Analyzing the Influence of Key Demographic Variables on the Learning Styles of Preservice Science and Non-Science Teachers

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Abstract

This study investigated the influence of demographic variables such as academic disciplines, gender, and education levels on the learning styles of preservice teachers within the framework of learning styles, specifically focusing on the Visual, Auditory, and Kinaesthetic (VAK) model. Drawing on a diverse body of literature, the research aimed to discern patterns and influences on cognitive development. The primary objective was to analyze the impact of the program of study, gender, and level of education on preservice teachers' learning styles, utilizing a questionnaire-based approach with 376 participants. Statistical methods, including frequencies, percentages and chi-square tests, revealed significant variations in learning styles across different academic disciplines, genders, and education levels. The findings emphasized the mixed nature of these relationships, calling for tailored approaches in teacher training programs that consider individual difference. These findings contribute to understanding the dynamics influencing learning style of preservice science and non-science teachers

Keywords: gender, learning style, preservice teachers, program of study

Introduction

For over thirty years, educational research has focused on learning styles, highlighting their profound impact on instruction and learning. Auditory, visual, kinaesthetic, and tactile learning styles are among the different styles proposed by various educational theories. This framework has helped provide a customized approach to teaching by recognizing and capitalizing on each student's preferred learning method. In higher education, educators have applied learning style theory to enhance instructional techniques and boost student achievement. According to Armstrong (2017), applying this idea to higher education can increase students' involvement, motivation, and academic performance. Researchers also believe it stimulates college students' critical thinking and creativity (Sternberg & Grigorenko,

2002). Studies show that the learning style profiles of college students can differ according to their major, with differences seen between majors in the arts and sciences (Vermunt & Donche, 2017).

Bringing learning style theory to higher education aims to improve student learning and success. Those who have developed effective learning styles will be more able to adjust to the demands of their academic careers and subsequent professional problems. Several research studies have examined how college students' learning styles develop, showing encouraging patterns throughout their schooling (Entwistle & Ramsden, 2015). Scholarly performance and specific learning styles, like auditory and kinaesthetic learning, have also been linked (Ariastuti & Wahyudin, 2022). Research has looked at educational

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strategies to improve various learning styles in addition to learning style development.

Aguayo et al. (2021) found that a learning style-based training approach significantly enhanced the development of effective learning styles, particularly in kinaesthetic and tactile learning.

The relationship between learning styles and attitude, motivation, constraints, and perception of learning science can be complex and multifaceted (Coffield et al., 2004). Learning styles, referring to individual preferences and approaches to learning, such as visual, auditory, or kinaesthetic learning preferences, can be influenced by various factors. Attitude towards learning science can impact the choice of learning style, as individuals with a positive attitude may be more inclined to engage actively in learning activities that align with their preferred style (Amponsah, 2013; Mohammed & Amponsah, 2021b). Similarly, motivation plays a crucial role in adopting and utilizing learning styles. Individuals motivated to learn may be more likely to adapt their learning styles to optimize their learning experiences (Biggs, 2014).

Conversely, constraints, such as time limitations or resource availability, may impact how individuals can align their learning styles with their preferences (Amponsah et al., 2014; Taylor & Hamdy, 2013). Additionally, the perception of learning science can influence the adoption and effectiveness of learning styles. If individuals perceive science learning as challenging or irrelevant, they may be less motivated to adapt their learning styles to effectively engage with the subject matter (Schmeck, 2013). However, if they perceive science learning as meaningful and valuable, they may be more inclined to explore different learning styles to enhance their understanding and retention of scientific concepts.

Statement of the problem

According to educational theories, individuals exhibit various learning styles, which can impact teaching and learning outcomes (Armstrong, 2017). Although these learning styles are widely acknowledged, there is a notable gap in research regarding the potential influence of demographic variables, such as age, gender, religion, and residential status, on the learning style profiles of preservice teachers in Ghanaian university settings (Budu et al., 2022). This lack of investigation is significant because developing effective teaching strategies and optimizing learning outcomes relies on understanding how these demographic characteristics affect preservice teachers' diverse learning style patterns.

