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RESEARCH ARTICLE

Determining Nursing Students' Dominant Learning Styles and Evaluating the Affecting Factors Using Decision Tree Method

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ABSTRACT

Aim and Background: Identifying the learning styles is important to ensure full and effective learning in nursing students studying in a field that requires clinical practice and experience. For this aim, determined the dominant learning styles of nursing students and to evaluate the affecting factors using the decision tree method.

Methods: The study was conducted with 421 students studying nursing at a university in Turkey. "CART", "CHAID" and "QUEST" decision tree algorithms were used to evaluate the factors affecting learning styles.

Results: Of the students, 48% had visual, 36% tactile, 9% kinesthetic, and 7% auditory learning styles. In the decision tree model, living place and university entrance scores were found to have statistically significant effects on learning styles ($p<0.05$).

Conclusion: This study determined that nursing students predominantly had the visual learning style and that the living place was the variable with the most pronounced effect on learning style.

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INTRODUCTION

KEYWORDS:
Decision tree, learning style, nursing student

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The different ways individuals prefer in their process of processing, comprehending, learning, expressing, and remembering information are defined as learning styles (Doğan et al., 2018; Ekici, 2016). Identifying students' learning styles is central to developing effective teaching strategies. It is known that students remember information for a longer time and learning becomes more efficient when education is given with consideration to different learning styles (Sidekli & Akdoğdu, 2018; Şeker & Yılmaz, 2011; Yeşilyurt, 2019).

Individual differences of students are important at every stage of the learning process because each person is unique, and the differences among individuals are reflected as diversity in the learning process (Myftiu, 2015). Previous studies have reported that teaching methods developed with due consideration to the learning styles had a positive effect on the academic success of the students and their accomplishments in business life after graduation (Çelik & Yıldırım, 2014; Dikmen, 2015; Sidekli & Akdoğdu, 2018) making it necessary to closely distinguish the individual differences of students. There may be students with different backgrounds with different abilities, interests, personality traits, and learning styles in the same classroom (Candan et al., 2015; Turgut, 2016). Thus, effective education should be able to address the individual differences, learning speed, and learning style of each student (Candan et al., 2015; Sidekli & Akdoğdu, 2018). Besides, determining students' learning styles is important in identifying their individual differences and similarities. Achieving this can make it possible to plan teaching that addresses both the common aspects of the students and the aspects that distinguish them (Candan et al., 2015).

To effectively maintain the rapid and continuous development of health services in today's world, it is important to train well-qualified nurses in their fields, do effective research, solve problems, and think creatively and critically. To this end, nursing students are expected to have acquired cognitive, affective, and psychomotor skills before graduation (Şimşek, 2018). Acquisition of these skills can be possible by identifying the students' learning styles and providing them the environments that will improve the learning and teaching process accordingly (Doğan et al., 2018).

While the importance of determining students' learning styles is emphasized in the literature, studies conducted with the scale developed for nursing students are quite limited. For this purpose, Otrar and Kuyucak (2019) developed the "Learning Styles Scale for Health Sciences Students (SB-SSS)", which also covers nursing students. Otrar and Kuyucak (2019) investigated the validity and reliability of a scale they developed to determine the dominant learning styles of students, including visual, auditory, tactile, and kinesthetic learning. Because there is still a need in the literature for studies to determine the learning styles of nursing students, researching the learning styles of nursing students based on HCS-LSS is the leading feature of our study.

There are many tools designed to identify students' learning styles. Kolb's experiential learning style model (Aşkar & Akkoyunlu, 1993), Dunn and Dunn's learning style model (Dunn et al., 1993), McCarthy learning style model (McCarthy & Morris., 2000) and Gregorc's learning style model (Ekici, 2013) are widely used learning style models. However, Otrar and Kuyucak (2019) developed the HCS-LSS specifically for students studying in the field of health sciences.

In HCS-LSS, learning styles are divided into 4 main groups as follows:

Visual learning style: Individuals with this learning style learn the information better when presented as visual data (picture, diagram, algorithm, demonstration, diagram, map, etc.). For this reason, it is very important for instructors to include visual tools and materials in classroom practices. Technological devices such as pictures, diagrams, demonstrations, maps, bulletin boards, videos, computers, and projections are the best stimulants for individuals with a visual learning style. Such students cannot retain auditory information for a long time, and they avoid long narratives that are not based on visual materials (Doğan et al., 2018).

