



Research Article/Araştırma Makalesi

The relationship between individual learning preferences and academic achievement: A VARK model perspective among physical education and sports teaching students

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Abstract

Understanding the relationship between learning styles and academic achievement among students in Physical Education and Sports Teaching programs is crucial for designing more effective and student-centered instructional approaches. Accordingly, the primary aim of this study was to examine pre-service teachers' individual learning styles and their relationship with academic performance. The study sample consisted of 548 undergraduate students from different year levels. Data were collected using a Personal Information Form and the VARK Learning Style Inventory (Version 7.0). The collected data were coded and analyzed using IBM SPSS Statistics (Version 27.0). Descriptive statistics were used to determine participants' demographic characteristics, dominant learning modalities, and learning model types. To examine the relationship between dominant learning styles and academic achievement, chi-square and Linear-by-Linear Association tests were employed. The findings revealed that students predominantly preferred kinesthetic and read/write-oriented learning styles, and a considerable proportion exhibited multimodal learning preferences. Although no direct significant relationship was found between dominant learning styles and academic achievement, the influence of learning models on performance was observed particularly among students with moderate academic achievement levels. In conclusion, while learning styles do not solely determine academic success among pre-service teachers in sports sciences, they appear to be an influential factor in shaping the quality and flexibility of the learning process. Therefore, it is recommended that teaching practices incorporate applied and multidimensional approaches that take students' individual learning preferences into account.

Keywords: Academic achievement, Sensory modality, Flexible teaching, Learning style, VARK

Bireysel öğrenme tercihleri ve akademik başarı ilişkisi: Beden eğitimi ve spor öğretmenliği bölümü öğrencilerinde VARK modeli perspektifi

Öz

Beden Eğitimi ve Spor Öğretmenliği programlarında öğrenim gören öğrenciler arasında öğrenme stilleri ile akademik başarı arasındaki ilişkinin anlaşılması, daha etkili ve öğrenci merkezli öğretim yaklaşımlarının tasarlanması açısından büyük önem taşımaktadır. Bu doğrultuda, araştırmanın temel amacı öğretmen adaylarının bireysel öğrenme stillerini belirlemek ve bu stillerin akademik başarı ile olan ilişkisini incelemektir. Araştırmanın örneklemini farklı sınıf düzeylerinde öğrenim gören toplam 548 lisans öğrencisi oluşturmaktadır. Veriler, Kişisel Bilgi Formu ve VARK Öğrenme Stili Envanteri (Versiyon 7.0) kullanılarak toplanmıştır. Elde edilen veriler kodlanarak IBM SPSS Statistics programı aracılığıyla analiz edilmiştir. Katılımcıların demografik özelliklerini, baskın öğrenme modalitelerini ve öğrenme modeli türlerini belirlemek amacıyla tanımlayıcı istatistikler kullanılmıştır. Baskın öğrenme stilleri ile akademik başarı arasındaki ilişkiyi incelemek için ki-kare ve Doğrusal-Doğrusal İlişki (Linear-by-Linear Association) testlerinden yararlanılmıştır. Araştırma bulguları, öğrencilerin ağırlıklı olarak kinestetik ve okuma/yazma odaklı öğrenme stillerini tercih ettiklerini ve önemli bir bölümünün çoklu (multimodal) öğrenme tercihinin sahip olduğunu göstermiştir. Baskın öğrenme stilleri ile akademik başarı arasında doğrudan anlamlı bir ilişki bulunmamakla birlikte, özellikle orta düzey akademik başarıya sahip öğrencilerde öğrenme modellerinin performans üzerindeki etkisinin daha belirgin olduğu tespit edilmiştir. Sonuç olarak, spor bilimleri alanındaki öğretmen adaylarında öğrenme stilleri tek başına akademik başarıyı belirleyen bir unsur olmamakla birlikte, öğrenme sürecinin niteliğini ve esnekliğini şekillendiren önemli bir faktör olarak değerlendirilebilir. Bu nedenle, öğretim uygulamalarında öğrencilerin bireysel öğrenme tercihlerini dikkate alan, uygulamaya dayalı ve çok boyutlu yaklaşımların benimsenmesi önerilmektedir.

Anahtar Kelimeler: Akademik başarı, Duyusal modalite, Esnek öğretim, Öğrenme stili, VARK

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INTRODUCTION

The fundamental aim of education is to facilitate individuals' learning processes and to enable them to access knowledge effectively. Understanding students' learning behaviors plays a critical role in developing and diversifying effective teaching strategies. Various theoretical approaches have been proposed to explain the dynamic nature of learning, which is rooted in individual differences. Among these, the concept of learning styles has gained increasing visibility in the educational sciences literature in recent years (İlçin et al., 2018). At the higher education level, growing ethnic, cultural, and academic diversity, coupled with the widespread adoption of distance education practices and the expansion of digital learning tools, has prompted educators to reconsider traditional instructional methods. In light of these developments, designing instructional models that take into account students' individual learning preferences is considered an influential factor in enhancing academic achievement (Romanelli et al., 2009).

