutorial” lectures where the instructor presented case studies or scenarios based on the previous block of new content material. In these discussions, an instructor-driven question and answer format was used to guide students through application of the lecture content to solve the scenario. Discussions followed blocks of new content lecture material and averaged one per week. Student attendance was strongly encouraged, but not mandatory. Lecture captures were made available within one hour after lecture delivery, and were available to all students throughout the remainder of the semester.

The laboratory component consisted of a weekly 100-minute anatomy laboratory session in which cadaver dissections, models, and select tissue slides were provided for viewing and handling. A custom laboratory manual provided structure lists and descriptions. After a brief summative lecture by the teaching assistants to introduce students to the weekly topic, students were expected to independently identify and study structures. Students did not

dissect, but were allowed and encouraged to handle and critically examine all specimens and models. Teaching assistants remained in the laboratory to help students identify structures on the cadaver, slides, and on models, but no additional formal activities were conducted. Attendance in laboratory was strongly encouraged, but not mandatory, and students were not required to remain in the classroom for the entire laboratory period. Additional hours of supervised laboratory time were provided during the two weeks prior to each of three unit examinations (described below). Supervision was provided by faculty and/or teaching assistants who were available for questions and who, when asked by students, implemented informal question and answer dialogues to assist with their learning. Students were allowed to register and attend an additional two hours/week for each of the two weeks prior to each examination. This was done to allow all students an equal opportunity to attend additional laboratory study hours while complying with fire codes. The maximum *additional* laboratory study time a student could attend was 12 hours for the semester. Sign up and attendance were monitored by the senior, supervising teaching assistant for the course. Additional anatomical models were available in a small study room that was open during normal business hours each week.

Course performance was assessed by examination. Assessment of lecture material consisted of four multiple-choice examinations, including three unit and one comprehensive final. The final lecture examination was administered the week after the 15-week instructional period. The difficulty of these questions varied. Some involved simple recall, but others required students to compare and contrast certain systems, interpret figures, calculate, and occasionally predict an outcome given a simple scenario. Assessment of laboratory material consisted of three practical examinations administered during the same week as each unit lecture examination. Students identified structures and/or named a basic function of a structure at each station; the answers were written on a blank answer sheet. No word bank was provided. Students were given one minute at each station to answer the question. Of the seven total examinations, 58% of the total points were from lecture and 42% of the total points were from the laboratory component of the course. Letter grades are assigned as follows: 89.5 – 100% = A, 79.5 – 89.4% = B, 69.5 – 79.5% = C, 59.5 – 69.4% = D, 59.4% and below = F.

Questionnaire

Students completed one, two-part survey administered during the eleventh and twelfth weeks of the 15-week semester. This time was chosen as it was immediately after the drop date for the semester, so that all remaining students were most likely to complete the course. All students were informed of the opportunity to participate in this survey during the tenth week of the semester through an electronically submitted announcement containing an Institutional Review Board approved study information sheet. The paper and pencil survey was administered to each student once during laboratory sessions by two of the authors (G.J.F. and E.M.); completion of the survey took approximately 15 minutes. Students who completed the survey received one point extra credit toward their final grade (0.25% of final grade).

The first part of the survey was composed of the 16-question VARK sensory modality questionnaire, version 7.1 (Fleming, 2011), which identified the visual, aural, read/write, and/or kinesthetic learning preferences of the students. Students were categorized as multimodal (M) if they exhibited two or more strong preferences. The multimodal categories were further subdivided into bimodal (two strong preferences), trimodal (three strong preferences), and quadmodal (all four preferences).

The second part of the survey consisted of questions asking students to identify gender, academic year, future career plans, and the amount of time they spent studying for this specific course. Additional questions were asked concerning additional courses taken and perceived level of coursework difficulty among five-credit classes. However, only the data from the four questions of gender, academic year, future career plans and time spent studying are included for analysis in this study.