Auditory learning style: Individuals with this learning style tend to encode information verbally. They learn information faster through verbal explanation, self-talk, and listening. They prefer to listen to a new topic in the class, listen to it from someone who knows the subject or learn by discussing it. Such students avoid written and illustrated materials, preferring to listen to the subject instead of reading (Otrar & Kuyucak, 2019).

Tactile learning style: Individuals with this learning style tend to learn information using physical skills. They learn better by using three-dimensional teaching materials, demonstration, and experimenting. They have difficulty remembering what is heard and seen, struggle to understand by hearing, and make spelling and punctuation mistakes (Otrar & Kuyucak, 2019).

Kinesthetic learning style: Individuals with this learning style prefer to be in an environment where they can move freely and comfortably when learning. They learn more effectively in the applied lessons. They tend to forget the information they hear and see in a short time. They ignore their environment in their actions (Orkun & Bayırlı, 2019; Otrar & Kuyucak, 2019).

MATERIAL AND METHODS

Objective

The aim of this study is to determine the dominant learning styles of nursing students and to determine the factors affecting their learning styles by using decision tree algorithms.

The questions of the research:

(1) What are the dominant learning styles of nursing students?
(2) What are the factors affecting the dominant learning styles of nursing students?

Design

This was a descriptive and cross-sectional study.

Participants and setting

The study was carried out between June and August 2021 with undergraduate students in the nursing department of a university in Turkey. The population of the study covered 706 students, including 187 students in the 1st grade, 177 students in the 2nd grade, 162 students in the 3rd grade, and 180 students in the 4th grade. It was aimed to reach the entire population without a specific sampling approach. All nursing students over the age of 18 who could read and understand Turkish and agreed to participate in the study were included in the study. 421 students who met the inclusion criteria participated in the study.

Data Collection

The research was conducted with nursing students who received online education between May and July 2021. Due to the Covid-19 pandemic, the data were collected through an online platform called "Google forms". It is a professional online survey platform that focuses on providing data to users. Telecommunication tools (WhatsApp groups, telegram, Instagram, etc.) were used in the delivery of online questionnaires to students. The forms were left open for two months from the moment they were sent. Each student was allowed to access the form only once.

Data Collection Tools

Data were collected through an online questionnaire that included socio-demographic details and the Learning Styles Scale for Health Sciences Students.

Socio-demographic details questionnaire: Socio-demographic details questionnaire included 15 questions on age, gender, living place, disability, if any, type of disability, chronic condition, regular medication, type of high school graduated, university entrance score, mother's education level, father's education level, income level, number of individuals in the household, and number of siblings.

Learning Styles Scale for Health Sciences Students (SB-SSS): Developed by Otrar and Kuyucak (2019) to determine the learning styles of health science students, including nursing students, the scale consists of 70 items. The Cronbach's Alpha coefficient of the scale was found as α=0.933 (Otrar & Kuyucak, 2019). In our study, Cronbach's Alpha coefficient was found to be α=0.743.

Data Analysis

Data were analyzed with IBM SPSS v23. Conformity to the normal distribution was evaluated based on kurtosis and skewness values. The reliability of the scale was examined with Cronbach's alpha coefficient. Analysis results were presented

as mean ± standard deviation for quantitative data. The significance level was taken as $p<0.05$. Decision tree methods were used to evaluate the factors affecting learning styles.

Decision Tree: Decision trees are machine learning algorithms that have been extensively used in recent years for classification, regression, pattern identification, and feature selection problems (17). They have been used in the literature frequently because they provide an advantage to decision-makers as they are economical, give fast results, and provide interpretable and comprehensible results (18). A tree-like structure is followed in the decision tree, consisting of structures such as root node, branches, and leaf nodes. A root is, as the name suggests, the topmost node. In the decision tree, each node represents a feature, each branch represents a decision, and each leaf an outcome. Analyzing and interpreting data is quite easy, as decision trees mimic the human decision-making and thought process. Another advantage of decision trees is the ability to select the most effective feature. It is easy to classify and can be easily interpreted. It can also be used for both continuous and categorical datasets (19). There are different algorithms used in decision trees.

Classification and Regression Trees (CART): This decision tree algorithm has a suitable structure for classification and regression analysis. Branches in the tree structure constantly target variables. Since the CART algorithm is used for both numerical and nominal data, it is frequently used in regression problems for dependent variables. The CART algorithm uses the Gini index as a branching criterion. It is a popular algorithm that performs non-parametric analysis (20, 21). The CART algorithm's ability to work with continuous, nominal, and ordinal variables saves time for the researcher. Another advantage is that even someone not interested in statistics can easily interpret it. For this reason, it is frequently used as a decision tree algorithm (22).

