Original Article

Describing learning styles and associated demographic characteristics among university students: Implications for instructional provision in a higher education context

Anemut Mehari[1], Bezina Kassahun[1], Hana Berhanu[1], Biniam Birru[1]*

[1]Dilla University

**Corresponding author: E-mail: meharipsyc@gmail.com*

Abstract

The purpose of this study was to describe students' learning styles and identify associated demographic characteristics to imply appropriate instructional provisions in a higher education setting. We employed a cross-sectional descriptive survey design. Four universities—Arbaminch, Dilla, Wachamo, and Jinka—were selected from Southern Ethiopia. Three hundred seventeen participants were chosen at random. A learning style (ILS) scale was employed. The finding shows that active, sensing, visual, and sequential learning styles are the major learning styles among students. As in bivariate and multivariate analysis, age was positively associated with reflective, intuitive, verbal, and global learning styles. However, students' sex, stream, and university were not significantly associated with their learning styles. Generally, looking into the way the learners prefer to learn, and adjusting the instructional provision to fit into their preference is vital. Periodic modification of the instructional provision is also essential as students learning styles change with their age or seniority. Finally, including more demographic and psychosocial variables to examine students' association with their learning styles is suggested for future research.

Keywords: Higher education, instructional provision, learning styles, university students

1. Introduction

Educational institutions primarily aim to qualify learners for market demand. Qualification is maintained in a variety of ways. Advancing the quality of learning is one way. Improving the quality of learning requires a better understanding of the learning process from the perspective of the learner (Mitiku & Seleshi, 2011). Understanding the learning process needs intensive knowledge of how students absorb instructional objectives.

Students' academic performance is another indicator that ensures the quality of student learning. Yet, it is a prevalent problem in higher education institutions—leads to dropout and academic dismissal (Ganyaupfu, 2013). Although this is a single factor for the growth of the unemployment rate and impacts one's quality of life ultimately (Parvizi et al., 2021). Ethiopian university students as well as graduates are not exceptional in such trends. Poor academic achievement, connected with a lack of academic skills, is inadequately viewed from the student's learning style perspective. Stakeholders (e.g., experts in the education system and parents of students) are questioning the quality of the teaching-learning process (Haan, 2019)—not of the students' style for learning as well as its alignment with the instructional provision.

Learning style is a vital factor affecting students' learning. The way students process, perceive, receive, and understand course information is different and largely influences their ability to succeed at school (Annual et al., 2017; Lee et al., 2016). Regardless of differences in students' learning styles, the way in which instructors teach and interact with their students is nearly the same across the globe. There are studies touching on the issue in an Ethiopian context. For example, Mihrka and Schulze (2016) explored the students learning preferences at high school and second-year university student levels and found sensing to be the major preference among second-year university students using Felder and Soloman's model (i.e., reflective, active, sensing, intuitive, visual, verbal, sequential, and global learning styles). Sahile (2022) also examined learning style preferences and its association with academic achievement of medical students at Ambo University (2^{nd} to 5^{th} year) and found kinesthetic being the most preferred learning style by 61.11% of students. Graduate students learning styles were also examined by Berhanu (2014) at Addis Ababa University. Accordingly, tactile was found to be the major learning style of auditory, visual, and kinesthetic learning styles (Berhanu, 2014). However, freshman students and determinants of learning style remain unaddressed in all above studies. Representativeness of sampled universities is also another concern—one university per study is not enough to give a compressive explanation on the issue under study.

Evidence regarding the students' learning style difference as a function of their demographic characteristics (e.g., sex) is also contradictory. For instance, there is a relationship between students' gender and their learning style (Marantika, 2022; Nuzhat et al., 2013); there is a gender difference among graduate students learning styles (Berhanu, 2014); and female students prefer

aural or auditory learning styles (Sarabi-Asiabar et al., 2014). However, others (e.g., Bin Eid et al., 2021; Nasution, 2019) found no significant difference between males and females in their learning styles. This means that there is limited, consistent evidence across scholars.

Inadequate evaluation of students' learning styles results in academic problems, and these problems are more prevalent among first-year university students than among their seniors. Compared to freshman students, senior students accommodate more their learning styles to the instruction provisions. Instructional designers and course instructors also tend to be more aware of accommodating students' learning styles in their instructional tactics, as they stay longer with students. Researchers (e.g., Hebat-Allah, Gabal, Rasha, Hussein, 2021; Ghanney, Appiah, & Esia-Donkoh, 2019) strongly believe that teaching practices and learning styles determine students' academic achievement; thus, instructors should recognize students' learning styles, accept individual differences among students in their learning styles, and apply instructions that best suit students' learning styles. Therefore, this research project identified the distribution of students' learning styles and examined the students demographic characteristics (e.g., age, sex, university, and stream) associated with their learning styles.