To identify career plans, students were asked to select from one of nine career choices. A tenth career choice was labeled “other” with a space allotted that allowed students to write in choices not included on the list. For analysis, career plans, including those that emerged from the “other” category, were grouped according to similarities in type of work, amount of continued training, and/or application requirements. For example, medicine, dentistry, optometry, and pharmacy are grouped together as all have a specialty-specific entrance examination for admission. Nutrition students are admitted to our department under a specific set of criteria that differs from other undergraduate students. Groups which include all career choices selected by students are listed in Table 1.

Students were also asked to estimate the amount of time spent studying per week in hours. The specific question was, “Please select the BEST overall estimate of the amount of time spent studying per week (in hours) for KN 251, including lecture attendance, your enrolled laboratory session, open/review lab sessions, and time spent studying independently.” To assist with the hourly estimates, students were presented with the following choices: 5 hours or fewer, 6–10, 11–15, 16–20, 21–25, 26–30, or greater than 30 hours per week. The choice to include all of these activities as a single “study time” question, rather than separate class time vs. independent study time was due to the active involvement and availability of the teaching staff in class discussions, supervised study time (described above), and outside of normal class time (e.g. office hours, tutoring, and email availability). The authors felt that distinguishing “in class” from “independent” invested study time would be difficult given the involvement of the department’s highly attentive teaching staff. Furthermore, some evidence exists that lecture attendance correlates with academic performance (Schuman et al., 1985, Horton et al., 2012). Student questionnaires were tabulated and scored to determine the amount of time spent studying, gender, year in school, and the specific career plan. VARK preferences were also tabulated according to the stepping stone method (Fleming, 2006).

Statistical analysis

Pearson correlations were used to compare time spent studying and examination scores. Cross-tabulations and chi-square tests were used to compare distributions of reported study time among students of different learning styles and career choices, as well as the VARK

distributions for gender and academic year in school. Comparisons of mean examination scores of students among career choices and learning preferences grouped by modality were made using one way analysis of variance with post hoc Tukey's HSD where Levene's test indicated equal variances and Games-Howell for unequal variances. Additionally, for all multimodal learners (bi-, tri-, and quad-modal), each individual sensory modality score for each student was calculated as a percentage of that student's total VARK score. This created a continuous variable for each sensory modality among all multimodal learners. Pearson correlations could then be used to compare the relationship between each sensory modality of multimodal learners with examination scores and time spent studying. This eliminated the multiple groups of uneven sizes for different combinations of V, A, R, and K, while still allowing the comparison of relative modality preferences against time and examination performance. Because our students were of varied academic backgrounds, analysis of covariance with post hoc Bonferroni adjustments was performed to determine the influence of year in school on any significant differences in course performance among students grouped by career choice or learning preference. A mediation analysis using robust regressions due to the skewness of the data was used to determine if learning styles and career choice independently influenced the amount of time spent studying, and overall examination scores. Statistics were performed using SPSS statistical package, version 22 (IBM Corp., Armonk, NY) and SAS, version 9.3 (SAS Institute, Cary, NC) statistical packages.

RESULTS

Participants in the study

All of the 559 enrolled students were invited to participate. Of these, 492 (88.0%) gave consent and completed the questionnaire for the study. Females numbered 342 (69.5%). A total of 131 (26.6%) were sophomores, 217(44.1%) were juniors, 113 (23.0%) were seniors, and 31 (6.3%) were graduate students. Table 1 shows the distribution of students grouped by gender and academic year among different career choices.

Learning style characteristics

The majority of students (57%) in this study exhibited two or more learning preferences (Table 2). The largest unimodal preference was kinesthetic, with 41% of the 213 unimodal learners choosing this preference. The distribution of learning styles among students was not significantly different between males and females ($\chi^2 = 6.422$, $P = 0.093$) or among students ranked by academic years ($\chi^2 14.048$, $P = 0.726$). As for unimodal learners, multimodal learners exhibited a slight bias toward the kinesthetic preference. Mean ($\pm$ SD) for each learning style expressed as a percentage of total VARK sum were: 22.14 ($\pm 9.08\%$), 25.16 ($\pm 8.5\%$), 25.25 ($\pm 8.8\%$), and 27.45 ($\pm 7.4\%$) for V, A, R, and K, respectively.