Chi-Squared Automatic Interaction Detector (CHAID): The logic of the CHAID method is based on the x^2 association test. A CHAID tree is a decision tree that starts from the entire dataset and is divided into two or more sub-nodes. With the CHAID analysis, a decision tree can be obtained from the independent variables that have a significant effect on the dependent variable. The variables used to determine the best split in any node are based on statistical significance (23, 24). This algorithm is one of the most preferred algorithms in the literature due to its advantages such as being used in nominal, ordinal, or continuous type-dependent and independent variables, and as an alternative to binary and multinomial logistic regression models (22).

Quick, Unbiased, Efficient Statistical Tree (QUEST): The QUEST algorithm is a decision tree algorithm used for classification and data mining. It is a popular decision tree model that produces as homogeneous subsets of data as possible according to the dependent variable. The QUEST algorithm is a fast, unbiased, and efficient statistical tree model. This model has advantages such as using linear or unbiased variable selection and missing value handling performance (25). Further advantages include using an unbiased variable selection method and the ability to work with multiple categorical variables (26).

RESULTS

The data of 421 students were analyzed. Descriptive statistics of students' socio-demographic details are given in Table 1.

Table 1: Descriptive statistics of socio-demographic details

Variables	*n(%)*	
Gender		
Female	351 (83.4)	
Male	70 (16.6)	
Place of birth		
City/town	377 (59.5)	
Village	44 (10.5)	
Living place		
City/town	326 (77.4)	
Village	95 (22.6)	
Income level		
1001 TL- 3000 TL	176 (41.8)	
3001TL-5000 TL	126 (29.9)	
1000 TL and lower	47 (11.2)	
5000 TL and higher	72 (17.1)	
Presence of any disability		
No	410 (97.4)	
Yes	11 (2.6)	
Chronic condition		
No	386 (91.7)	
Yes	35 (8.3)	
Regular medication		
No	392 (93.1)	
Yes	29 (6.9)	
Graduated high school		
Anatolian high school	288 (68.4)	
Science high school	53 (12.6)	
Other	36 (8.6)	
Health vocational high school	33 (7.8)	
General high school	11 (2.6)	
Mother's education		
Primary education	269 (63.9)	
High school	82 (19.5)	
Literate	31 (7.4)	
Illiterate	26 (6.2)	
Bachelor and above	13 (3.1)	
Father's education		
Primary education	212 (50.4)	
High school	119 (28.3)	
Bachelor's degree	59 (14.0)	
Literate	12 (2.9)	
Illiterate	10 (2.4)	
Postgraduate	9 (2.1)	
Variables	*Mean ± SD*	*(Median) (min-max)*
Age	20.5 ± 1.7	20 (17- 38)
Number of individuals in the household	4.9 ± 1.5	5 (1 - 13)
Number of siblings	2.8 ± 1.5	3 (0 - 10)
University entrance score	337.1 ± 45.4	335 (0 - 489)

Of the students, 83.4% were women, 77.4% were living in a city/town, 41.8% had an income between 1001-3000 TL, 97.4% did not have a disability, 91.7% did not have a chronic condition, and 93.1% were not on regular medication. 68.4% were graduated from Anatolian high school, mothers of 63.9% were primary school graduates, and fathers of 50.4% were primary school graduates. The average age of the students was 20.5 years, the average number of individuals living at home was 4.9, the average number of siblings was 2.8, and the average score for university entrance was 337.1.

Descriptive statistics for the HCS-LSS sub-dimensions are given in Table 2. The tactile mean score was 4.12, the auditory mean score was 3.64, the visual mean score was 4.22, and the kinesthetic mean score was 3.74.

The results of the HCS-LSS scale of nursing students are given in Figure 1. Accordingly, the dominant learning style was visual for 48% of the students, tactile for 36%, kinesthetic for 9%, and auditory for 7%.

The tree diagram obtained by using CHAID as the decision tree algorithm is presented in Figure 2. As a result of the analysis using the CHAID method, it was found that the living place and the university entrance scores had a statistically significant effect on the students' learning styles ($p<0.05$). 51.2% of the students living in a city/town had a visual learning style, and 53.7% of those living in a village had a tactile learning style. 57% of those living in a city/town with a university entrance score of 335 and below had a visual learning style, and 44.8% of those with a placement score of more than 335 had a visual learning style.