The concept of learning style has been a subject of discussion since the 1970s (Griffiths, 2020) and is now widely recognized as a fundamental variable for understanding individual differences among learners. Learning styles are defined as the cognitive, affective, and psychosocial characteristics that shape how individuals perceive, interact with, and respond to learning environments (Robles et al., 2012). The quality of student-teacher interaction is one of the key factors that directly influence learning processes, and instructional environments that align with students' learning styles have the potential to enhance academic performance (Mohsenipouya et al., 2024). Conversely, when learning preferences are disregarded, students may experience a decline in motivation and academic achievement (Awang et al., 2017).

Learning preferences may influence academic performance; however, individuals' dominant learning styles can also be shaped by variables such as age, gender, and academic level (Khanal et al., 2019). In other words, both cognitive and social factors may play a role in determining a person's predominant learning style, as well as the use of sensory modalities that mediate the learning process. The VARK model developed by Neil Fleming provides a widely accepted framework for explaining how individuals receive and process information during learning. The acronym VARK stands for Visual, Aural, Read/Write, and Kinesthetic modalities, representing four primary dimensions through which learners are categorized based on their preferred sensory channels (Fleming & Bonwell, 2001, p. 1; Prithishkumar & Michael, 2014). Visual learners prefer diagrams, charts, and illustrations; aural learners benefit from listening and discussion; read/write learners favor text-based materials; and kinesthetic learners rely on movement, physical engagement, and hands-on experience (Urval et al., 2014).

According to Fleming and Bonwell, (2001, p. 1) a learning style is not a fixed personality trait but rather a tendency that reflects the sensory channels through which individuals most effectively acquire information (as cited in Yeşilyurt, 2019). Research indicates that most students do not adhere strictly to a single learning style; even when they exhibit a dominant preference, they often adopt a multimodal learning approach (Fahim et al., 2021). However, findings on the relationship between learning styles and academic achievement remain inconsistent. While some studies have reported no significant relationship, others have identified a positive association between the two variables (Mozaffari et al., 2020). Moreover, in recent years, several scholars have raised critical perspectives regarding the conceptual validity of the VARK model and its actual impact on academic performance (Pashler et al., 2009; Newton & Miah, 2017).

Criticisms of the VARK model primarily focus on its conceptual validity and the implications of directly integrating learning styles into instructional design. Some researchers argue that VARK oversimplifies individuals' cognitive processes and that treating learning styles as fixed categories contradicts the dynamic and multidimensional nature of learning (Pashler et al., 2009). Newton and Miah (2017) further contend that the so-called learning styles hypothesis the assumption that matching instructional methods to students' preferred styles enhances academic performance lacks sufficient empirical evidence. In other words, several studies have reported no significant effect of congruence between preferred learning style and instructional method on academic outcomes (Cuevas, 2015; Rogowsky et al., 2015). Nevertheless, claims that the VARK model is entirely ineffective have also been regarded as overgeneralized. Some studies suggest that awareness of learning styles may contribute to greater learner self-awareness, helping students organize and regulate their learning processes more effectively (Fleming & Mills, 1992; Coffield et al., 2004). Consequently, these contradictory findings in the literature underscore the need to further investigate the relationship between VARK learning styles and academic achievement across different samples and disciplinary contexts. Overall, this debate highlights that learning style research should not only aim to identify individual differences but also critically examine the effectiveness of instructional strategies in promoting meaningful learning.

Teaching processes and strategies in the field of sports sciences possess a complex structure in which cognitive knowledge and psychomotor skills are integrated. Students in this discipline benefit from cognitive learning processes in theoretical courses while simultaneously developing their knowledge and skills through motor learning in practical courses. Therefore, learning styles in this field may be associated not only with academic achievement but also with performance development.

Research in sports sciences has indicated that learning styles provide valuable insights into the relationship between training structure, individual differences, and achievement, and that students in this field tend to prefer kinesthetic and multimodal learning styles (Braakhius et al., 2015; Bostanci, 2020). However, some studies have also reported that the visual style is prominent among this group of students (Mareek et al., 2025). In a comparative study conducted by Türker and Bostancı (2023) involving students from Physical Education, Music, and Visual Arts Education programs, kinesthetic learning style was found to be dominant in both visual arts and sports disciplines, whereas aural and kinesthetic tendencies were more prevalent among music education students. Furthermore, the majority of pre-service teachers (61.2%) were found to adopt a multimodal

learning model. These findings demonstrate that sports sciences students exhibit diverse learning styles and that instructional strategies should be designed with consideration of these individual differences to support their developmental processes effectively. Consequently, examining the effect of learning styles on academic achievement is considered crucial for developing and planning instructional strategies that align with the nature of the sports sciences discipline.

In light of this literature, the present study aims to investigate the relationship between individual dominant learning styles, learning models based on the VARK framework, and academic achievement among students enrolled in Physical Education and Sports Teaching programs. Building upon both the theoretical and motor dimensions of sports sciences, the study seeks to describe the distribution of learning styles and to identify their potential effects on academic performance. Moreover, given the inconsistent findings in the literature regarding the direction of the relationship between learning styles and academic success within the VARK framework, this research aims to contribute to the ongoing debate through evidence derived from a sports sciences sample.

METHOD

Research design

This study was structured based on the relational survey model, one of the quantitative research approaches. Survey models aim to identify individuals' attitudes, preferences, and characteristics as they exist in their current state. Among these designs, the relational survey model specifically focuses on examining the relationships between two or more variables (Fraenkel et al., 2019, p. 11).