Reported study time

The majority of students (78%) reported investing 15 or fewer hours per week both in and outside of class for this five-credit laboratory and lecture course. Forty one percent reported spending 6–10 hours per week. An additional 30% reported studying 11–15 hours per week. The reported time was similar regardless of the year in school ($\chi^2 = 17.938$, $P = 0.653$).

When grouped by learning style, the distribution of time spent studying among students of different learning styles was not significantly different (Table 3). However, examination of Table 3 shows some trends. The majority of unimodal kinesthetic learners (82%) reported studying 6–15 hours per week compared to approximately two-thirds of other unimodal learners. However, the number of aural learners spending 16 or more hours per week was 28%, which was greater than all other types of learners. When examined by career, the number of students studying from 6–15 hours ranging from 54.1% for those in the “Other” category to 83.4% of the small number of students in the graduate school category (Table 4).

Course performance

Mean ($\pm$ SEM) for the overall course score was 76.27% ($\pm$ 0.62) which corresponded to a grade of C in the course. Mean ($\pm$ SEM) for the laboratory performance 84.23 ($\pm$ 0.59) was significantly better than lecture performance 70.51 ($\pm$ 0.70%; $P = 0.000$). Course performance was associated significantly with study time, ($r = 0.111$, $P = 0.013$). The association was retained for lecture alone ($r = 0.118$, $P = 0.009$) but not for laboratory examinations ($r = 0.087$, $P = 0.055$). Mean ($\pm$ SEM) overall course performance was consistent among males vs. females, and sophomores, seniors, and graduate students, but was lower for juniors compared to seniors and graduate students only (Table 2).

The relationship between course performance and learning style was not significant for either multimodal or unimodal groups for laboratory, lecture, or overall scores (Figures 1 and 2). However, a trimodal student who scored exactly the mean for this group would have been only 0.6% percentage points below what would have been awarded a grade of B. Among unimodal students, an aural student who scored exactly the mean for this group would have been only 1.2% points away from a B, whereas a kinesthetic student would have had to improve by 5.8 percentage points.

The relationship between overall course performance and career choice demonstrated a significant difference in performance, with students planning to enter nutrition/dietetics and medicines each performing significantly higher than those of students planning to enter physical/occupational therapies or nursing/physician assistant programs. However, when controlled for year in school, this relationship remained significant only for students choosing to pursue medicines (Figure 3). A student who scored exactly the mean for both nutrition/dietetics and medicines would have earned a B, whereas a research student who scored exactly the mean for that group would have earned a D.

Learning style and career choice versus time spent studying

To explore a mediation effect of study time to the relationship between (1) learning style and course performance, and (2) career choice and course performance, robust regression analysis was performed. The analysis confirmed the positive effect of time spent studying on overall performance among all students in the course ($\chi^2 = 4.51$, $P = 0.034$). However, there was no independent influence of either learning styles categorized by modality or career choices on the amount of time spent studying (Tables 5 and 6). Among multimodal students, no single modality preference demonstrated a relationship that was significant when compared to time spent studying or course performance (Table 7).

DISCUSSION

Academic performance in our undergraduate combined anatomy and physiology course is associated with increased time spent studying and differs among select career choices, but is not associated with VARK learning style. To our knowledge, this is the first study to specifically evaluate the academic performance of a single cohort of pre-health care students with respect to their reported time spent studying, career choice, and VARK learning styles.