The tree diagram obtained using the CART algorithm is presented in Figure 3. In this method, living place and university entrance score had a statistically significant effect on learning style ($p<0.05$). While 51.2% of the people living in a city/town had a visual learning style, 53.7% of those living in a village had an auditory learning style. 42.4% of those living in a city/town with a university entrance score of 341.5 or higher had a visual learning style. 67.3% of those living in a city/town with a university entrance score below 341.5 and those with a university entrance score of 311.5 and above had a visual learning style. 44.6% of those with a university entrance score of 311.5 and below had a visual learning style.

Table 2. Descriptive statistics for the sub-dimensions of the scale

	Mean	*Standard deviation*	*Median*	*Minimum*	*Maximum*
Tactile	4.12	0.49	4.10	2.70	5.00
Auditory	3.64	0.47	3.60	2.30	5.00
Visual	4.22	0.43	4.22	3.00	5.00
Kinesthetic	3.74	0.53	3.71	2.43	5.00

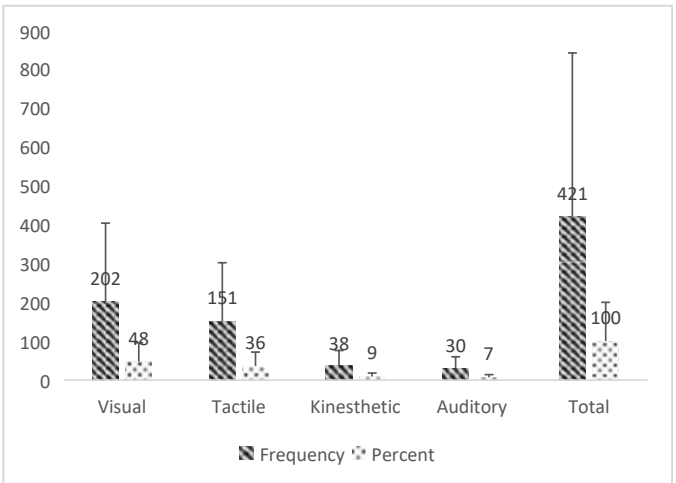

Fig 1: Students' dominant learning styles

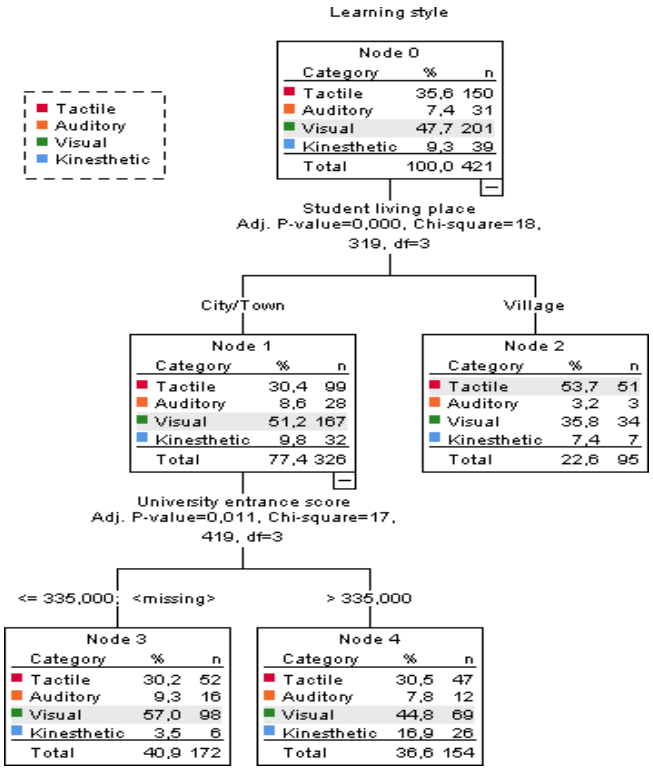

Fig 2: Decision tree diagram of the CHAID method

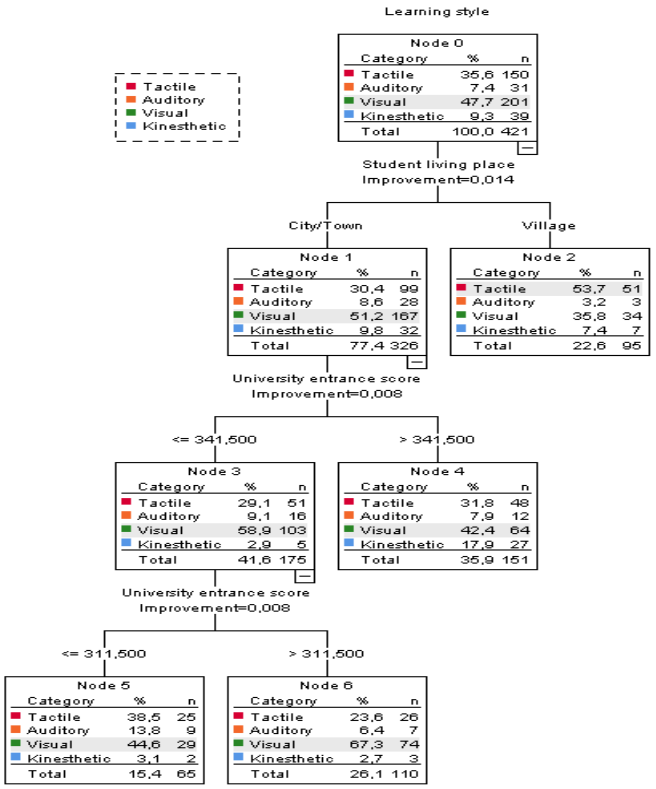

Fig 3: Decision tree diagram of the CART method

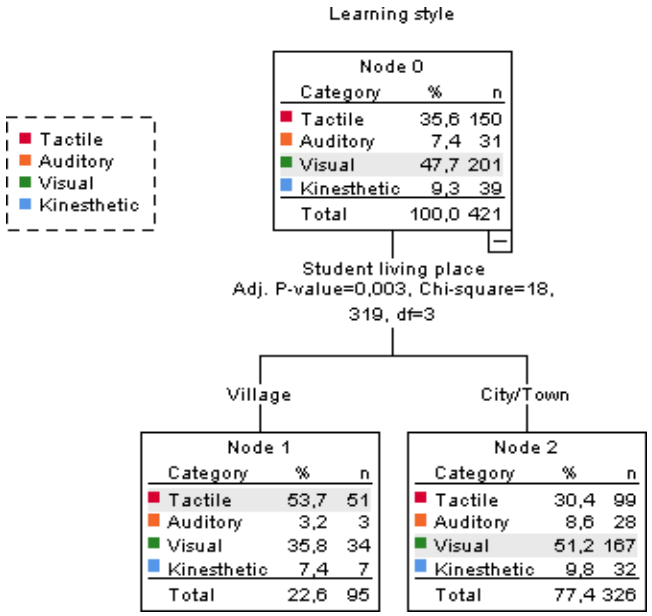

Fig 4: Decision tree diagram of the QUEST method

The tree diagram obtained by using QUEST as the decision tree algorithm is presented in Figure 4. The analysis demonstrated that only the living place had a statistically significant effect on the learning style ($p<0.05$). While 53.7% of those living in a village had a tactile learning style, 51.2% of those living in a city/town had a visual learning style.

DISCUSSION

Nurses are health care professionals with a key role in maintaining effective health care services. It is thus very important to train nurses who are competent in the field. To maximize the learning potential of nursing students, it is necessary to be aware of their learning styles (Doğan et al., 2018). Therefore, we evaluated the dominant learning styles of nursing students and the factors affecting their learning styles in our study.