2. Theoretical orientation

The Felder and Soloman's (2005) learning style model was used in this study. It has four dimensions, each with dichotomous learning styles: (1) perceiving, *sensing* (concrete and practical oriented toward facts and learning procedures) vs *intuitive* (abstract and innovative oriented toward theories and underlying meanings); (2) receiving, *visual* (preferring visual representations of presented material, such as pictures, diagrams and flow charts) vs *verbal* (preferring written and spoken explanations); (3) processing, *active* (learning by trying things and learning by enjoying working in groups) vs *reflective* (learning by thinking through and preferring working alone or with a single familiar partner); and finally, (4) understanding, *sequential* (linear thinking process, learning in small incremental steps) vs *global* (holistic thinking process, learning in large leaps) (Ghanney & Esia-Donkoh, 2019; Annual et al., 2017; Yeung et al., 2005).

We preferred the model over others due to the following reasons: (1) it is has more inclusive nature - incorporates the Grasha and Riechmann's (1994) six learning styles – competitive vs cooperative, avoidant vs participatory, and dependent vs independent (Dalmolin et al., 2018); (2) it has wide application, detailed descriptions, and high tested reliability and validity compared with other

models of learning styles (Hamada & Hassan, 2017); and (3) it better fits for higher education learners than Shindler and Yang's (2002) model which classifies learning style based on Myers-Briggs Type Indicator (MBTI) personality preference - extravert vs. introvert, intuitive vs. sensing, thinking vs. feeling, perceiving vs. judging. Shindler and Yang's orientation was also criticized for a lack of clearly specifying learners' age (i.e., it is designed for learners of 8- or more-year-old schoolchildren).

A single learner can have either or all of those learning styles with one dominant style (Marantika, 2022; LdPride, 2008). For this reason, multimodal learning style learners have more opportunities to perceive, interact with, and respond to different learning environments and instructional provisions (Cohen et al., 2010). Therefore, these learning styles are required to be calibrated into the way the instruction is provided, and the flexibility of instructors with the learning styles of the learners yields a better academic outcome.

3. Methods

3.1. Study design and setting

We employed a cross-sectional descriptive survey design, and the data were gathered from the target population at a single time across the sampled universities. Students were randomly selected from the southern part of the country. We categorized the eight universities on the basis of year of establishment, and four were randomly selected. These included Arbaminch, Dilla, Wachamo, and Jinka Universities.

3.2. Participants and sampling

Since this study is part of the major theme study "instructors' teaching practices and students' learning styles as determinants of academic achievement," the potential participants were all first-year university students who obtained first-semester academic status. The total sample size was determined via Draper and Smith's (1998) formula for the non-single population, as cited in Tefera and Ahmed (2015). Sample size (n) is a function of the factors and categories involved in research, as Draper and Smith implied. A minimum of 10 observations is required for each category of a factor. Typically, the sample size (n) is calculated as 10 $[C_{nf1}\ x\ C_{nf2}\ x\ C_{nf3}\ \ldots.x\ C_{fn}]$.

Where:

n = sample

Cf_1 - number of categories of factor 1

Cf_2 - number of categories of factor 2

Cf_3 - number of categories of factor 3

Cf_n - number of categories of factor n

The three factors identified in our potential participants included sex (with 2 categories—male and female), stream (with 2 categories—natural science and social science), and university (with 4 categories—Arbaminch, Dilla, Wachamo, and Jinka). Hence, the minimum total sample size is 160. Assuming a small number of factors and a non-response rate, we doubled the sample size. Following the determination of the total sample size, a proportional number of participants were drawn from the four universities via Kothari's (2004) formula, nh = (Nh/N) *n

Where

N = represents the entire population size

Nh= represents the population size for the h^{th} stratum

nh= represents the sample size, and n is the sample size.

Hence, the total population across the sampled universities was 9,343. With the determined sample size of 320, we proportionally selected 93, 84, 73, and 70 students from Arbaminch University, Dilla University, Wachamo University, and Jinka University out of the total population of 2,719, 2,450, 2,118, and 2,056, respectively.

3.3. Data collection tool

The students' learning styles were measured by adapting the Felder-Silverman (1988) Index of Learning Style (ILS) scale. The scale is designed for technology-enhanced and traditional learning settings (Graf, Viola, Leo, & Kinshuk, 2007) to promote effective learning (Ozerem, 2015). It has simple, easy-to-use, and wide applicability (Park & Merlot, 2014) and good validity and reliability, with a Cronbach's alpha of .6 for 288 Polytechnic Malaysian students (Hamada & Hassan, 2017; Omar et al., 2015) and .56 to .77 for Litzinger et al. (2005).

ILS has 4 bipolar continua in the processing (active-reflective), perception (sensing-intuitive), receiving/input (visual-verbal), and understanding (sequential-global) dimensions. The active style examined students' preferences for learning by trying out and enjoying working in groups. While reflective measures students' preference for learning by thinking things through, they prefer

working independently or with a single familiar partner. Sensing style tests students' preferences for learning through concrete thinking and practical, factual, and procedural methods.