Reported study time and academic performance

The positive correlation between reported study time, including time spent in the classroom with instructors, was fairly weak, but significant. However, this finding is consistent with similar weak, but significant, associations reported for undergraduate students of different majors (Schuman et al., 1985; Credé and Kuncel, 2008). The survey question asked students to combine both in-class and out-of-class study time, therefore, students reporting ten or fewer hours per week of studying would have invested little more than the allotted class time. This could potentially have confounded results. However, class attendance has been shown to be a weak predictor of performance by some (Horton et al., 2012), and a slightly stronger predictor of academic performance than outside study time by others (Schuman et al., 1985). Teacher-guided lecture and laboratory learning experiences have also been shown to be positive indicators of course performance (Selvig et al., 2015). Therefore, directed classroom instruction and instructor interaction may itself have contributed to student success for students who chose to attend lecture and laboratory sessions.

The correlation between laboratory performance and time spent studying was very weak, and approached, but did not reach significance. This might be related to the construct of the laboratory component of the course. The laboratory is designed to encourage interaction and discussion among peers and instructors. This type of “active” or “meaningful” learning is associated with academic success (Michael, 2006). This may have promoted efficient, rather than prolonged use of time. However, successful performance on laboratory examinations primarily required recall and recognition of tagged laboratory structures with very limited higher level thinking involved. Given that this is an undergraduate course with only a handful of enrolled graduate students, the investment of students’ time may have been sufficient only to achieve this level of learning (Aharony, 2006). Lecture questions, although multiple-choice, did require higher level critical thinking skills to answer successfully. Greater critical thinking skills are associated with improved course performance (Pizzimenti and Axelson, 2015), but assimilation of knowledge through critical analysis of material may require substantially more time (Meyer, 2003) and be a reflection of age and maturity (Aharony, 2006). The study survey did not ask students to differentiate time spent on lecture vs. laboratory material, nor were specific study methods assessed. Therefore, although the investment of time may have resulted in increased critical analysis by some, it cannot be determined the degree to which this or other factors such as efficient active learning, or level of cognitive skill assessment contributed to the difference between laboratory and lecture performance.

Learning styles, reported study time, and academic performance

Academic performance, regardless of type of examination (lecture or laboratory) was similar among students grouped by learning styles in this study, and was not influenced by the amount of time of materials were available. Academic performance has been shown by some to be significantly better for students whose learning style matches the dominant course component (El Tantawi, 2009; Dobson, 2009, 2010; Koch et al., 2011). The kinesthetic learning preference has been positively associated with academic success in courses where the bulk of the students' time is spent in kinesthetic activities (Koch et al., 2011) and negatively associated with performance when kinesthetic activities are de-emphasized (Good et al., 2013). In this course, interactive discussions and handling of the material is encouraged in the laboratory. Theoretically, because of the limited availability of these materials, kinesthetic students' performance and time spent studying could have been negatively impacted. In contrast, visual, aural, and read-write learners have material that matches their learning style available at all times of the day. However, within this cohort of students, no significant relationships between time, learning style, and performance were found among any of the learning styles.

Students' academic progression, or possibly assessment techniques, might also explain the differences between findings in the aforementioned studies and these data. The significant associations between VARK learning styles and academic performance have been reported primarily among cohorts of professional students such as nursing and dentistry (Alkhasawneh et al., 2008; El Tantawi, 2009; Koch et al., 2011) who are engaged in higher level coursework. Indeed, relationships between VARK learning styles and performance were found only among advanced students enrolled in higher level courses, but not among those enrolled in general biology courses (Good, et al., 2013). Course structure in higher level classes may be different, requiring greater engagement and application to ensure success (Good, et al., 2013; Pizzimenti and Axelson, 2015). It is possible that as students progress, so do their learning preferences as they adapt to different curricular demands (Kell and van Deursen, 2002, Alkhasawneh, 2013), mature (Ahoney, 2006), and understand the importance of coursework on their future career (Diseth et al., 2010, Selvig et al., 2015). Among studies examining large undergraduate cohorts similar to this one, it should be noted that although a significantly lower performance among kinesthetic learners has been reported (Dobson, 2009, 2010), this difference was maintained only among students who *perceived* themselves to be kinesthetic learners. When these students were *assessed* as kinesthetic learners via the VARK questionnaire, the difference was not significant (Dobson, 2010). Additionally, the use of multiple-choice (lecture) and written recall (laboratory) as a method of assessment may have limited sufficient evaluation of all modalities (Ramirez, 2011). Therefore, among diverse undergraduate students enrolled in very large classes where logistics may limit assessment methods, the influence of learning styles may be more difficult to discern.