The VARK model, which describes individual differences in perceiving, processing, and learning information, provides researchers with a widely used framework for identifying learning styles in educational psychology research (Fleming & Baume, 2006). Accordingly, in the present study, the learning styles and preferences of students in the Department of Physical Education and Sports Teaching were considered as the independent variables, while their academic achievement performance during undergraduate education was defined as the dependent variable. In this context, the study aimed to determine the relationship between students' individual learning preferences and their academic achievement.

The design of this research is particularly significant given the dual theoretical and practical nature of the sports sciences discipline. By integrating both dimensions, the study aims to identify students' learning styles and examine their association with academic achievement. The contribution of learning styles to understanding individual differences provides a unique perspective in explaining variables related to academic performance within the literature. In light of this, the present study seeks to establish a foundation for both describing variations in students' learning styles and informing the development of individualized instructional programs, thereby contributing to more effective and learner-centered teaching designs in sports sciences education.

Research group

The population of this study consisted of pre-service teachers enrolled in the Departments of Physical Education and Sports Teaching at public universities in Türkiye. Referring to a similar study by Khanal et al. (2019), a power analysis was conducted using GPower* version 3.1.9.7. Based on a medium effect size (Cohen's $d = 0.5$), an alpha level of 0.05, and a power ($1 - \beta$) of 0.80, the minimum required sample size for the present study was calculated as 210 participants. The final study sample consisted of 548 students, indicating sufficient statistical power to detect meaningful differences. Initially, data were collected from 569 students studying in Physical Education and Sports Teaching departments at various state universities in Türkiye, who volunteered using a randomised method. After excluding incomplete or invalid responses ($n = 21$), the final sample comprised 313 males (57.1%) and 235 females (42.9%), with a mean age of 21.74 ± 2.61 years ($n = 548$).

Participants were distributed relatively evenly across academic years: first year ($n = 126$; 23.0%), second year ($n = 126$; 23.0%), third year ($n = 145$; 26.5%), and fourth year ($n = 151$; 27.5%). Regarding high school background, nearly half of the participants (49.5%) graduated from general high schools, followed by vocational high schools (17.2%), Anatolian high schools (13.1%), science high schools (7.8%), and sports high schools (12.4%). Participants' Higher Education Entrance Exam (YGS) scores ranged from 150 to 399 points, with the majority (39.8%) falling within the 200–249-point range. Their Grade Point Averages (CGPA) varied between 2.01 and 4.00, and 36.9% of the students were within the 3.01–3.50 CGPA range, indicating moderate to high academic performance (see Table 1). Ethical approval for this study was obtained from the Ethics Committee of Bayburt University/Türkiye (Decision No: E-51694156-050.99, dated December 29, 2020).

Data collection tools

In this study, a Personal Information Form was used to determine students' gender, age, year level, type of high school graduation, Higher Education Entrance Exam (HEEE) score, and academic achievement level in their undergraduate studies. To identify their dominant learning styles and learning model preferences, the VARK Learning Style Inventory (Version 7.0) was administered.

Table 1. Descriptive statistics of the research group

Variable	Group	n	%
Gender	Male	235	42.9
	Female	313	57.1
Class level	1st Year	126	23.0
	2nd Year	126	23.0
	3rd Year	145	26.5
	4th Year	151	27.5
Type of secondary school graduation	Vocational High School	94	17.2
	General High School	271	49.5
	Anatolian High School	72	13.1
	Science High School	43	7.8
	Sports High School	68	12.4
Higher Education Entrance Exam Score Range	150 – 199	70	12.8
	200 – 249	218	39.8
	250 – 299	182	33.2
	300 – 349	57	10.4
	350 – 399	21	3.8
Cumulative Grade Point Average (CGPA)	2.01 – 2.50	82	15.0
	2.51 – 3.00	194	35.4
	3.01 – 3.50	202	36.9
	3.51 – 4.00	70	12.7
Total		548	100

VARK learning style inventory

The VARK Learning Style Inventory (v7.0), developed by Fleming and Mills (1992) and adapted into Turkish by Düzgün (2018), is a measurement tool consisting of 16 questions and 64 items that seeks to answer the question, “How do I learn best?” Each of the 64 items contains in its background pattern the learning style preferences visual, aural, read/write, and kinesthetic (VARK) embedded within the answer options. While responding to the items, participants may select one or more options or may leave the question unanswered if none of the options are suitable for them. This situation, which is part of the methodology of the inventory, indicates that participants may possess one or more dominant learning styles and learning models, and also that the inventory has a multi-trait, multi-method (MTMM) structure. In addition, it has been stated that if a participant who completes the inventory makes fewer than 10 selections out of the total 64 items, their data should not be included in the analyses. According to the scoring criteria of the inventory, in the first stage, it is determined whether participants have a dominant learning style or belong to a dual, triple, quadruple, or multi-modal learning model. In line with this evaluation, the V, A, R, and K scores are ranked from highest to lowest, and the style(s) with the highest score(s) are identified as the dominant learning path(s). After this stage, if the total score of the four learning styles is between 10–16, the distance value is 1; if between 17–22, the distance is 2; if between 23–30, the distance is 3; and if above 30, the distance is 4. When the difference obtained by subtracting the second-highest score from the highest score is greater than the distance value, the individual is classified as having a single learning model. If this value is lower on the distance scale, the third-highest score is then subtracted from the second-highest score; if the result is greater than the distance value, the individual is considered to have a dual learning model. Otherwise, the fourth-highest score is subtracted from the third-highest score; if the resulting number is again greater than the distance value, the individual is understood to have a triple learning model. If none of these conditions are met, the individual is concluded to have adopted a quadruple learning model. Finally, during comparative analyses, the dual, triple, and quadruple preferences excluding the single learning model are collectively evaluated as the multi-modal learning model (Fleming & Mills, 1992; Fleming & Bonwell, 2001, p. 1).