However, the intuitive style assesses students' preferences for learning through abstract thinking, innovative methods, theories, and underlying meanings. Students with visual styles prefer visual representations of learning materials (e.g., pictures, diagrams, and flow charts). In contrast, students with verbal styles prefer written and spoken explanations. Sequential-style learners prefer a linear thinking process and learn in small incremental steps. However, global learners prefer a holistic thinking process and learn in large leaps (Felder & Spurlin, 2005; Felder & Silverman, 1988) (Table 1).

Table 1: Index of learning styles (ILS)

Dimension	**Learning style**	**Item Group**	**Questions**
Processing	Active	Trying something out	1, 5, 17, 25, 29
		Social oriented	9, 13, 21, 33, 37, 41
	Reflective	Think about material	
		Impersonal oriented	
Perception	Sensing	Existing ways	2, 30, 34
		Concrete material	6, 10, 14, 18, 26, 38
		Careful with details	22, 42
	Intuitive	New ways	
		Abstract material	
		Not careful with detail	
Receiving/input	Visual	Pictures	3, 7, 11, 15, 19, 23,
	Verbal	Spoken words	27, 31, 35, 39, 43
		Written words	
		Difficulty with visual style	
Understanding	Sequential	Detail oriented	4, 28, 40
		Sequential progress	20, 24, 32, 36, 44
		From parts to the whole	8, 12, 16
	Global	Overall picture	
		Non-sequential progress	
		Relations/connections	

For 11 items per dimension, the ILS has a total of 44 items that measure how students process, perceive, receive, and understand instructional information. A single learner has a relative preference along each of the four dimensions but can learn to function in the other directions. The participants gave their preference by choosing one of two endings to a sentence that focused on some aspect of learning. Sample item include "I understand something better after I (a) try it out,

(b) think it through." Each question of the scale option 'a' represents the first continuum of learning preference, and option 'b' represents the second continuum of learning styles (Jiraporncharoen et al., 2015; Omar et al., 2015).

3.4. Procedures

3.4.1. Instrument validation

Researchers have used different subject matter experts (SMEs) to evaluate the relevance of items measuring the construct. For example, Mehari (2022a; 2022b) involved a panel of ten, and Mehari et al. (2024) employed a panel of nine experts and produced valid evaluation scores. Five to ten experts are suggested in most literature (e.g., Lynn, 1986). Therefore, we fulfilled the minimum requirement and purposefully selected five experienced experts. A Lawshe's (1975) statistical approach content validity evaluation method was used to evaluate the relevance of each as well as overall items in measuring the construct. The computational formula is presented as follows:

$$CVR = (ne - N\ /\ 2)/(N\ /\ 2)$$

CVR = content validity ratio

ne = number of panellists pointing to the item as 'essential.'

N = total number of panelists

The panelists were ranked via a three-point rating system (1 for not essential, 2 for useful but not essential, and 3 for essential). The value of the CVR ranges between -1 and +1. If the value is positive (1), the item is deemed acceptable and clear; if it is negative (2), it should be reworded, modified, or rejected; and if 50% of the panellists of N size assess the item as essential (3), it is deemed necessary and legitimate (Lewashe, 1975).

The CVR for 44 items was one (adjusted to .99 for ease of manipulation), which satisfied the acceptable range ≥.78 (Polit et al., 2007) and more panelists (beyond 50%) perceive an item as ''essential'', the greater the extent or degree of its content validity (Gilbert & Prion, 2016).

The reported CVR to determine the validity of individual items, as rated by a panel of content experts, providing a numeric value for the overall mean of all items in the scale via the content validity index (CVI) statistical technique is also important. Therefore, the score content validity index average (S-CVI/Ave) proportion of relevance of items across experts was .99, exceeding the ≥ .70 (Tilden et al., 1990) or ≥ .8 (Davis, 1992).

3.4.2. Scoring

The students' learning style score ranges from 1 to 11 per dimension. The responses for each item were 1 or -1. For example, if a student prefers an active style in one question of the "active-reflective" dimension, a score of 1 is added to the active dimension, where 1 is subtracted from the reflective style score. For each of the four scales, the smaller total is subtracted from the larger one. This means that if a student scored a total of 3 for "a" and 8 for "b," it was calculated as 5b. Therefore, the scoring for each domain of the learning style is divided into three with two polarities. A score between 1 and 3 represented "balanced." learning style; a score between 5 and 7 indicated "moderate preference and a score between 9 and 11 indicated "strong preference" (Jiraporncharoen et al., 2015).

11a 9a 7a 5a 3a 1a ! 1b 3b 5b 7b 9b 11b

The degree of preference for each dimension is just the algebraic sum of all values of the answers to the eleven questions, as presented in the following equation:

$$Dim \sum_{i=1}^{11} qi^{Dim}$$

Dim - set of dimensions that embrace four pairs of dimensions: active-reflective, sensory-intuitive, visual-verbal, sequential-global

i the vector of indexes composed of (iA/R, iS/I, iV/V, iS/G) describes the attributes in each dimension.

q is the sum of questions belonging to each dimension; thus, Q = (q1, q2,…, q11), and each qi indicates the contribution given by the i-th question within the 11 questions for each Dim to detect whether preference 1 or -1 is substituted into qi. Thus, a student's academic achievement is given a CGPA score of 4 points.