While learning style theory has garnered attention in educational research, there needs to be more exploration into how demographic factors might shape preservice teachers' learning style profiles (Papadakis et al., 2021; Kalogiannakis & Papadakis, 2019). Identifying the relationships between learning style patterns and demographic factors like program of study, gender, and Level of study can inform preservice teacher education programs to better cater to the diverse needs of students (Rowan et al., 2021). Thus, this research's primary question is: How do vital demographic factors influence preservice teachers' various learning style patterns enrolled in a Ghanaian university?

Although researchers have extensively studied learning style theory at the college level, few studies have examined how demographic factors affect learning style patterns in Ghanaian preservice teachers. By examining the effects of significant demographic factors on the learning styles of preservice teachers at the University of Ghana, this study seeks to close this gap. The objectives of the study, therefore, are:

1. To explore the prevalent learning styles of preservice teachers at the University of Ghana; and
2. To explore how demographic factors (i.e., gender, programme and level of training) influence preservice teachers' learning styles.

Literature review

Conceptual Framework

The conceptual framework for this study draws upon the VAK (Visual, Auditory, and Kinaesthetic) model of learning styles proposed by Neil Fleming in 1987. According to this model, individuals have preferred modalities through which they perceive, process, and retain information.

learners learn most effectively through hands-on experiences, physical activities, and movement. They prefer to engage in activities involving touching, feeling, and doing, and they often learn best when manipulating objects or performing tasks.

Figure 1 depicts the influence of demographic factors on learning style. The researchers examined the influence of demographic factors on learning styles within the VAK model. These factors included exploring how factors such as gender, Level of study, and program of study impacted individuals' preferences for visual, auditory, or kinaesthetic learning modalities. By investigating these relationships, this

Figure 1 Conceptual framework that depicts key demographic variables' influence on learning style
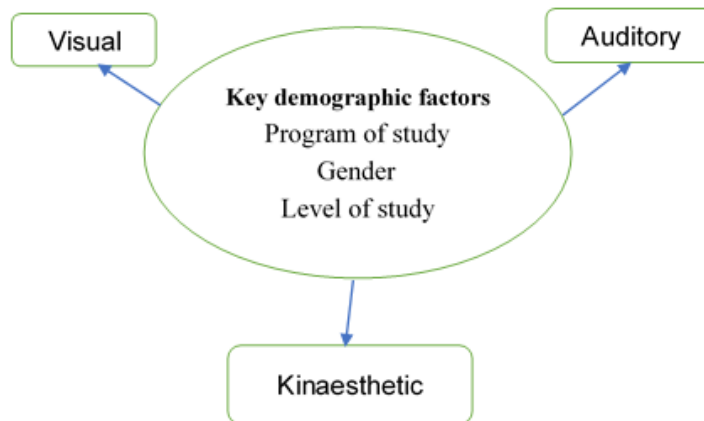
Source: Authors own construct

The VAK model proposes that learners categorize themselves as visual, auditory, or kinaesthetic learners based on their predominant learning style preferences (Fleming, 1987). Visual learners prefer to acquire information through visual stimuli such as diagrams, charts, and written instructions. They benefit from seeing information presented in a graphical or pictorial format. Auditory learners, on the other hand, learn best through auditory cues such as lectures, discussions, and audio recordings. They often prefer spoken instructions and benefit from listening to information presented verbally. Kinaesthetic

study aimed to provide insights into the intersection of demographic factors and learning styles, which can inform educational practices and interventions tailored to meet the diverse needs of learners.

Theoretical framework

The theoretical framework for this study is grounded in the VAK (Visual, Auditory, and Kinaesthetic) model of learning styles proposed by Neil Fleming in 1987. According to this model, individuals have preferred modalities through which they perceive, process, and retain information

(Fleming, 1987). Visual learners prefer to acquire information through visual stimuli such as diagrams, charts, and written instructions. They benefit from seeing information presented in a graphical or pictorial format. Auditory learners learn best through auditory cues such as lectures, discussions, and audio recordings. They often prefer spoken instructions and benefit from listening to information presented verbally. Kinaesthetic learners learn most effectively through hands-on experiences, physical activities, and movement. They prefer to engage in activities involving touching, feeling, and doing, and they often learn best when manipulating objects or performing tasks. The VAK model posits that individuals may have a dominant learning style. However, they can also utilize a combination of visual, auditory, and kinaesthetic modalities depending on the context and the nature of the material being learned (Fleming & Mills, 1992). This theoretical framework provides a lens through which to examine the influence of demographic variables such as academic disciplines, gender, and education levels on individuals' preferred learning styles. Educators and practitioners can better tailor instructional strategies and interventions to accommodate learners' diverse needs by understanding how these factors interact with learning style preferences.

