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Original research

Exploring the Latent Dimensions of STEM Orientation among Albanian Upper-Secondary Students: An Exploratory–Confirmatory Factor Analysis Approach

Orgeta Gjermëni[1], Miftar Ramosaçaj[1], Elmira Kushta[1], Astrit Denaj[1]

[1] Department of Mathematics and Physics, Faculty of Technical and Natural Sciences, University "Ismail Qemali", Vlorë, Albania
*Corresponding author:*orgeta.gjermeni@univlora.edu.al

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Abstract

This study investigated the latent dimensions underlying upper-secondary students' orientation toward STEM fields in the Fier-Vlora region of Albania. It aimed to identify the factorial structure underlying perceptions of cognitive, contextual, and sociocultural influences; assess the instrument's psychometric properties; and confirm its structural validity through confirmatory factor analysis.

A quantitative, cross-sectional design was applied using a structured SCCT-informed questionnaire administered to grade 11-12 students. Data suitability was verified via KMO and Bartlett's tests. Exploratory factor analysis (MINRES extraction, oblimin rotation) was conducted to identify the latent structure. Confirmatory factor analysis (WLSMV estimator) was then applied to assess factorial stability, with model fit evaluated using classical/robust CFI, TLI, RMSEA and SRMR indices. Reliability (Cronbach's α, KR-20), convergent validity (CR, AVE), and discriminant validity (Fornell–Larcker criterion) were examined.

Complete responses from 499 students were analyzed. The dataset showed excellent factorability (KMO = 0.94; Bartlett's $p < 0.001$). Exploratory analysis revealed a five-factor structure, and reducing the item set from 20 to 16 improved parsimony and inter-factor distinction. The refined model demonstrated satisfactory fit (Robust CFI = 0.945; Robust TLI = 0.929; Robust RMSEA = 0.079; SRMR = 0.037), with all standardized loadings significant. Reliability values ranged from 0.617 to 0.885, and convergent and discriminant validity criteria were met.

The study validated a coherent five-factor structure that captures: cognitive engagement with STEM; outcome expectations and career utility; behavioral exposure to STEM activities; social and family support; instructional and career guidance. The instrument demonstrates strong psychometric properties and provides a contextually grounded tool for assessing STEM-related orientations among Albanian upper-secondary students.

Keywords: *STEM orientation; upper-secondary education; factor analysis; Social Cognitive Career Theory; psychometric validation; Albanian students*

Introduction

The acronym STEM (science, technology, engineering, and mathematics) was introduced in the early 1990s. Blackley and Howell have examined the evolution of the STEM movement, highlighting both enabling and limiting factors [1], while in [2], Reeve provides a brief discussion of the components of STEM and STEM education, Emphasizing their importance in a global context. Upper-secondary education in Albania (KNSA 3, ages 15-18) includes about 95% of students from basic education and is provided in gymnasiums, vocational schools, and institutions with a vocational focus. Due to declining birth rates and emigration, the population under 25 is expected to decrease by 10.74%, leading to a reorganization of the education system and more efficient restructuring of funding. According to the National Strategy for Education 2021-2026 and the Action Plan for its Implementation, higher education aims to be inclusive, aligned with international standards, and closely connected to the labor market. The promotion of STEM and interdisciplinary programs is viewed as a key tool for economic growth, preparing in-demand specialists and fostering digital, critical, managerial, and entrepreneurial skills [3]. Interest in STEM programs over the years is shown in Table 1, based on INSTAT data [4]. The fields of study are outlined in accordance with the manual “Fields of Education and Training ISCED-F 2013” [5].

Table 1. Interest in STEM university programs over the years, given by fields of study.