3.4.3. Data collection procedure

Well-experienced research assistants (4) and data collectors (4) were purposefully selected, oriented, randomly assigned, and contacted freshman program dean offices and student group representatives at each sampled university. In cooperation with the student group representatives,

orientations were given to potential participants. Using a random lottery method, questionnaires were administered to willing participants in the classroom setting.

3.4.4. Data analysis

Microsoft Excel 2013 and SPSS-23 were used to manage the data. Before the data analysis, data screening and frequency counting were performed to check the accuracy of proper data entry. Descriptive statistics were used to determine the distribution and level of students' learning styles. Univariate and multivariate multinomial regressions were performed to examine the demographic characteristics associated with students' learning styles. Factors associated with the learning styles in the univariate analysis with p values < 0.2 were included in the multivariable model so that we can limit the potential risk of over adjustment without compromising the identification of potential factors for the learning styles. Crude and adjusted ratios at 95% confidence intervals were used to estimate the strength of potential factor associations with the outcome variables. An alpha value of 0.05 was set for all the statistical tests.

3.5. Ethics and consent

The Center for Educational Research, along with the Office of Research and Dissemination and the Office of Vice President for Research and Technology Transfer at Dilla University, have ensured that the issue under investigation complies with academic research criteria and ethical standards on 13/01/2023 (DU/164/2023). Representatives from the Center for Educational Research, the Office of Research and Dissemination, and the Office of Vice President for Research and Technology Transfer at Dilla University approved the unharmed effect of the data collection tool, assumed the number of participants, and confirmed that collecting verbal consent from participants is sufficient for the present study.

Potential participants were briefed about the aim of the study and the nature of the instrument. Informed consent was obtained from the participants. The confidentiality of the participants was protected by avoiding mentioning their names and other relevant identifiers during the data collection and reporting procedures.

4. Results

4.1. Students' demographic characteristics

Table 2 shows the proportions of participants from each study site. Three response questionnaires from Arbaminch University participants (2) and Wachamo University participants (1) were removed because of inappropriate and incomplete responses. Among the distributed questionnaire sheets, 99.06% were useful for analysis, indicating a very good response rate.

A total of 317 students were proportionally selected from each stratum: Arbaminch (28.4%), Dilla (26.5%), Wachamo (22.7%), and Jinka (22.1%). Both natural science stream students (59.9%) and social science stream students (40.1%) participated. More than half (54.6%) were male, and 45.4% were female. The age of the participants ranged between 18 and 25 years, with a mean of 21.28 years and a standard deviation of 1.65 years. The CGPA also ranged between 1.72 and 3.93, with a mean of 3.13 and a standard deviation of 0.52.

Table 2: Students' socio-demographic characteristics *(N = 317)*

Variables	Label	Number (%)	Mean (SD)
Universities	Arbaminch	91 (28.4%)	
	Dilla	84 (26.5%)	
	Wachamo	72 (22.7%)	
	Jinka	70 (22.1%)	
Stream	NSS	190 (59.9%)	
	SSS	127 (40.1%)	
Sex	Male	173 (54.6%)	
	Female	144 (45.4%)	
Age	Max.	25	21.28 (1.65)
	Min.	18	
CGPA	Max.	3.93	3.13 (.52)
	Min.	1.72	

NSS Natural Science Stream, *SSS* Social Science Stream, *SD* Standard Deviation

4.2. Learning style distribution across demographic factors

A cross-tabular distribution of students' learning styles on the basis of their demographic characteristics was performed, as shown in Table 3. The results indicated that more active (27.76%), reflective (26.81%), visual (24.92%), verbal (29.65%), sequential (27.13%), and global learning styles (27.44%) were distributed among male students than female students. However, more females are inclined to be more intuitive (28.71%). In terms of learning style, both sexes show equal learning preferences (25.87%). With respect to the student stream, most natural science

stream students are inclined to be active in 102 (32.18%), reflective (27.76%), sensing (27.44%), intuitive (32.49%), visual (29.34%), verbal (30.6%), sequential (30.6%), and global learning styles (29.34%).