Different studies using machine learning methods have been carried out in the field of educational sciences, for example, to estimate the course choice of the students, whether they will be successful in the course and their learning styles, and to determine the factors affecting internet addiction (Ahmad and Shamsuddin, 2010; Kayri & Günç, 2010; Sheeba& Krishnan, 2018; Maaliw & Ballera, 2017). In a study in which different machine learning methods such as Naive Bayes, logistic regression, and decision tree were compared in detecting and defining students' learning styles in a virtual learning environment, the decision tree method gave the most successful result with an accuracy of 87.42% (Maaliw & Ballera, 2017). A study determined the variables affecting the internet addiction levels of the students using the classification tree and the decision tree technique CHAID and demonstrated that variables such as the purpose of the individual's use of the Internet, daily use of the Internet, gender, income level, and father's education level were statistically significant (Kayri & Günç, 2010). A study conducted with 300 students to determine the students' learning styles used the Felder and Silverman learning styles model (FSLM), and the learning styles were estimated with the classification tree method, obtaining successful results (Sheeba & Krishnan, 2018). A study comparing the estimation performances of different data mining methods concluded that the estimations with the decision tree were more successful than the other methods (Ahmad & Shamsuddin, 2010). Decision tree is a machine learning method that is frequently used in educational sciences and is also quite popular as it is easy to interpret and understand and provides successful results.