	Academic year	**2015-2016**	**2016-2017**	**2017-2018**	**2018-2019**	**2019-2020**	**2020-2021**	**2021-2022**	**2022-2023**	**2023-2024**
STEM fields of education	Natural sciences, mathematics, and statistics	6719	7816	6325	7060	5962	4924	4553	5056	2297
	Information and Communication Technologies (ICTs)	8260	7487	8228	10016	8883	8341	8458	9297	8964
	Engineering, manufacturing, and construction	18005	18480	18730	20019	20775	20537	22555	22834	23053
Total	STEM	32984	33783	33283	37095	35620	33802	35566	37187	34314
	All	148277	141410	131833	139043	130264	123797	123880	121352	116994
	% STEM	0.2224	0.2389	0.2525	0.2667	0.2734	0.2730	0.2871	0.3064	0.2934

The data indicate a marked and sustained decline in the field of "Natural sciences, mathematics and statistics" starting after the 2016-2017 academic year, alongside stabilityin ICT and continued growth in "Engineering, manufacturing and construction". This trend highlights the need for further reflection on educational policies, as the weakening of this category may impact the future development of the other two fields within STEM.

The 2023-2030 National Strategy prioritizes fostering a scientific culture by promoting research and integrating STEM into the pre-university curriculum (Objective 3.1) [6]. STEM-related subjects in upper-secondary education currently include mathematics, natural sciences (biology, physics, chemistry, earth sciences), and ICT [7].

Social Cognitive Career Theory (SCCT) [8], presented by Robert W. Lent, Steven D. Brown, and Gail Hackett in 1994, built on the foundation of Bandura's work [9], explains three connected aspects of career development: the formation and elaboration of career-relevant interests, selection of academic and career options, and performance and persistence in educational and occupational pursuits. Choosing a university major involves personal interests, high school experiences, teacher guidance, available information, and views on curriculum subjects. Career guidance coordinators in grades 10-12 play a key role by designing counseling plans that align students' choices with their interests and abilities [10]. Previous studies have shown that teaching methods [11], career guidance [12], and gender attitudes [13], [14], [15], influence STEM experiences.

To our knowledge, these dimensions have not yet been studied comprehensively in the Fier-Vlora region or in Albania. The present study aimed to explore and validate the latent structure underlying upper-secondary students' orientation toward STEM-related academic pathways in the Fier-Vlora region of Albania. Specifically, it sought to (i) identify the factorial dimensions that characterize students' perceptions of cognitive, contextual, cultural, and gender-related influences on STEM orientation; (ii) assess the reliability, validity, and internal consistency of the measurement instrument; and (iii) confirm the factorial stability of the reduced model through confirmatory factor analysis. By integrating exploratory and confirmatory procedures, this study contributes to the psychometric validation of a contextually adapted instrument for understanding STEM-related career orientation among Albanian upper-secondary students.

Methods

This study used a quantitative, cross-sectional, and psychometric research design to examine and validate the underlying dimensions of upper-secondary students' orientation toward STEM-related academic pathways. The methodological framework followed an exploratory-confirmatory sequence. Exploratory factor analysis (EFA) was used to identify the factorial structure, and confirmatory factor analysis (CFA) was used to evaluate its stability. The research was non-experimental and depended on self-reported data collected through a structured questionnaire administered at a single point in time.

A purposive, controlled sample ensured diversity by school type (public/private, general/vocational) and location (urban/rural) across the Fier–Vlora region in southern Albania. The targeted sample size followed the guidelines proposed in [16], recommending at least 10 participants per item. Inclusion criteria included student enrollment in grade 11 or 12, providing informed consent, and completing the entire questionnaire. Data collection was coordinated with school administrators.

The questionnaire was based on the SCCT framework, guided by prior studies [11], [17], [18], [19], and expert consultation, to ensure content validity and relevance to the Albanian education context. Administered in classrooms in October 2025 in paper format, it comprised 32 items across four dimensions: demographics (11), cognitive factors (10), contextual factors (6), and cultural/gender factors (5) [12]. Most items used a 5-point Likert scale (1 = Strongly disagree to 5 = Strongly agree). Participants were informed about the study's aims, STEM definition, and academic use of the data. Informed consent was obtained through a required agreement confirming voluntary participation. As the questionnaire was anonymous, parental consent was not needed; however, teacher and administrator approval were secured. During data entry, binary items were coded (1 = Yes, 0 = No) and Likert items retained their 1-5 scale. Only data from students with informed consent were included in the R software [20] dataset for analysis.