Table 3: Learning style distribution across demographic factors

Variables	**Categories**	**Outcome variable: Learning style**							
		A (%)	**R (%)**	**Sen (%)**	**I (%)**	**Vi (%)**	**Ve (%)**	**Seq (%)**	**G (%)**
Sex	F	70(22.08)	74(23.34)	82(25.87)	91(28.71)	61(19.24)	83(26.18)	65(20.5)	79(24.92)
	M	88(27.76)	85(26.81)	82(25.87)	88(27.76)	79(24.92)	94(29.65)	86(27.13)	87(27.44)
Stream	SSS	56(17.67)	71(22.4)	51(16.09)	76(23.97)	54(17.03)	73(23.03)	54(17.03)	73(23.03)
	NSS	102(32.18)	88(27.76)	87(27.44)	103(32.49)	93(29.34)	97(30.60)	97(30.6)	93(29.34)
University	JU	37(11.67)	33(10.41)	32(10.09)	38(11.99)	31(9.78)	39(12.30)	35(11.04)	35(11.04)
	AMU	50(15.77)	40(12.62)	44(13.88)	46(14.51)	45(14.2)	45(14.2)	48(15.14)	42(13.25)
	DU	43(13.56)	41(12.93)	38(11.99)	46(14.51)	39(12.29)	45(14.2)	42(13.25)	42(13.25)
	WU	28(8.83)	45(14.2)	24(7.57)	49(15.46)	25(7.89)	48(15.14)	26(8.2)	47(14.83)
Age	Mean±SD	.51±.50	.55±.50	.57±.49	.49±.50	.56±.49	.50±.5	.53±.49	.53±.45

F *female,* M *male,* SSS *social science stream,* NSS *natural science stream,* JU *Jinka University*, AMU *Arbaminch University* DU *Dilla University* WU *Wachamo University, A* active, *R* refelective, *Sen* sensing, *I* intuitive, *Vi* visual, *Ve* verbal, *Seq* sequential, *G* global

4.2. Students' learning style distribution

As depicted in Figure 1 below, slightly more than half of the participants were active learners (50.5%), sensing learners (56.5%), visual learners (55.8%), or sequential learners (52.4%). In other words, slightly more than half of the learners preferred active, sensing, visual, and sequential learning styles than reflective (49.5%), intuitive (43.5%), verbal (44.2%), and global (47.6%) learning styles, respectively. This implies that most of the respondents prefer to learn by trying something that they learned in the course material, practically doing and observing facts, using visual inputs such as drawings, pictures, and diagrams, and using step-by-step procedures. On the other hand, they prefer learning less through thinking and intuitively processing information about the learning material, one-way auditory learning from the teacher to the student, and creating an overall picture of the subject matter.

More students' learning styles fall into the active-reflective dimension (mean = 1.30 and SD = 7.18), followed by the sequential-global dimension (mean = .56 and SD = 8.33), the visual-verbal dimension (mean = -.104 and SD = 7.93), and the sensing-intuitive dimension (mean = -.69 and SD = 8.11).

With respect to the level of learning styles, the majority (32.2%) were balanced active-reflective learners, followed by sequential-global (24.6%), visual-verbal (20.2%), and sensing-intuitive balanced dimensions (12.5%). At the moderate level, most students were sensing (22.4%), visual (20.8%), active (17%), sequential (13.9%), intuitive (12.3%), verbal (10.1%), reflective (8.5%), and global (7.9%). At the high level, the majority (31.2%) of the learners were highly global, followed by reflective (30.6%), sensing (28.1%), verbal (26.1%), intuitive (24.3%), visual (22.7%), sequential (22.4%), and active (11.7%) learners. Overall, active-reflective balanced learners (32.2%) outperform other balanced, moderate, and high-level learners (see Figure 2). These findings indicate that students are multimodal in their learning styles.