In our study, the dominant learning style of most nursing students was visual. According to the studies on learning styles, university students mostly prefer the visual style, indicating that these students prefer to use symbolic materials containing information such as shapes, graphics, algorithms, and demonstrations. These students remember what they saw the most because they tend to encode information visually (Veznedaroğlu & Özgür, 2005). Consequently, giving lessons through distance education during the pandemic can contribute to the effective learning of students whose dominant learning style is visual.

In our study, visual, tactile, kinesthetic, and auditory learning styles were taken as dependent variables, and 10 independent variables affecting learning styles were used. Decision tree diagrams of "CART", "CHAID" and "QUEST" algorithms were used in the evaluation of these variables. In the trees created with all three algorithms, the independent variables that affect learning styles are shown. According to the classification tree created by the CART algorithm, variables affecting learning styles were the living place and university entrance score. Likewise, the variables affecting learning styles according to the tree created by the CHAID algorithm included living place and university entrance score. According to the tree created with the QUEST algorithm, living place was the only variable affecting learning styles. These results support that the learning process of individuals is shaped by the environment they lived in from birth. Behaviors such as providing learning environments that can appeal to many sense organs from the moment, they are born establish the foundation for learning. Encouraging individuals to learn in line with the opportunities available in their environment and providing settings where they will enjoy learning can create a positive attitude towards the education life. This result suggests that the learning styles of the students differ according to the places they live. Parallel to our study, Rahmati et al.'s (2015) study found that the place where students lived affected their learning styles. The study of Alp et al. (2020) also concluded that the place where the students lived before, they entered the university affected their learning styles.

University entrance score is one of the most important steps in determining the career preferences of many students. The limited time during the university entrance exam is one of the important factors affecting the success of the candidate. The aim of using time effectively in these exams has led to the emergence of practical solutions and algorithms in preparation for the university exam. According to Basturk (2011), students tend to resort to algorithm-based solutions in solving questions. Students with a visual learning style achieve learning more effectively and permanently in education using algorithms or schemas. This may mean that university entrance score of students with visual, auditory, tactile, and kinesthetic learning styles may be affected. In addition, conducting the

university entrance exam in the form of a test exam may cause high scores for students who have mastered the test technique. Yorulmaz (2013) investigated what has changed for students who had high scores from the university entrance exam but graduated from their departments with average and lower scores and those who had lower scores in the university entrance exam but were more successful in university. The results emphasized the importance of planning education and training by considering individual differences such as students' predisposition to verbal and numerical fields and their mastery of test technique. Different learning styles can be included in students preparing for university, and activities that can switch between these learning styles can be offered. In our study, mother's education level, father's education level and the type of high school graduated from had no significant effect on learning styles. The results obtained by Alp et al. (2020) support these results.

In conclusion, if education and training are planned according to the individual abilities, needs and interests of nursing students who differ in terms of learning styles, it can increase the learning levels of the students and ensure the permanence of knowledge. The results of our study can provide guidance for research on the development of education and training curricula that are planned by considering important concepts such as individual differences and learning styles.

Based on the results of the study, nursing students mostly had visual and tactile learning styles. It was concluded that the learning styles of the students were especially affected by the living place and university entrance scores. It can be concluded that laboratory applications should be emphasized and supported by visual course materials in lesson planning of the students attending the application-oriented nursing department. Besides, students with auditory and kinesthetic learning tendencies should not be ignored and supported with course materials suitable for their learning styles.

We think that being aware of the learning style that students are prone to will affect their approach to the lesson positively and will increase the success of the lesson by reducing the effort and time they spend for learning. We believe that educators' knowledge of learning styles will guide them in using appropriate techniques and materials and support their personal development. Although there is no standard measurement tool that determines the learning styles specific to nursing students in the literature, the results obtained from this, and similar studies can shed light on the development of such a measurement tool.

Ethical Considerations

- The approval for research was obtained from the Scientific Research Ethics Committee of Karadeniz Technical University (approval number:24237859-290, date:25/03/2021).
- Before questionnaire the data form, a summary was given to the participants about the study, and individuals who voluntarily agreed to participate in the study and ticked the checkbox were included.
- We have no conflicts of interest to disclose and received no funding for this study

Authorship contributions

Conceptualization, methodology, writing- original draft preparation of the study, the questionnaire preparation was performed by DS, methodology, study design, and analysis, and writing of the manuscript was performed by İBK, data gathering, visualization, revision was performed by BCA, investigation, data gathering and revision was performed by ÇTK. Final approval and contributions for the publication of the manuscript was made by all authors.

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