Research around learning styles, particularly within the framework of the VAK model, has explored various aspects of how individuals' preferred modalities influence learning outcomes and instructional practices. For example, a study by Awla (2014) examined the effectiveness of matching instructional methods with students' preferred learning styles, including visual, auditory, and kinaesthetic preferences. The researchers found that when instruction aligned with students' preferred modalities, they demonstrated increased engagement, motivation, and academic achievement. Similarly, Corbin (2017) investigated the relationship between students' learning styles and academic performance in the Caribbean. Utilizing the VAK model, they found that students who aligned their study strategies with their preferred learning styles tended to achieve higher grades than those who did not. Coffield et al. (2004) systematically reviewed research on learning styles in another study. They concluded that while evidence suggests that individuals have preferred learning styles, the effectiveness of matching instruction to these styles still needs to be more conclusive. They emphasized the importance of considering contextual factors and individual differences when applying learning style theories in educational settings. These studies highlight the relevance of the VAK model in understanding how individuals' preferred modalities impact learning outcomes and instructional practices. While the effectiveness of tailoring instruction to match learning styles remains debated, research continues to explore the slight relationships between learning styles, instructional methods, and academic achievement.

Empirical Review: Impact of demographic variables such as gender, level of education and program of study on learners' learning styles

Demographic variables such as gender, Level of education, and program of study can significantly impact learners' learning styles. Research has shown that these factors can influence individuals' preferences for specific modalities of learning, as well as their approaches to acquiring and processing information. For instance, studies have found gender differences in learning style preferences, with some research suggesting that females may tend to prefer auditory and verbal learning modalities, while males may lean towards visual and kinaesthetic modalities (Subramoney, 2019; Khan, 2015). Additionally, Subramoney (2019) found that females had higher scores in the

auditory learning style dimension than males.

The level of education can also impact learning style preferences, with research indicating that preferences may evolve as individuals progress through different educational levels. For example, undergraduate students may exhibit different learning style preferences than graduate students or professionals undergoing continuing education (Ariastuti & Wahyudin, 2022). Furthermore, the program of study or academic discipline can influence learning style preferences due to the nature of the content and instructional methods employed within specific fields. For instance, students in STEM disciplines may gravitate towards visual and logical-mathematical learning modalities, whereas humanities or arts may prefer auditory and interpersonal learning modalities (Schunk et al., 2014).

Method

This study adopts a positivist quantitative approach, employing descriptive survey research designs. According to Creswell and Creswell (2017), in such a design, research inferences about relationships among variables are made systematically and empirically without direct control or manipulation of independent variables, as their manifestations have already occurred and are inherently non-manipulable.

In this researcher, the University of Ghana because of its recent entry into the teacher education space in Ghana. The aim was to understand how the learning styles of its preservice teachers compare with research findings on preservice teachers from more established, tradtionally education-focused universities in Ghana.

The target population for this study includes all undergraduate students at the University of Ghana Teacher Education Department during the 2022/2023 academic year. The accessible population comprises the 449 first to fourth-year undergraduate preservice teachers within the Teacher Education Department.

This study utilized a convenience sampling technique alongside a purposive sampling technique. Convenience sampling involves selecting accessible individuals from a target population based on practical considerations like accessibility, proximity, availability, or willingness to participate, rather than through random selection, as defined by Dörnyei (2007), and Purposive sampling, described by Etikan et al., (2016), entails selecting individuals deemed relevant to the research topic based on researchers' judgment. I conveniently chose the University of Ghana's Teacher Education Department, considering factors such as accessibility, cost, and labor. In total, 376 department preservice teachers (PTs) participated voluntarily during the 2022/2023 academic year. The researcher purposively selected English PTs, Mathematics PTs, Science PTs, and JHS specialism PTs due to their unique attributes and experience working with pupils in inclusive classrooms. Participants were required to be current undergraduate preservice teachers who voluntarily agreed to participate.