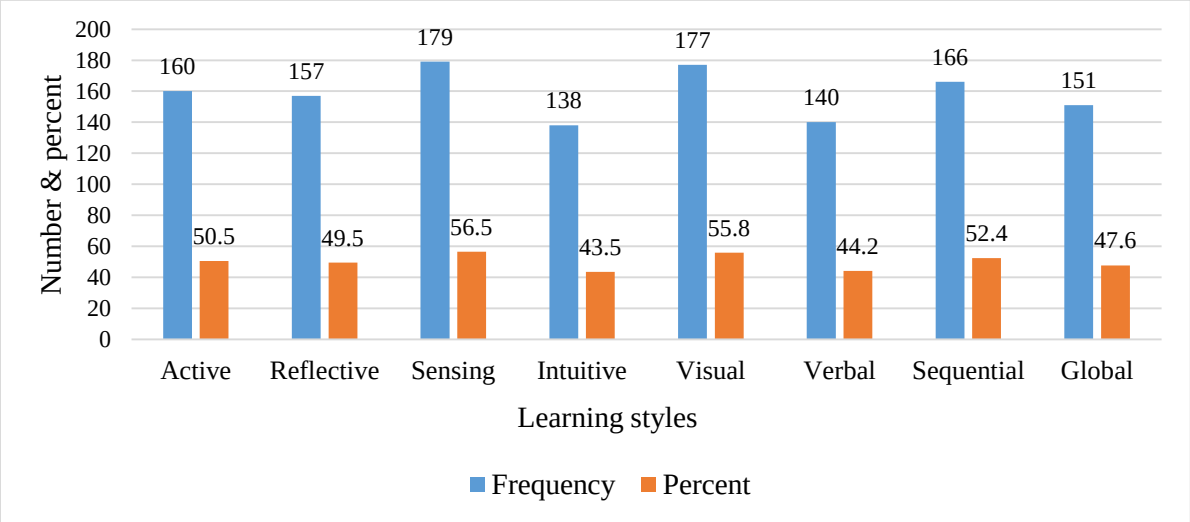
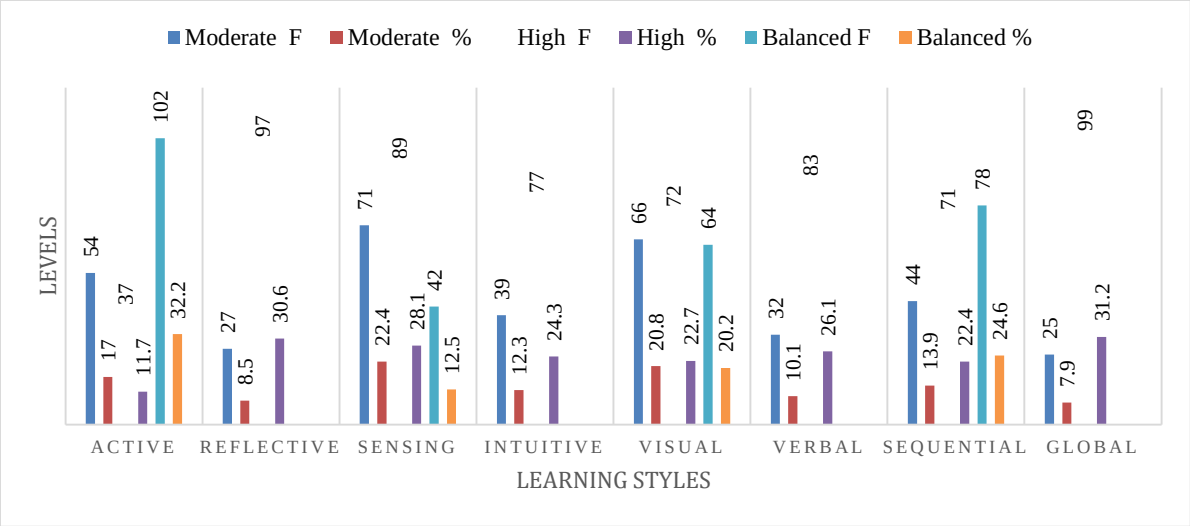


Figure 1: Level of students' learning styles



F frequency, *%* percent

Figure 2: Distribution of students' learning style levels

4.3. Factors associated with learning styles

4.3.1. Assumptions of multinomial logistic regression

Various assumptions were tested for logistic regression analysis. For example, the first assumption is that the response variable must be binary or a dummy. The second assumption is that the observations must be independent, the sample size must be sufficiently large (at least 10 records per predictor variable), and there must be a non-multicollinearity effect. Accordingly, the response variable (i.e., learning style) was a binary variable, the observations were independent, and the sample size was sufficiently large (n = 317).

4.3.2. Demographic characteristics associated with learning styles

The results from both the univariate and multivariate multinomial logistic regression models of learning styles are presented in Table 4. According to the univariate analysis, only age was significantly associated with learning style. Students' sex, stream, and university were not significantly associated with their learning styles. In the adjusted model, older age was increasingly associated with reflective learning style (Wald chi-square = 17.51; df = 1; AOR = 1.358, 95% CI = 1.18-1.57; p =.00), intuitive learning style (Wald chi-square = 15.76; df = 1; AOR = 1.343, 95% CI = 1.17-1.55; p =.00), verbal learning style (Wald chi-square = 12.15; df= 1; AOR = 1.282, 95% CI = 1.12-1.47; p =.00), and global learning style (Wald chi-square = 19.81; df = 1; AOR = 1.383, 95% CI = 1.20-1.60; p =.00). Conversely, students' age was not associated with sensing, visual,

or sequential learning styles. The findings generally indicate that a one-year increase in the students' age was 1.358 times greater for adopting more reflective learning styles, 1.343 times greater for adopting more intuitive learning styles, 1.282 times greater for adopting more verbal learning styles, and 1.383 times greater for adopting more global learning styles.

Table 4: Bivariate and multivariate analyses of factors associated with learning styles