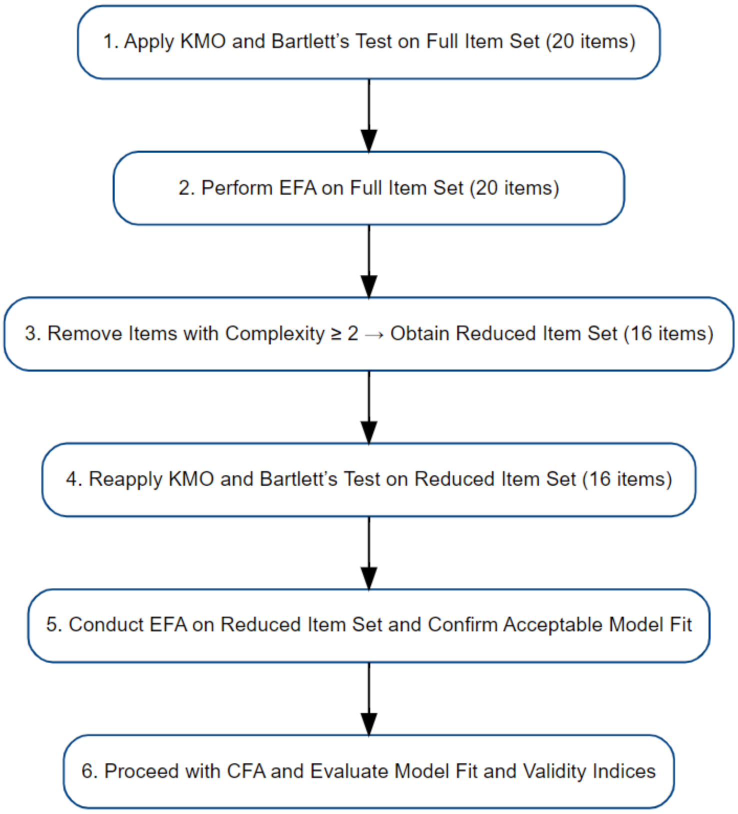

Figure 1. Analytical workflow from data suitability testing to exploratory and confirmatory factor analyses.

Before conducting EFA, demographic items and the dependent variable (Q1-Q11; Q21; see Table 2) were excluded. The following study was conducted on the remaining 20 items. After confirming non-normality in the data distribution using the Anderson-Darling normality test [21], a Spearman correlation matrix was computed to assess inter-item associations.

Figure 1 presents the analytical workflow applied in this study. Initially, the full item set (20 items) was evaluated using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (MSA ≥ 0.80; acceptable threshold ≥ 0.50) [22], [23], [16] and Bartlett's test of sphericity ($p < 0.05$) [24]. Given the mixture of ordinal and binary indicators, a mixed correlation matrix was calculated and used as the input for the parallel analysis to determine the optimal number of latent factors to retain.

The EFA was conducted using the fa() function from the psych package [25], applying the minimum residual (MINRES) extraction method and oblimin rotation to account for correlated factors. A loading threshold of 0.30 [16], [26] was adopted to interpret the factor structure. Items with high complexity (≥ 2) were flagged for further review, while items with communalities ≥ 0.50 and complexity less than two were retained [16]. Model fit for the EFA was evaluated using the root mean square error of approximation (RMSEA; acceptable ≤ 0.08, preferably ≤ 0.06; poor > 0.10) [27], [28], [29], the root mean square of the residuals (RMSR; ≤ 0.05), and the Tucker-Lewis index (TLI; adequate ≥ 0.90, preferably ≥ 0.95) [29]. The likelihood-ratio chi-square statistic [30], [31], and the empirical chi-square statistic [32] were used to test overall model fit and stability under resampling, respectively. The Bayesian Information Criterion (BIC) [33] was used to compare models, favoring those with better fit and lower complexity. Finally, mean item complexity [34] was used to evaluate factor simplicity, with lower values indicating more distinct item loadings on single factors.

The CFA was performed using the cfa() function from the lavaan package [35]. Given the mixed measurement levels and non-normal data, the WLSMV estimator was used, and missing data were handled through pairwise deletion. CFA model fit was assessed using: the scaled chi-square test ($p > 0.05$) [36], comparative fit index (CFI; adequate ≥ 0.90, preferably ≥ 0.95) [29], TLI, RMSEA, and standardized root mean square residual (SRMR; good ≤ 0.08, acceptable ≤ 0.10) [31], [28], [29]. Robust versions of CFI, TLI, and RMSEA were also examined alongside the classical indices. Standardized factor loadings (≥ 0.50 = acceptable; ≥ 0.70 = strong) and squared multiple correlations (R^2) were interpreted according to established psychometric conventions.