Data were collected using a questionnaire based on the School of Educators (2008) and School on Wheels (2010) and modified, piloted, and validated by (Xhomara & Shkembi, 2020). The questionnaire covered three main types of learning styles (LS) with 18 items. To be more specific, the researcher included elements in the questionnaire that were created to evaluate Neil Fleming's Visual, Auditory, and Kinaesthetic (VAK) learning styles. The statements in these items were divided into sections according to the different learning styles. Participants were asked to rate their agreement with each statement on a five-point Likert scale. The ratings of the items from the learning style inventory were used to compute the students' mean rating of each of the three learning styles, and based on Fleming's (1987) rubrics, the learning style with the

largest rating was taken as each participant's dominant learning style.

A research permit was obtained from the University of Ghana Teacher Education Ethics Review Committee. The questionnaires were administered during lectures, with the data collected cross-sectionally over one month, allowing students present during the sessions to participate voluntarily. Face-to-face administration ensured immediate responses and minimized interference from other variables. To ensure face and content validity, the instruments were screened by psychometric experts from the Department of Teacher Education, University of Ghana. Ethical considerations included informed consent, anonymity through code identification, and confidentiality. The Statistical Package for Social Sciences (SPSS) was used to process the questionnaire data. The data were analyzed using frequencies and percentages to determine the number and percentage of preservice teachers regarding their learning styles modalities and chi-square tests were used to examine variations in learning styles based on demographic characteristics..

Results

Objective 1:   Prevalent learning styles of preservice teachers

The data employed in categorizing the students into their prevalent learning styles was obtained from a sample of 376 preservice teachers who responded to the learning styles questionnaire. Table 2 presents the number and percentage of the participants' dominant learning styles.

The results from Table 2 reveal kinaesthetic is the most common learning style which about a half of the preservice teacher predominantly employ in their learning. The least common learning style is visual learning which is predominantly employed by about a third of the preservice teachers.

Objective 2:   Influence of demographic factors (i.e., gender, programme and level of training) preservice teachers' learning style preferences.

To explore the influence of demographic factors (i.e., gender, programme and level of training) on the preservice teachers' learning style preferences, the Chi-square test was performed on the data. Table 3 shows a crosstabulation distribution of learning style preferences by the three demographic factors and the chi-square test results.

From Table 3, an observation across programmes is the prevalence of Kinaesthetic learning in more applied subjects like Mathematics (60%) and Science (50%), where students strongly prefer active and hands-on approaches. Junior high school specialism students have a relatively equal inclination towards Auditory (45%) and Visual (43.68%) learning, but BA Education English students strongly choose Kinaesthetic learning (66.67%). These findings underscore the significance of hands-on, experiencing learning in these disciplines, with Visual learning being the least favoured in Mathematics and Science. Also,

Table 2   Distribution of the preservice teachers showing their dominant learning styles

Learning Styles	Preservice Teacher Participants	
	Number	Percentage
Auditory	138	37
Kinesthetic	190	51
Visual	51	14
	376	100

142

Table 3   **Results of the Chi-square test of Relationship between Demographic factors and learning styles**

	N	Auditory	Kinaesthetic	Visual	λ^2 Value	df	Asymp. Sig. (2 sided)
Programme							
JHS Specialism	116	52 (44.8)[1]	13 (11.5)	51 (43.7)	75.63	6	0.000
BA Ed. English	129	18 (14.3)	86 (66.7)	25 (19.1)			
BSc Ed. (Maths)	42	17 (40)	25 (60)	0 (0)			
BSc Ed. (Sci.)	89	38 (42.9)	45 (50)	6 (7.1)			
Gender							
Male	187	70 (37.5)	98 (52.5)	19 (10)	21.76	2	0.000
Female	189	54 (28.6)	108 (57.1)	27 (14.3)			
Level							
100	103	34 (33.3)	46 (44.4)	23 (22.2)	14.59	6	0.024
200	96	30 (30.8)	52 (53.9)	15 (15.4)			
300	135	58 (42.9)	68 (50)	10 (7.1)			
400	42	16 (37.5)	24 (56.3)	3 (6.3)			

[1]Percent in parenthesis

Kinaesthetic learning is the prevailing technique for males and females, with 52.50% of males and 57.14% of females expressing such preference. Audiological learning closely trails behind, particularly among males (37.50%). Visual learning is the least favoured method by both genders.