Career choice, reported study time, and academic performance

When grouped by career choice, differences in performance between some groups of students did emerge (Figure 3). However, contrary to our expectations, career choice did not influence study time. This suggests that within this cohort of students, irrespective of the

time spent studying and/or VARK assessed learning style, the students who performed the best regardless of academic year in school were those who were pursuing what are perceived to be highly demanding careers.

Students attending University of Illinois at Chicago are from varied socioeconomic and cultural backgrounds. A higher level of performance among students pursuing medicines could be due to prior preparation and experience (Diseth et al., 2010, Selvig et al., 2015), class attendance (Schuman et al., 1985), and quality of study skills (Plant et al., 2005; Crede and Kuncel, 2008, Selvig et al., 2014), or motivation. However, each of these factors themselves could have been influenced by socioeconomic status (Aharony, 2006) and cultural norms (James et al., 2011; Kharb, et al., 2013; Mustafa et al., 2013). This study did not evaluate cultural and socioeconomic variables with respect to academic performance, therefore, the degree to which these variables influenced academic performance among students choosing various careers cannot be assessed.

Study limitations

One of the main questions in this study involved the amount of time students spent studying. This information was gathered by self-reporting, which may not always be reliable (Nasby, 1989). This could especially be true for busy undergraduate students enrolled in multiple courses, where study time for each course likely varies per week. The variable numbers of students in different career choices may have affected the significance of performance comparisons. Furthermore, students were given an incentive of one point toward their grade for their participation. It is possible that some students simply answered the questionnaire just to receive the bonus point without investing thought into their responses.

The educational background of students may have influenced performance. Students of all academic years reported similar amounts of study time, however, only juniors (and not sophomores) struggled significantly with performance compared to upperclassmen (Table 2). It is possible that this is an effect of the number of junior-level transfer students who completed pre-requisite courses at different institutions with different instructional emphases. Since both academic and experiential preparation, as well as management of time and study environment (Pizzimenti and Axelson, 2015; Selvig et al., 2015) can influence performance, it is possible that these factors influenced the performance of a number of junior-level students.

CONCLUSION

Academic performance among undergraduate students enrolled in an anatomy and physiology course is associated with time spent studying and career choice, but is not associated with VARK learning styles. The amount of time most students choose to study is limited, but these limitations appear unrelated to career choices or to the availability of specific teaching modalities. The extent to which these factors are related to prior preparation, individual study habits, or cultural and socioeconomic factors warrants further investigation.

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Figure 1.

Laboratory, lecture, and overall scores (mean $\pm$ SEM) for students grouped by learning preferences. Values represent percentages of total points for that component of the course. No significant differences were found between scores of students with different learning styles for laboratory ($P = 0.745$), lecture ($P = 0.244$), or overall score ($P = 0.370$).

Figure 2.

Laboratory, lecture, and overall scores (mean $\pm$ SEM) for unimodal students. Values represent percentages of total points for that component of the course. No significant differences were found between scores of students with different learning styles for laboratory ($P = 0.078$), lecture ($P = 0.422$), or overall score ($P = 0.239$).

Figure 3.

Overall scores (mean $\pm$ SEM) for students grouped by career choices. Values represent percentages of total for that component of the course. ^aScores of students' career choice of Medicines are significantly greater than Therapies ($P = 0.033$) and Nurse/PA ($P = 0.040$) when adjusted for year in school. ExTraining = Exercise Training, PA = Physician Assistant.