Convergent validity was assessed using the average variance extracted (AVE; ≥ 0.50) [37] and composite reliability (CR; acceptable 0.60-0.70, preferable ≥ 0.70). Discriminant validity was evaluated via the Fornell-Larcker criterion. Internal consistency reliability was estimated using Cronbach's alpha (≥ 0.70 [38], [39], [40], though ≥ 0.60 may be acceptable) for ordinal constructs, and the Kuder-Richardson 20 (KR-20) coefficient for the binary factor.

Results

Participant Demographics and STEM Interest Distribution

A total of 514 students from 14 upper-secondary schools in the Fier and Vlora regions (public (12)/private (2); general (11)/vocational (3); urban (11)/rural (3)) were invited to participate. Of these, 499 students in grades 11 and 12 provided voluntary, complete responses. Table 2 summarizes the distribution across key demographic variables (Q1-Q11) and the dependent variable Q21.

Table 2. Distribution (n, %) of Q1–Q11 and Q21.

Item	Categories	n	%
Q1: Gender	Female	269	53.91
	Male	230	46.09
Q2: Grade	11th	254	50.90
	12th	245	49.10
Q3: Place of residence	Rural	115	23.05
	Urban	384	76.95
Q4: School location	Rural	50	10.02

	Urban	449	89.98
Q5: School type	Private	84	16.83
	Public	415	83.17
Q6: What is your mother's highest educational degree or certificate?	Primary school	10	2.00
	Lower-secondary school (8/9-years)	145	29.06
	Upper-secondary school	214	42.89
	Bachelor's degree (3 years)	36	7.21
	Master's degree (professional/scientific 4/5 years)	85	17.03
	PhD degree	9	1.80
Q7: What is your father's highest educational degree or certificate?	Primary school	15	3.01
	Lower-secondary school (8/9-years)	140	28.06
	Upper-secondary school	205	41.08
	Bachelor's degree (3 years)	66	13.23
	Master's degree (professional/scientific 4/5 years)	61	12.22
	PhD degree	12	2.40
Q8: What is your father's current employment status?	Full-time employee	293	58.72
	Part-time employee	40	8.02
	Business owner / Self-employed	116	23.25
	Unemployed, seeking a job	22	4.41
	Unemployed, not seeking a job	7	1.40
	Unable to work	7	1.40
	Retired	5	1.00
	Deceased	9	1.80
Q9: What is your mother's current employment status?	Full-time employee	261	52.30
	Part-time employee	31	6.21
	Business owner / Self-employed	56	11.22
	Unemployed, seeking a job	6	1.20
	Unemployed, not seeking a job	11	2.20
	Unable to work	3	0.60
	Retired	1	0.20
	Deceased	2	0.40
	Housewife	128	25.65
Q10: What is your father's main occupation?	STEM Field	176	35.27
	Non-STEM Field	323	64.73
Q11: What is your mother's main occupation?	STEM Field	43	8.62
	Non-STEM Field	309	61.92
	Housewife	147	29.46
Q21: I'm interested in university studies related to a STEM career.	1- Strongly disagree	42	8.42
	2- Disagree	36	7.21
	3- Neither	94	18.84
	4- Agree	142	28.46
	5- Strongly agree	185	37.07

Exploratory Factor Analysis

Both the KMO and Bartlett's test confirmed the dataset's suitability for factor analysis. The full and reduced item sets (after the first round of EFA) showed excellent sampling adequacy. In both cases, Bartlett's test was highly significant, supporting the use of factor extraction. A summary of these results is presented in Table 3.

The first round of EFA, using all 20 items, identified four items ("Q15: I would feel comfortable talking to people who work in STEM careers.", “Q16: I will work hard in my STEM classes.”, “Q31: I have enough access to information on careers related to STEM.”, “Q32: My gender influences my choice of a future career related to STEM.”) with high complexity. After their removal, the second EFA on the 16-item set confirmed the same five-factor structure, as shown in Figure 2. The reduced model showed improved parsimony and internal consistency. It was reflected in lower item complexity, higher communalities, and strong factor score reliability. Detailed results are presented in Table 4.