Processing method

Following the acquisition of ethical approval for the initiation of the research process and the use of the scale, the Personal Information Form and the VARK Learning Style Inventory (v7.0) were prepared in physical (paper-based) format. In accordance with the guidance of Fleming and Mills (1992), it was decided that data collection would be conducted solely through face-to-face and paper-based administration. Accordingly, the forms were distributed together with official permission letters to academic units offering programs in sports sciences across different regions of Türkiye. Particular attention was given to ensuring that the faculty members at these academic units provided students with a detailed explanation of the methodology of the inventory prior to its completion. The data collection process was carried out during the fall and spring semesters of the

2024–2025 academic year. Upon completion of the in-person applications, the forms originally distributed by mail were collected again via postal delivery, after which the data were processed and prepared for statistical analysis.

Data analysis

Responses obtained through the Personal Information Form and the VARK Learning Style Inventory (v7.0) were coded and analyzed using the IBM SPSS Statistics software (Version 27). Following data screening for accuracy, scoring consistency, missing data, and outliers, responses from 21 participants were excluded, leaving a final dataset of 548 valid cases for analysis. Examination of skewness and kurtosis values for the four VARK factors (Visual: 0.888 – 1.163; Aural: 0.756 – 1.059; Reading/Writing: 0.636 – 0.336; Kinesthetic: 0.447 – 0.192) indicated that all variables were within the acceptable range of – 2.5 to +2.5, confirming normal distribution and supporting the use of parametric tests (Tabachnick & Fidell, 2007, p. 16). Descriptive statistics including frequency, percentage, mean, and standard deviation were used to examine participants' demographic characteristics, dominant learning styles, learning model types, and academic achievement levels. Each student's dominant learning style and model were determined based on the scoring manual of Fleming and Mills (1992). To assess the relationships between learning styles and academic achievement, cross-tabulation analyses and Pearson's chi-square (χ^2) tests were conducted. The Linear-by-Linear Association test was additionally employed to evaluate the direction of trends among ordinal variables. Furthermore, supplementary chi-square analyses were performed across different Cumulative Grade Point Average (CCGPA) ranges to explore the specific relationships between academic performance levels and learning styles. Through these comprehensive analyses, the study sought to provide an integrated understanding of the potential relationships between learning preferences and academic performance among Physical Education and Sports Teaching students. A significance level of $p < 0.05$ was adopted for all statistical procedures.

FINDINGS

Table 2. Distribution of dominant VARK Learning Styles according to Academic Achievement Performance

Dominant Learning Style		Cumulative Grade Point Average (CGPA)				Total	
		2.01-2.50	2.51-3.00	3.01-3.50	3.51-4.00		
Visual	n	7	23	14	9	53	
	%	13.2%	43.4%	26.4%	17.0%	100%	
Aural	n	18	55	45	17	135	
	%	13.3%	40.7%	33.3%	12.6%	100%	
Read/Write	n	11	28	38	16	93	
	%	11.8%	30.1%	40.9%	17.2%	100%	
Kinesthetic	n	29	47	70	19	165	
	%	17.6%	28.5%	42.4%	11.5%	100%	
VARK's Dominant Learning Style Combinations	AK	n	6	13	7	3	29
		%	20.7%	44.8%	24.1%	10.3%	100%
	AR	n	5	3	6	0	14
		%	35.7%	24.4%	42.9%	0.0%	100%
	ARK	n	0	1	1	1	3
		%	0.0%	33.3%	33.3%	33.3%	100%
	RK	n	3	6	6	1	16
		%	18.8%	37.5%	37.5%	6.2%	100%
	VA	n	0	8	3	2	13
		%	0.0%	61.5%	23.1%	15.4%	100%
	VAK	n	0	1	3	1	5
		%	0.0%	20.0%	60.0%	20.0%	100%
	VAR	n	1	0	0	0	1
		%	100.0%	0.0%	0.0%	0.0%	100%
	VARK	n	0	3	1	0	4
		%	0.0%	75.0%	25.0%	0.0%	100%
	VK	n	0	5	5	1	11
		%	0.0%	45.5%	45.5%	9.0%	100%
	VR	n	1	1	2	0	4
		%	25.0%	25.0%	50.0%	0.0%	100%
	VRK	n	1	0	1	0	2
		%	50.0%	0.0%	50.0%	0.0%	100%
Total	n	82	194	202	70	548	
	%	15.0%	35.3%	36.9%	12.8%	100%	

According to the responses of students enrolled in the Department of Physical Education and Sports Teaching, the dominant learning preference was predominantly kinesthetic ($n = 165$). This dominant modality was followed by aural, read/write, and

visual learning styles, respectively. These findings indicate that students in this field tend to favor experiential, hands-on, and practice-based learning approaches (Table 2).