Learning Style		**COR (95% CI)**	**AOR (95% CI)**
Reflective	Age	**1.328 (1.16, 1.53)***	**1.358 (1.18, 1.57)***
	Male	.924 (.59, 1.44)	.751 (.47, 1.19)
	Female	1	1
	NSS	.687 (.44, 1.08)	.313 (.10, .98)
	SSS	1	1
	AMU	.915 (.49, 1.72)	2.673 (.73, 9.85)
	DU	1.069 (.57, 2.02)	3.116 (.84, 11.52)
	WU	1.802 (.93, 3.51)	2.079 (1.0, 4.31)
	JU	1	1
Sensing	Age	.976 (.84, 1.14)	.978 (.84, 1.14)
	Male	1.178 (.74, 1.87)	1.180 (.74, 1.88)
	Female	1	1
	NSS	.946 (.59, 1.52)	.570 (.16, 2.03)
	SSS	1	1
	AMU	1.038 (.56, 1.94)	1.835 (.45, 7.54)
	DU	1.022 (.54, 1.95)	1.809 (.44, 7.49)
	WU	.991 (.48, 2.04)	1.161 (.53, 2.57)
	JU	1	1
Intuitive	Age	**1.307 (1.14, 1.50)***	**1.343 (1.17,1.55)***
	Male	.832 (.51, 1.28)	.687 (.44, 1.07)
	Female	1	1
	NSS	.751 (.48, 1.17)	.492 (.17, 1.41)
	SSS	1	1
	AMU	.914 (.50, 1.68)	1.702 (.51, 5.72)
	DU	1.042 (.56, 1.93)	1.934 (.57, 6.54)
	WU	1.704 (.89, 3.26)	1.814 (.88, 3.72)
	JU	1	1
Visual	Age	1.041 (.90, 1.21)	1.036 (.89, 1.20)
	Male	1.042 (.66,1.66)	1.033 (.65, 1.64)
	Female	1	1
	NSS	1.097 (.68, 1.77)	1.160 (.37, 3.64)
	SSS	1	1
	AMU	1.096 (.59, 2.05)	.937 (.26, 3.44)
	DU	1.083 (.57, 2.06)	.926 (.25, 3.43)
	WU	1.066 (.52, 2.19)	.997 (.44, 2.26)
	JU	1	1
Verbal	Age	**1.256 (1.10, 1.44)***	**1.282 (1.12, 1.47)***
	Male	.911 (.59, 1.40)	.781 (.50, 1.22)

	Female	1	1
	NSS	.672 (.43, 1.05)	.301 (.10, .94)
	SSS	1	1
	AMU	.871 (.48, 1.60)	2.696 (.74, 9.77)
	DU	.993 (.54, 1.84)	3.065 (.84, 11.15)
	WU	1.626 (.85, 3.11)	1.928 (.95, 3.92)
	JU	1	1
Sequential	Age	.964 (.83, 1.12)	.966 (.83, 1.12)
	Male	1.065 (.68, 1.67)	1.072 (.68,1.68)
	Female	1	1
	NSS	.996 (.63, 1.59)	.801 (.25,2.61)
	SSS	1	1
	AMU	1.036 (.56, 1.91)	1.305 (.35,4.91)
	DU	1.033 (.55, 1.94)	1.302 (.34,4.95)
	WU	.982 (.49, 1.99)	1.065 (.49,2.34)
	JU	1	1
Global	Age	**1.346 (1.17, 1.54)***	**1.383 (1.20,1.60)***
	Male	.886 (.57, 1.37)	.708 (.45,1.12)
	Female	1	1
	NSS	.706 (.45, 1.11)	.397 (.13,1.18)
	SSS	1	1
	AMU	.906 (.49, 1.68)	2.074 (.59,7.26)
	DU	1.033 (.55, 1.94)	2.358 (.67,8.29)
	WU	1.774 (.92, 3.43)	1.952 (.95,4.03)
	JU	1	1

a. The reference category is active; * Significant association at *p* value = .00

5. Discussion

5.1. Students' learning style distribution

In the present study, active, sensing, visual, and sequential learning styles were the dominant learning styles among first-year university students at the selected study sites. This means that the respondents in our study favor processing lesson information actively, working alone and in groups; perceiving by practically doing and observing course contents; receiving visual inputs such as drawings, pictures, and diagrams via slide projector and blackboard-chock techniques; and preferring more step-by-step processes in synthesizing the course content. This finding is consistent with those of previous studies, which revealed that except sequential learning styles, active, sensing, and visual learning styles are the dominant learning styles (Berková et al., 2020; Cada, 2021; Hebat-Allah et al., 2021; Ghanney et al., 2019; López et al., 2013; Magulod, 2019; Naimie et al., n.d.; Njoku & Abdulhamid, 2016; Omar et al., 2015); sequential learning style is preferable for most learners (Jiraporncharoen et al., 2015; Omar et al., 2015). Consistently, as

Mihrka and Schulze (2016) found that students significantly prefer sensing and visual learning styles over the intuitive and verbal dichotomies. However, they prefer reflective and global learning styles over the active and sequential categories. Students' seniority at university, type of participants, and the context may explain these difference. Furthermore, reflective learning style is a dominant learning style among excellent learners (López et al., 2013), and auditory learning style is found to be the dominant learning style among junior and high school students (Njoku & Abdulhamid, 2016). Considering these similar and contradicting studies with respect to the present finding, the general contexts, participants, and even the learning style models are different. For example, most of the literature employed on high school and college students using VARK (visual, auditory, read/write, and kinesthetic) model of learning styles.