Table 1

Student career choice groups and academic year in school.

Group Name n (males)	Group Description	Sophomores (%)	Juniors (%)	Seniors (%)	Graduate (%)
Ex Training n = 14 (6)	Exercise Physiology, Personal Training	7.1	71.4	0	21.4
Research n = 6 (3)	Graduate Research	16.7	16.7	33.3	33.3
Medicines n = 170 (54)	Dentistry, Medicine, Optometry, Pharmacy	13.5	44.1	37.6	4.7
Therapies n = 153 (60)	Occupational and Physical Therapy	29.4	52.3	15.7	2.6
Nurse/PA n = 105 (17)	Nursing, Physician Assistant	55.2	28.6	13.3	2.9
Nutrition n = 20 (2)	Nutrition/Dietetics	0	30	25	45
Other n = 24 (8)	Other: Health Information Management (n = 2), Law (n = 1), Medical Illustration (n = 1), Orthotics/Prosthetics (n = 1), Oriental Medicine (n = 2), Public Health (n = 1), No-response or undecided (n = 16)	12.5	62.5	16.7	8.3

n = number of students in each career group with the number of males denoted in parenthesis; total n = 492; academic level in school data is presented as percentage of the number of students in that career group;

VAR K distribution and course performance among students grouped by independently by gender and academic year.

Table 2

Groups	Unimodal (n = 213)				Multimodal (n = 279)			Grades (%)
	V (n = 19)	A (n = 61)	R (n = 45)	K (n = 87)	Bimodal (n = 92)	Trimodal (n = 62)	Quadmodal (n = 125)	
Females (n = 342)	4.7	12.6	8.5	16.4	17.3	14.9	25.7	77.02 (±0.70)
Males (n = 150)	2.0	12.0	10.7	21.3	22.0	7.3	24.7	74.55 (±1.24)
Sophomores (n = 131)	2.3	11.5	8.4	22.1	16.0	13.0	26.7	75.68 (±1.11)
Juniors (n = 217)	3.7	12.9	9.2	16.6	21.2	11.5	24.9	74.33 (±1.01)
Seniors (n = 131)	5.3	15.9	8.8	17.7	15.9	12.4	23.9	79.12 (±1.09) ^a
Graduate (n = 31)	6.5	0.0	12.9	9.7	22.6	19.4	29.0	81.95 (±2.47) ^a

Numbers are expressed in percentages of total number of students within each group; total $n = 492$.

^aSignificantly different than juniors ($P = 0.008$ seniors vs. juniors; $P = 0.032$ graduate students vs. juniors).

V = visual, A = aural, R = read/write, K = kinesthetic.

Table 3

Self-reported time spent studying among students grouped by learning style.

Time (hours)	Unimodal (n=213)				Multimodal (n=279)		
	V (n=19)	A (n=61)	R (n=45)	K (n=87)	Bimodal (n=92)	Trimodal (n=62)	Quadmodal (n=125)
no report				1.1		3.2	0.8
5	10.5	6.6	8.9	3.4	7.6	8.1	10.4
6-10	36.8	41.0	42.2	52.9	33.7	45.2	36.0
11-15	31.6	24.6	24.4	28.7	34.8	25.8	31.2
16-20	0.0	14.8	15.6	5.7	15.2	8.1	13.6
21-25	10.5	9.8	8.9	6.9	4.3	6.5	4.0
26-30	0.0	1.6	0.0	1.1	2.2	3.2	2.4
31	10.5	1.6	0.0	0.0	2.2	0.0	1.6

Numbers are percentages of students grouped by learning style; total $n = 492$.

$\chi^2 = 44.849, P = 0.343; V = \text{visual}, A = \text{aural}, R = \text{read/write}, K = \text{kinesthetic}$

Table 4

Self-reported time spent studying among students grouped by career choice.