In terms of academic achievement performance (CGPA), the majority of students across all learning styles were concentrated within the 2.51–3.00 range. Students with kinesthetic and read/write learning styles were more frequently represented in the 3.01–3.50 CGPA range, whereas those with predominantly aural and visual learning styles were mostly found within the 2.51–3.00 range. This finding suggests that learning styles grounded in practical experience and theoretical comprehension may be associated with higher levels of academic performance.

Although no clear superiority in academic performance was observed among students with different combinations of dominant learning preferences, certain combinations such as Read/Write - Kinesthetic (R/W-K) and Visual - Aural - Kinesthetic (VAK) were more frequently represented within the higher academic achievement range. Overall, these findings suggest that students with kinesthetic and read/write dominant learning styles may hold a relative advantage in terms of academic performance.

Table 3. Pearson chi-square test

	Chi-square Test		
	Value	df	p
Pearson Chi-square	46.577 ^a	42	0.290
Likelihood Ratio	51.140	42	0.158
Linear by Linear Association	.355	1	0.551
N of Valid Cases	548		

According to Table 3, the analysis yielded a value of $\chi^2(42) = 46.577$, indicating no significant relationship between the dominant VARK learning styles and academic achievement performance ($p = 0.290$). These findings suggest that students' preferred dominant learning styles are not strong predictors of their academic performance on their own. In other words, students with different dominant learning styles exhibited similar distributions of achievement levels, and this variation did not result in a statistically significant difference in academic performance.

Table 4. Distribution of VARK Learning Models According to Academic Achievement Performance

VARK Learning Model	Cumulative Grade Point Average (CGPA)					Total
		2.01-2.50	2.51-3.00	3.01-3.50	3.51-4.00	
Uni-modal	n	22	71	74	32	199
	%	11.1%	35.7%	37.2%	16.0%	100%
Bimodal	n	14	30	22	8	74
	%	18.9%	40.5%	29.8%	10.8%	100%
Trimodal	n	14	29	34	11	88
	%	15.9%	33.0%	38.6%	12.5%	100%
Quadmodal	n	32	64	72	19	187
	%	17.1%	34.2%	38.5%	10.2%	100%
Total	n	82	194	202	70	548
	%	15.0%	35.3%	36.9%	12.8%	100%

As shown in Table 4, pre-service teachers in the field of sports sciences most frequently preferred the unimodal learning model (36.3%), followed by the quadrimodal model (34.1%). These were followed by the trimodal (16.1%) and bimodal (13.5%) learning models, respectively. In terms of academic achievement performance, the majority of students across all groups had grade point averages (CGPA) within the 2.51–3.50 range. Notably, the proportion of students within this achievement range was slightly higher in the trimodal and quadrimodal groups. Conversely, students in the bimodal group were primarily concentrated in the 2.51–3.00 range, while the quadrimodal group exhibited a comparatively lower proportion of high-achieving students.

Table 5. Pearson chi-square test

	Chi-square Test		
	Value	df	p
Pearson Chi-square	8.383 ^a	9	0.496
Likelihood Ratio	8.508	9	0.484
Linear by Linear Association	2.500	1	0.114
N of Valid Cases	548		

The relationship between academic achievement performance and VARK learning models is presented in Table 5. The analysis yielded a chi-square value of $\chi^2(9) = 8.383$, and since the p-value was greater than 0.05, it was determined that there was no statistically significant relationship between the VARK learning models and academic achievement performance ($p > 0.05$).

Table 6. Distribution of Unimodal and Multimodal (MM) VARK Learning Models According to Academic Achievement Performance

VARK Learning Model		Cumulative Grade Point Average (CGPA)				Total
		2.01-2.50	2.51-3.00	3.01-3.50	3.51-4.00	
Uni-modal	n	22	71	74	32	199
	%	11.1%	35.7%	37.2%	16.0%	100%
Multi-modal	n	60	123	128	38	349
	%	17.2%	35.2%	36.7%	10.9%	100%
Total	n	82	194	202	70	548
	%	15.0%	35.3%	36.9%	12.8%	100%

MM: *Bimodal+Trimodal+Quadmodal*

The distribution of academic achievement according to the unimodal and multimodal learning preferences of students in the Department of Physical Education and Sports Teaching is presented in Table 6. The findings indicate that, in both groups, the majority of students were concentrated within the 2.51–3.50 CGPA range. Among unimodal learners, the highest concentration of achievement was observed in the 3.01–3.50 range (37.2%), while a relatively higher proportion of students achieved top-level performance (3.51–4.00 CGPA) in this group (16.0%) compared to the multimodal group (10.9%). Similarly, most students in the multimodal group also fell within the 3.01–3.50 range, although their representation in the higher achievement level was comparatively lower than that of unimodal learners. Overall, these findings suggest that students with a unimodal learning style may hold a slight advantage in terms of higher academic performance, although the overall distribution of academic achievement appears to follow a similar trend across both learning models.