Ultimately, more students fall into the active-reflective learning style dimension in the present study. In terms of learning style level, reflective, sensing, verbal, and global learning styles are more common, followed by active-reflective balanced, intuitive, visual, and sequential styles. In contrast, a small number of respondents fall under reflective, verbal, and global moderate and sensing-intuitive balanced levels. In contrast, Mihrka and Schulze (2016) found that 2nd year university students are balanced in all dimensions of learning styles. The type of participants and contexts the study was done may result is such unlike evidences. This finding generally mean that that students are multimodal learners, as indicated in other scholarly works (e.g., Bouchey et al., 2021). Multimodalists benefit from various instructional styles (Cohen et al., 2010).

5.2. Demographic characteristics associated with students' learning styles

According to the univariate and multivariate multinomial logistic regression model analyses, age was significantly associated with learning style. In the adjusted model, older age was increasingly associated with adopting more reflective, intuitive, verbal, and global learning styles. On the other hand, student age was not significantly associated with the sensing, visual, or sequential learning styles. Consistently, there is no relationship between learning styles (e.g., auditory and visual) and demographic variables (e.g., gender and age) (Fernandez-Caronan et al., n.d.); no relationship between auditory and visual learning style and age via a VARK model (Mohammadi et al., 2015); and no significant relationship between age and an active-reflective pair learning style. In contrast, Naimie et al. (n.d.) reported significant relationships with the sensing-intuition pair. The statistical methods employed and setting may yield such different outcomes.

Students' sex, stream, and university were not significantly associated with their learning styles. Similarly, no significant relationship was observed between learning styles and gender in all four dimensions in the Felder and Soloman learning model (Naimie et al., n.d.). Male and female students are not different in their learning styles using the VARK learning style model (Bin Eid et al., 2021; Nasution, 2019). In contrast, students' gender is related to their learning style (Marantika, 2022; Nuzhat et al., 2013). For example, auditory learning style is associated with students gender (Mohammadi et al., 2015), and male students prefer to use the kinesthetic learning style more than females do, whereas female students prefer the aural learning style (e.g., Sarabi-Asiabar et al., 2014). Berhanu (2014) also found gender differences among graduate students learning styles in the Addis Ababa University context. Finally, students' learning style relationships with their streams and universities were not adequately addressed in the literature.

6. Conclusion and implications for instructional provision

Active, sensing, visual, and sequential learning styles were dominant among first-year university students. This imply that more than half of the students (1) prefer an active learning style (e.g., practicing and working in groups) than contemplating on instructional objectives and work individually; (2) prefer more sensing learning style (e.g., choose conventional and concrete ways and detailed procedures); (3) prefer more visual information (e.g., pictures than spoken words); and (4) prefer more sequential style (e.g., favor detail, step-by-step procedures, and start from parts to figure out the overall picture) to process, receive, perceive, and understand the instructional objectives.

Accordingly, to ensure whether the students better process the learning outcomes or not, the instructional provision must favor practice (field or laboratory) first by the students rather than thinking it through or about it. The instructors and/or the instructional or lesson planning must encourage students to be outgoing, contribute ideas in class, and allow them to fully understand the problem first when doing home works, assignments, or exams. The instruction must also encourage students to know one another; encourage them to brainstorm and study in the group. In such cases, there may be student loafing—disengagement in group activities. When it happens, the instructor as well as the instructional practice need to be cautious and remediate it.

The instructional provision should primarily target realistic, factual, and real-life situations; deal with ideas and theories or concepts; focus on how to do things; use pictures, diagrams, graphs, charts, or maps rather than words, written directions, or verbal information; contain more detailed procedures and parts of a subject than on the overall picture of the course; and pay more attention to clear sequential or step-by-step procedures.

In terms of the level of students learning styles, reflective, sensing, verbal, and global learning styles are more common, followed by active-reflective balanced, intuitive, visual, and sequential styles. This implies that students are multimodal in their learning styles. Accordingly, a single instructional provision must consider multiple types of learning styles. Assuming the extent of students' dominant learning styles and the nature of the course, the instructor needs to design and provide visual, written, factual, or sequential instructions. Therefore, multimodal learners benefit from parts from each and can build a bigger picture or solid practice about the given instructional objective.

Older students are increasingly associated with reflective, intuitive, verbal, and global learning styles. This specifies that as the students grow older, the instruction must be designed to elicit higher orders of thinking such as evaluation, abstraction, and hypothetical thinking. It should be more on spoken/written ways and relational methods, or reduce trial methods of instruction, use of concrete, pictorial, and sequential ways. Generally, growing older at university directly infer the level of seniority. Therefore, as students become seniors, they require more abstract, general, and relational instructions as well as instructors. Unless they become exhausted, show frequent class absenteeism (or attend only for attendance purpose), and fail to master the instructional objectives properly. On the other hand, student age was not significantly associated with the sensing, visual, or sequential learning styles. In addition, students' sex, stream, and university were not significantly associated with their learning styles. Future researchers should further include more socio-demographic factors (e.g., academic achievement) and other psychosocial factors (e.g., studying styles) and examine learning styles with a large sample size.

Declaration of Conflicts of interest

The authors declare no conflicts of interest.

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Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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