However, females exhibit a much greater propensity for it (14.29%) than males (10%). One important observation is that both genders significantly prefer practical, kinaesthetic learning, while only a minority depend on visual approaches. However**,** throughout all academic levels, Kinaesthetic learning constantly maintains its position as the most favoured style, with its popularity gradually rising as students' progress, reaching 56.25% by Level 400. At 42.86%, auditory learning is the second most preferred method, reaching its highest point at Level 300. Visual learning diminishes progressively as students advance, with a mere 6.25% of Level 400 students expressing a preference for this methodology. The prominent pattern is that as students' progress through their academic trajectory, they progressively choose practical, experience learning while transitioning away from visual learning

modalities. The study findings indicate a persistent pattern across all variables, where kinaesthetic learning is the preferred learning style, particularly in practical disciplines such as Mathematics and Science, and at advanced academic levels. Although auditory learning continues to be necessary, visual learning is generally the least favoured modality.

The findings of the chi-square test, a statistical method used to determine the association between two categorical variables, demonstrate statistically significant associations between demographic variables and students' preferred learning methods. In the context of the study programme, the obtained λ^2 value of 75.63 and the corresponding p-value of 0.000 indicate a statistically significant association. This finding suggests variation in learning style preferences among students of different programmes of study. Gender notably correlates with learning styles, as evidenced by a λ^2 value of 21.76 and a p-value of 0.000. This finding also suggests a substantial difference between males and females in their preferred learning methods. Similarly, the students' academic level, as indicated by a λ^2 value of 14.59 and a p-

value of 0.024, shows a statistically significant association with students' learning styles. These results accentuate the importance of considering demographic variables in educational planning. Preferences change as students advance through various levels of study, and understanding these changes is crucial for effective planning and assistance. Ultimately, programmes, gender, and level substantially impact students' preferences for learning styles, highlighting the need to consider these aspects in our work.

Discussion

The prevalence of Kinaesthetic learning in the practical domains of Mathematics (60%) and Science (50%) corresponds to established studies on learning preferences particular to each discipline. Research conducted by Ismail and Yusof (2023) indicates that students in STEM disciplines (Science, Technology, Engineering, and Mathematics) tend to favour active, experiential learning because of the practical and hands-on aspect of these tasks. The prevalence of kinaesthetic learners in scientific and mathematics education can be attributed to their successful adaptation to contexts that allow students to operate tools, participate in experiments, and apply theoretical knowledge to real-world issues. The balanced preferences for Auditory (44.83%) and Visual (43.68%) learning styles in JHS Specialism are consistent with research indicating that students in broader or more diverse programmes generally like multimodal instruction (Hu et al., 2021). The inclination towards Kinaesthetic learning in the BA Education English degree (66.67%) also indicates the necessity for interactive and collaborative methods in the humanities. This is achieved through role-playing, group activities, and practical assignments facilitating language acquisition and critical thinking (Gardner, 2006). Investigations on gender variations in learning styles provide evidence that males and females significantly prefer Kinaesthetic learning,

with percentages of 52.50% and 57.14%, respectively. A study conducted by Rulland and Marantika (2022) revealed that although there exist slight variations in learning preferences between males and females, both genders generally prefer hands-on, kinaesthetic experiences, especially in disciplines that include physical work. The marginal advantage in kinaesthetic preference among females (57.14%) could be attributed to their heightened inclination towards participating in collaborative learning settings, as indicated by Gurian and Stevens (2010), who established that female students frequently favour interactive and cooperative methods. Similarly, the lower percentage of Visual learners among both genders (10% for males and 14.29% for females) aligns with Neil Fleming's VARK model (2001), which indicates that purely visual approaches, such as reading and diagrams, are typically less favoured, especially in more dynamic learning environments. As the students' progress from Level 100 to Level 400, their growing inclination toward Kinaesthetic learning corresponds with adult learning theories (Hernandez, 2020). These theories highlight the need for experiential learning as students become more self-directed and strive to use their accumulated knowledge in practical situations.