Table 7. Pearson chi-square test

	Chi-square Test		
	Value	df	p
Pearson Chi-square	5.880 ^a	3	0.118
Likelihood Ratio	5.952	3	0.114
Linear by Linear Association	4.563	1	0.033*
N of Valid Cases	548		

* $p < 0.05$

The analysis yielded a chi-square value of $\chi^2(9) = 8.383$, indicating that there was no statistically significant relationship between the VARK learning models and academic achievement ($p > 0.05$). These findings suggest that whether students possess single (unimodal) or multiple (multimodal) learning styles does not have a decisive effect on their academic performance on its own.

When the academic achievement of pre-service teachers in the field of sports sciences was examined in relation to their unimodal (UM) and multimodal (MM) learning models and dominant learning style combinations, it was found that UM students were primarily concentrated within the 2.51–3.50 CGPA range, with a more limited representation in the higher achievement levels, and that the kinesthetic learning style was predominant within this group (Table 8). In contrast, MM students displayed a greater variety of dominant learning style combinations and were mostly concentrated within the 3.01–3.50 CGPA range. In the overall sample ($n = 548$), UM students showed more defined dominant styles (ranging between 12.1% and 42.1%), whereas MM students demonstrated a broader distribution (ranging between 0.3% and 8.3%) and an increasing diversity of modality combinations across the 2.51–4.00 CGPA levels. These findings indicate that while single or multiple learning styles alone do not have a determinative effect on academic achievement, the presence of multiple modality combinations may enrich learning processes and contribute positively to students' overall learning experiences.

Table 8. Distribution of dominant learning styles, academic achievement performance, and UM-MM Learning Models

CGPA	Modal		VARK's Dominant Learning Style Combinations														
			V	A	R	K	AK	AR	ARK	RK	VA	VAK	VAR	VARK	VK	VR	VRK
2.01-2.50	UM	n	2	5	3	12	-	-	-	-	-	-	-	-	-	-	-
		%	9.1	22.7	13.6	54.5	-	-	-	-	-	-	-	-	-	-	-
	MM	n	5	13	8	17	6	5	-	3	-	-	-	1	-	-	1
		%	8.3	21.7	13.3	28.3	10	8.3	-	5	-	-	-	1.7	-	-	1.7
2.51-3.00	UM	n	10	28	12	21	-	-	-	-	-	-	-	-	-	-	-
		%	14.3	40	17.1	30	-	-	-	-	-	-	-	-	-	-	-
	MM	n	13	27	16	26	13	3	1	6	8	1	-	3	5	1	-
		%	12	24.8	14.7	23.9	12	2.8	0.9	5.5	7.3	0.9	-	2.7	4.5	0.9	-
3.01-3.50	UM	n	7	14	13	40	-	-	-	-	-	-	-	-	-	-	-
		%	12.3	24.6	22.8	40.3	-	-	-	-	-	-	-	-	-	-	-
	MM	n	7	31	25	30	7	6	1	6	3	3	-	1	5	2	1
		%	7.1	31.3	25.3	30.3	7.1	6.1	1	6.1	3.1	3.1	-	1	5.1	2	1
3.51-4.00	UM	n	5	9	7	11	-	-	-	-	-	-	-	-	-	-	-
		%	15.6	28.1	21.9	34.4	-	-	-	-	-	-	-	-	-	-	-
	MM	n	4	8	9	8	3	-	1	1	2	1	-	-	1	-	-
		%	11.8	23.5	26.5	23.5	8.8	-	2.9	2.9	5.9	2.9	-	-	2.9	-	-
TOTAL (n=548)	UM	n	24	56	35	84	-	-	-	-	-	-	-	-	-	-	-
		%	12.1	28.2	17.6	42.1	-	-	-	-	-	-	-	-	-	-	-
	MM	n	29	79	58	81	29	14	3	16	13	5	1	4	11	4	2
		%	8.3	22.6	16.6	23.2	8.3	4	0.9	4.6	3.7	1.4	0.3	1.1	3.2	1.2	0.6

CCGPA: Cumulative Grade Point Average, UM: Uni-modal, MM: Multi-modal

Table 9. Pearson chi-square test

CCGPA		Chi-square Test		
		Value	df	p
2.01-2.50	Pearson Chi-square	9.381 ^b	9	0.403
	Likelihood Ratio	13.502	9	0.141
	Linear by Linear Association	2.566	1	0.109
	N of Valid Cases	82		
2.51-3.00	Pearson Chi-square	30.787 ^c	12	0.002*
	Likelihood Ratio	44.245	12	0.000***
	Linear by Linear Association	20.412	1	0.000***
	N of Valid Cases	194		
3.01-3.50	Pearson Chi-square	34.683 ^d	13	0.001**
	Likelihood Ratio	45.781	13	0.000***
	Linear by Linear Association	10.423	1	0.001**
	N of Valid Cases	202		
3.51-4.00	Pearson Chi-square	9.449 ^e	9	0.397
	Likelihood Ratio	12.858	9	0.169
	Linear by Linear Association	5.133	1	0.023*
	N of Valid Cases	70		
TOTAL	Pearson Chi-square	76.831 ^a	14	0.000***
	Likelihood Ratio	110.027	14	0.000***
	Linear by Linear Association	38.322	1	0.000***
	N of Valid Cases	548		