Table 3. Comparison of factorability tests and parallel analysis results.

Indicator	**Full item set**	**Reduced item set**
KMO (Overall MSA)	0.94	0.92
KMO (Per-item range)	0.81–0.96	0.78–0.95
Bartlett’s test χ^2(df); p-value	4919.24 (190); $p < 0.001$	3677.53 (120); $p < 0.001$

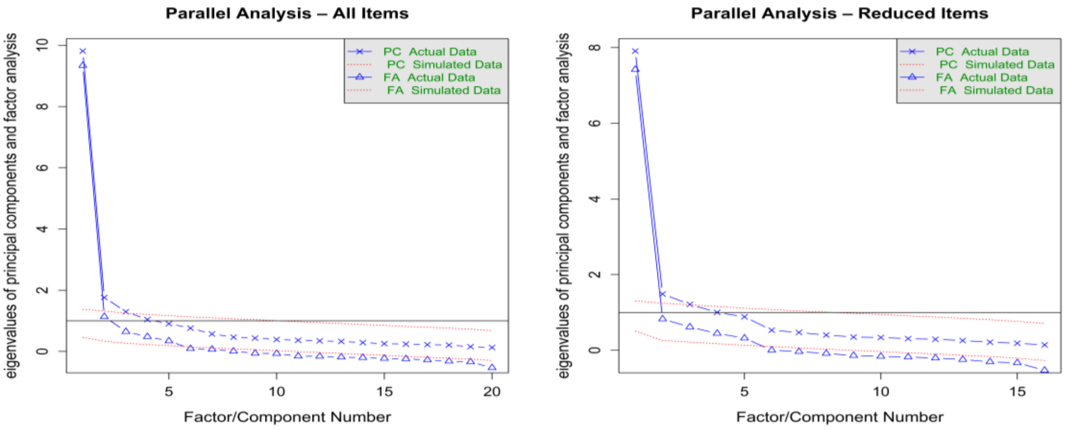

Figure 2. Scree plot and parallel analysis for factor retention.

Table 4. Results of EFA conducted in two stages: comparison between full and reduced models

	Factor	**Item**	**MR4**	**MR1**	**MR2**	**MR5**	**MR3**	**h^2**	**u^2**	**Com**	**SS Loa.**	**Prop. of Var.**	**r**	**R^2**	**Min r**
EFA full model	F1	Q13	**0.83**	-0.02	0.00	0.10	0.04	0.79	0.21	1.0	3.47	0.17	0.96	0.92	0.83
		Q14	**0.79**	0.04	0.06	0.02	0.00	0.74	0.26	1.0					
		Q12	**0.71**	0.08	0.12	-0.08	0.12	0.70	0.30	1.2					
		Q22	**0.53**	0.10	0.20	0.13	0.05	0.68	0.32	1.5					
		Q15	**0.46**	0.25	-0.01	0.26	-0.06	0.65	0.35	2.3*					
	F2	Q20	-0.14	**0.86**	0.12	0.01	0.07	0.76	0.24	1.1	3.46	0.17	0.96	0.92	0.84
		Q19	0.04	**0.81**	0.01	0.03	-0.04	0.73	0.27	1.0					
		Q18	0.21	**0.68**	0.02	0.03	-0.05	0.73	0.27	1.2					
		Q17	0.19	**0.64**	-0.07	0.11	0.11	0.75	0.25	1.3					
		Q16	0.44	**0.48**	0.01	0.01	0.07	0.76	0.24	2.0*					
	F3	Q28	0.04	0.01	**0.78**	-0.07	0.02	0.61	0.39	1.0	2.52	0.13	0.93	0.86	0.72
		Q29	0.01	0.09	**0.74**	0.04	-0.05	0.64	0.36	1.0					