Time (hours)	Exercise Training (n=14)	Graduate School (n=6)	Medicines (n=170)	Therapies (n=153)	Nurse/PA (n=105)	Nutrition (n=20)	Other (n=24)
no report			0.6		1.9		4.2
5			10.6	5.9	7.6		12.5
6-10	50.0	66.7	43.5	41.2	33.3	50.0	33.3
11-15	28.6	16.7	28.8	30.1	33.3	20.0	20.8
16-20	7.1		11.2	11.1	13.3	15.0	16.7
21-25	7.1		3.5	8.5	6.7	15.0	4.2
26-30	7.1		0.6	1.3	3.8		4.2
31		16.7	1.2	2.0			4.2

Numbers are percentages of students in each group; total $n = 492$.

$\chi^2=47.587$, $P = 0.256$; PA = Physician Assistant.

Table 5
Robust regression analysis of the effect of learning style on the amount of time spent studying.

Learning style	Coefficient	Standard Error	95% Confidence Limits		Chi-Square statistic	P-value
Intercept	2.5732	0.0982	2.3807	2.7657	686.34	<0.0001
V (<i>n</i> = 19)	-0.1504	0.2704	-0.6803	0.3796	0.31	0.5782
A (<i>n</i> = 61)	0.1059	0.1715	-0.2303	0.4420	0.38	0.5370
R (<i>n</i> = 45)	0.0391	0.1909	-0.3351	0.4133	0.04	0.8377
K (<i>n</i> = 87)	-0.1070	0.1528	-0.4065	0.1925	0.49	0.4837
Bimodal (<i>n</i> = 92)	0.1337	0.1509	-0.1619	0.4294	0.79	0.3753
Trimodal (<i>n</i> = 62)	-0.1690	0.1706	-0.5034	0.1653	0.98	0.3217
Quadmodal (<i>n</i> = 125)	Reference	.	.	.	.	.

All values are referenced against the quadmodal learning style; *n* = 492. V = visual, A = aural, R = read/write, K = kinesthetic.

Table 6

Robust regression analysis for the effect of career choice on the amount of time spent studying.

Professional Plan	Coefficient	Standard Error	95% Confidence Limits		Chi-Square statistic	P-value
Intercept	2.5409	0.2271	2.0958	2.9859	125.23	<.0001
Exercise Training (<i>n</i> = 14)	0.1458	0.3741	−0.5874	0.8790	0.15	0.6967
Research (<i>n</i> = 6)	−0.3495	0.5077	−1.3446	0.6456	0.47	0.4912
Medicines (<i>n</i> = 170)	−0.0686	0.2426	−0.5440	0.4068	0.08	0.7774
Therapies (<i>n</i> = 153)	0.1465	0.2442	−0.3321	0.6252	0.36	0.5485
Nurse/PA (<i>n</i> = 105)	0.1985	0.2517	−0.2948	0.6917	0.62	0.4303
Nutrition/Dietetics (<i>n</i> = 20)	0.2942	0.3368	−0.3658	0.9543	0.76	0.3823
Other	Reference	.	.	.	.	.

All values are referenced against the “Other” career group; *n* = 492.

Table 7

Pearson correlation comparisons of examination performance (lecture, laboratory, and overall scores) and reported time spent studying vs. individual learning style preferences among multimodal learners

	Visual (V)		Aural (A)		Read/Write (R)		Kinesthetic (K)	
	r	P-value	r	P-value	r	P-value	r	P-value
Laboratory	-0.090	0.134	0.084	0.160	0.024	0.687	-0.015	0.798
Lecture	0.025	0.672	-0.001	0.988	0.018	0.759	-0.052	0.386
Overall score	-0.019	0.752	0.033	0.584	0.022	0.718	-0.040	0.503
Study time	-0.021	0.723	-0.025	0.673	-0.011	0.860	0.068	0.259

n = 279.