CCGPA: Cumulative Grade Point Average

The Pearson chi-square test results revealed a significant overall relationship in the total sample ($n = 548$) ($\chi^2 = 76.831$, $df = 14$, $p < 0.001$). However, when analyzed by CGPA range, statistically significant differences were observed only within the moderate achievement group (2.51–3.50), whereas no significant relationships between VARK learning styles and academic

achievement were found in either the low or high achievement groups ($p > 0.05$). These findings suggest that for students with moderate academic performance, their learning styles and modality combinations have a notable influence on academic outcomes. Conversely, among students with lower or higher levels of achievement, learning style alone appears to have a limited predictive value for academic success. Within the context of sports sciences, these results highlight the importance of developing individualized and multimodal instructional strategies tailored to learners with different learning preferences. In particular, for students demonstrating moderate achievement levels, a balanced integration of visual, aural, read/write, and kinesthetic learning approaches appears essential for enhancing potential and supporting the learning process.

DISCUSSION AND CONCLUSION

The findings indicate that students in the Department of Physical Education and Sports Teaching predominantly exhibited kinesthetic and read/write learning tendencies, and that those with these learning styles tended to achieve higher academic performance levels compared to other groups (Table 2). However, the results of the Pearson chi-square test revealed no statistically significant relationship between dominant learning styles and academic achievement. This suggests that the differences observed between learning styles and academic performance may hold pedagogical and contextual relevance, rather than statistical significance. Similarly, Gangadharan et al. (2025) reported that students with kinesthetic and visual learning styles demonstrated enhanced ability to access and retain information effectively, which positively influenced their academic performance. Conversely, other studies have found either no significant association between learning styles and achievement (Pashler et al., 2009; Newton & Miah, 2017) or have emphasized that this relationship is influenced by factors such as the disciplinary structure, instructional strategies, and the learning environment (Liew et al., 2015). Overall, these findings suggest that the VARK model may be particularly functional in applied learning environments, though its impact on academic achievement appears to be constrained by interacting contextual variables. Considering that education in the field of sports sciences involves both theoretical and motor components, it may be concluded that the contribution of dominant learning styles to academic success should be evaluated not only from a cognitive perspective, but also in terms of their relevance to practical and experiential learning processes.

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As shown in Table 6, the majority of pre-service teachers in the field of sports sciences tended to adopt a multimodal (MM) learning approach, although the proportion of students with a unimodal learning style was also noteworthy. In both VARK learning models, most students' Grade Point Averages (CGPA) clustered within the 2.51–3.50 range. However, the proportion of students achieving higher performance levels (3.51–4.00 CGPA) was greater in the unimodal group than in the multimodal group, suggesting that individuals focusing on a single learning channel may have a slight advantage at the upper levels of academic achievement. Nevertheless, this difference was found to be statistically non-significant (Table 7). This finding aligns with previous research suggesting that learning styles may not exert a direct or deterministic influence on academic performance (Pashler et al., 2009; Newton & Miah, 2017). In other words, students' modes of processing information visual, aural, read/write, or kinesthetic alone do not sufficiently explain academic outcomes. Rather, achievement appears to be shaped through complex interactions involving the appropriateness of instructional methods, student motivation, cognitive strategies, and the diversity of learning environments. Additionally, the similar distribution of achievement levels between the unimodal and multimodal learning groups underscores the importance of flexible cognitive adaptability and varied learning strategies within the learning process. Students who adopt multimodal learning models may more easily adapt to different instructional contexts, while those with unimodal preferences may demonstrate greater depth of focus under specific conditions. Therefore, these results suggest that instructional programs should be designed according to the principles of diversity and adaptability, rather than being narrowly tailored to students' learning preferences. Supporting this interpretation, Shirazi and Heidari (2019) also reported no significant relationship between learning style preferences and academic achievement, while noting that most students adopted a multimodal learning approach. Similarly, Mozaffari et al. (2020) emphasized that the relationship between learning style and achievement becomes significant only under certain conditions, such as the type of course or teaching method employed.

The relationship between pre-service teachers' dominant learning styles, VARK learning models, and academic achievement demonstrated a trend different from that observed in earlier findings. Analyses conducted according to unimodal and multimodal learning preferences revealed a significant overall relationship. Notably, within the moderate achievement range (2.51–3.50 CGPA), learning styles and modality combinations appeared to exert distinct effects on academic performance. In contrast, previous analyses (Tables 2–7) indicated that this relationship was not statistically significant. This discrepancy may be attributed to the flexibility inherent in the VARK model and the applied learning dynamics characteristic of sports science education. Since the learning processes of pre-service teachers in this field typically encompass both cognitive and psychomotor components, the integrated use of multiple sensory channels rather than reliance on a single dominant style may enhance overall learning efficiency (Mozaffari et al., 2020; Türker & Bostancı, 2023). This outcome can be explained by the potential of multimodal learners to adapt their learning strategies more effectively and adjust more easily to diverse instructional environments.