The marginal decline in Visual learning from Level 100 (22.22%) to Level 400 (6.25%) could indicate an increasing demand for active involvement and problem-solving rather than passive, visual assimilation of material as students specialise and undertake more complex cognitive activities (Lu et al., 2022). Furthermore, research by Reeve et al. (2020) suggests that as students advance, they tend to choose learning styles that correspond to practical applications in the real world. This further elucidates the inclination toward Kinaesthetic learning at advanced academic levels. The consistent prevalence of Auditory learning as the second most favoured style across all levels suggests that

verbal communication and discourse continue to be significant in student learning, a pattern observed in collaborative and inquiry-based learning approaches (Rogowsky et al., 2020). Thus, consistent with existing literature, the results of this study indicate that kinaesthetic learning gains significance when students participate in practical and applied fields, such as Science and Mathematics, and as they advance through higher levels of education. Academic research in educational psychology and pedagogy has extensively demonstrated the preference of both male and female students for active learning methods that rely minimally on visual techniques. These observations affirm the need of customising teaching approaches to correspond with the learning preferences of students according to their academic field, gender, and level of study.

The chi-square test results, a pivotal aspect of this research, unveil strong associations between demographic factors and students' preferences for learning styles. These results, which reveal significant distinctions between science and non-science students, provide a profound understanding of the learning dynamics in our academic institutions. The most common learning style among science students, especially those in BSc Ed. Maths and BSc Ed. Science, is kinaesthetic learning. This preference is rooted in their proclivity for hands-on and practical involvement, a finding that aligns with prior studies on experiential learning in technical disciplines (Schmid, 2009). Similarly, students not pursuing science, such as those enrolled in BA Ed. English, exhibit a stronger inclination towards kinaesthetics learning. This discovery aligns with research indicating that students in the humanities, especially, English Language, may incorporate may active, practical activities like debates, projects or interactive tasks like role playing, group work, or real-life simulations (Fleming, 2001). Furthermore, gender and academic level substantially influence the formation of learning preferences. Sarabi-Asiabar et al's (2014) results support that male students prefer kinaesthetic learning, whereas females prefer auditory and visual learning orientations. As students advance in their academic levels, changes in their learning preferences become apparent, emphasising the importance of employing customised teaching methods that cater to the varied requirements of both science and non-science students (Vermunt et al., 2017).

Conclusion

In conclusion, the findings of this study provide valuable insights into the influence of program of study, gender, and Level of study on preservice teachers' learning styles. The investigation revealed significant correlations between academic disciplines and learning styles, echoing previous research findings and emphasizing the importance of considering cultural and contextual factors in interpreting these relationships. Additionally, the nuanced findings regarding gender differences in learning styles contribute to the ongoing discourse on gender and intelligence, highlighting the need for further research to understand these complexities fully. Moreover, the observed variations in learning styles across different levels of study underscore the significance of educational progression in shaping preservice teachers' cognitive development and learning preferences. Also, the chi-square test results indicate robust associations between demographic variables and students' preferences for learning styles. They emphasize notable differences between science and non-science students and the need for tailored teaching approaches to satisfy the diverse needs of these students.

Recommendation

To improve the effectiveness of teacher training, customized professional development programs that consider the particular learning style linked to various academic disciplines are recommended.

These programs should address the diverse learning styles among preservice teachers, ensuring a more personalized and practical approach to instruction.

Limitation of the Study

While the study offers valuable insights, certain limitations should be acknowledged. The reliance on self-reported data introduces the potential for response bias, and the cross-sectional design limits establishing causal relationships. Longitudinal studies could provide a more nuanced understanding over time. The study should have extensively explored the influence of socioeconomic factors on learning styles, leaving room for future investigations.

Acknowledgment

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