On the other hand, the absence of a significant relationship within the high- and low-achieving groups suggests that academic performance is not determined solely by learning style, but rather is influenced by multiple interacting factors such as motivation, instructional methods, course content, and the form of assessment (Newton & Miah, 2017; Shirazi & Heidari, 2019). Although the conceptual framework of the VARK model provides a useful tool for understanding individual differences in learning preferences, these preferences should not be regarded as fixed traits that directly predict academic success (Pashler et al., 2009). The tendency of pre-service teachers in the field of sports sciences to favor kinesthetic and multimodal learning styles as their dominant modes aligns with the applied nature of the discipline, which inherently relies on movement, observation, practice, and interaction-based learning (İlçin et al., 2018; Türker & Bostancı, 2023). Accordingly, the prominence of multimodal combinations among students with moderate levels of academic achievement suggests that the learning process becomes more effective when supported by flexibility, experiential engagement, and application-based knowledge. These findings emphasize that instructional strategies based on learning styles in sports science education should be implemented through individualized and flexible approaches. Beyond the distinction between unimodal and multimodal learners, enabling students to recognize their own learning preferences, supporting them with appropriate instructional techniques, and fostering their ability to shift between sensory modalities may enhance academic success (Fleming & Baume, 2006). In conclusion, although learning style alone may not directly determine academic performance, it plays a crucial role in shaping the quality and interactivity of the learning process, thereby contributing to more effective and adaptive educational experiences.

According to the results of this study, which examined the relationship between individual learning styles and academic achievement among students in the Department of Physical Education and Sports Teaching, it was found that the majority of students predominantly preferred kinesthetic and read/write learning styles, while a considerable proportion also adopted the multimodal (MM) learning model. This tendency can be explained by the nature of sports science education, which integrates both cognitive and psychomotor skills within its instructional content. The findings revealed no statistically significant relationship between dominant learning styles and academic achievement; however, when comparing unimodal and multimodal learning preferences, it was observed that students with moderate academic achievement levels demonstrated a stronger relationship between learning style and performance. This suggests that students who integrate multiple sensory channels into their learning processes develop more flexible and adaptable learning strategies, potentially enhancing their overall academic engagement and success.

Conclusion

The findings of this study indicate that learning style does not play a direct determinative role in academic achievement, yet it represents an important factor that shapes the quality and level of interaction within the learning process. Therefore, it is recommended to design multidimensional and flexible instructional frameworks that take into account students' individual learning preferences. In the context of sports sciences, learning styles should be considered not only in relation to academic success, but also regarding their indirect effects on psychomotor skill development and professional competence. Providing pre-service teachers with access to practice-based environments that support multiple learning approaches is likely to enhance both their academic and professional development. In conclusion, while the VARK model serves as a valuable tool for understanding the learning profiles of pre-service teachers in sports sciences, it remains insufficient to explain academic performance on its own. Promoting learning-style-sensitive, practice-oriented, and student-centered educational models is expected to contribute significantly to improving the quality of education within this field.

Recommendations

Based on the results of this study, it is recommended that instructional programs in Physical Education and Sports Teaching be designed with a strong emphasis on learning style sensitivity. In particular, applied teaching methods can be further strengthened for students who predominantly exhibit kinesthetic and read/write learning preferences. Additionally, considering the substantial number of students adopting a multimodal learning model, the use of blended instructional techniques integrating visual materials, digital content, and discussion-based classroom activities may enhance academic performance. Moreover, it is suggested that instructors and faculty members administer VARK assessments at the beginning of each academic term to identify students' dominant learning styles and adapt their lesson plans flexibly in accordance with these profiles to improve learning efficiency. Another practical recommendation involves organizing learning awareness workshops or advisory sessions to help students recognize their own learning styles and develop appropriate learning strategies.

accordingly. For future research, conducting longitudinal or qualitative studies to examine how learning styles evolve over time and to assess the contribution of practice-based learning environments to academic performance would provide valuable insights into the causal relationships underpinning learning processes in sports science education.

Limitations and strengths

As the first limitation, the research sample consisted exclusively of students from the Department of Physical Education and Sports Teaching, which restricts the generalizability of the findings to students from other disciplines or to those enrolled in pedagogical formation programs within the broader field of sports sciences. A second limitation concerns the voluntary participation of students, which may have influenced the representativeness of the sample. Finally, since the present study employed a cross-sectional design, the relationship between learning styles and academic achievement performance cannot be interpreted at a causal level. Future research could benefit from incorporating longitudinal designs and qualitative data collection methods with samples drawn from different faculties and departments, allowing for a more comprehensive and generalizable understanding of the dynamics between learning styles and academic achievement.

Ethical statement

This paper was conducted with the decision of Bayburt University/Türkiye, Scientific Research and Publication Ethics Committee dated January 15, 2021 and numbered 2021/10.

Generative AI Use Statement

Artificial intelligence-based tools, including ChatGPT (version 5.2), were used in this study solely for language editing purposes, such as improving grammar, clarity, and readability of the manuscript. No AI tools were used for data analysis, interpretation of results, or generation of scientific content.

CRedit authorship contribution statement

Türker Ü.: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision, Project administration; **Ateş Z. H.:** Methodology, Validation, Investigation, Resources, Data curation, Writing - Original Draft, Visualization, Project administration; **Bayrakdaroğlu Y.:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision, Project administration; **Demir S.:** Methodology, Investigation, Resources, Data curation, Writing - Original Draft, Visualization.

Data availability

The data used in this study may be requested from the corresponding author upon reasonable request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the study reported in this paper.

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