	Factor	Item	MR4	MR1	MR2	MR5	MR3	h^2	u^2	Com	SS Loa.	Prop. of Var.	r	R^2	Min r
		Q30	0.08	-0.04	**0.70**	0.11	0.05	0.65	0.35	1.1					
		Q31	0.07	0.10	**0.41**	0.26	0.13	0.59	0.41	2.2*					
		Q32	-0.23	0.04	0.28	0.28	0.21	0.28	0.72	3.8*	-	-	-	-	-
	F4	Q24	-0.03	0.05	0.02	**0.80**	0.07	0.71	0.29	1.0	2.13	0.11	0.91	0.83	0.67
		Q23	0.13	-0.06	0.07	**0.66**	-0.02	0.53	0.47	1.1					
		Q25	0.09	0.24	0.09	**0.45**	-0.12	0.49	0.51	1.9					
	F5	Q27_num	-0.01	0.05	-0.10	0.06	**0.80**	0.63	0.37	1.1	1.55	0.08	0.90	0.81	0.62
		Q26_num	0.07	-0.04	0.12	-0.05	**0.78**	0.70	0.30	1.1					
EFA reduced model	F2	Q20	−0.11	**0.86**	0.07	0.01	0.10	0.75	0.25	1.1	2.91	0.18	0.96	0.91	0.83
		Q19	0.02	**0.83**	−0.03	0.05	0.00	0.75	0.25	1.0					
		Q18	0.24	**0.70**	−0.06	0.01	0.01	0.74	0.26	1.2					
		Q17	0.21	**0.65**	0.10	0.08	−0.07	0.73	0.27	1.3					
	F1	Q13	**0.92**	−0.02	0.01	0.08	−0.05	0.86	0.14	1.0	2.83	0.18	0.96	0.92	0.85
		Q14	**0.75**	0.06	−0.01	0.03	0.06	0.70	0.30	1.0					
		Q12	**0.71**	0.10	0.09	−0.11	0.12	0.68	0.32	1.2					
		Q22	**0.56**	0.11	0.03	0.12	0.18	0.70	0.30	1.4					
	F5	Q28	0.02	−0.01	0.04	−0.03	**0.78**	0.63	0.37	1.0	2.03	0.13	0.92	0.85	0.69
		Q29	−0.02	0.07	−0.03	0.06	**0.77**	0.67	0.33	1.0					
		Q30	0.10	−0.03	0.05	0.10	**0.66**	0.60	0.40	1.1					
	F4	Q23	0.07	−0.08	0.00	**0.75**	0.05	0.59	0.41	1.0	1.70	0.11	0.90	0.81	0.62
		Q24	−0.01	0.10	0.08	**0.71**	0.01	0.64	0.36	1.1					
		Q25	0.00	0.24	−0.09	**0.49**	0.12	0.50	0.50	1.7					
	F3	Q26_num	0.02	−0.03	**0.90**	−0.02	0.07	0.85	0.15	1.0	1.46	0.09	0.94	0.88	0.75
		Q27_num	−0.01	0.07	**0.72**	0.08	−0.10	0.53	0.47	1.1					

*Note 1 SS Loa: Sum of squared loadings, h^2: communalities, u^2: unique variances, Com: item complexity, with * are marked those cases that are≥ 2; r: correlation of regression scores with factors; R^2: multiple R-squared of scores with factors; Min r: Minimum correlation of possible factor scores.*

Table 5 displays the inter-factor correlations for both EFA models. The full model showed moderate associations, with some overlap between MR1-MR4 and MR1-MR5.

Table 5. Factor correlation matrices for full and reduced EFA models.

Full model	MR4	MR1	MR2	MR5	MR3	Reduced model	MR1	MR4	MR3	MR5	MR2
MR4	1.00	0.66	0.47	0.51	0.31	**MR1**	1.00	0.66	0.52	0.60	0.29
MR1	0.66	1.00	0.50	0.59	0.29	**MR4**	0.66	1.00	0.50	0.56	0.35
MR2	0.47	0.50	1.00	0.53	0.40	**MR3**	0.52	0.50	1.00	0.53	0.40
MR5	0.51	0.59	0.53	1.00	0.29	**MR5**	0.60	0.56	0.53	1.00	0.27
MR3	0.31	0.29	0.40	0.29	1.00	**MR2**	0.29	0.35	0.40	0.27	1.00

After item reduction, correlations remained comparable but reflected greater balance and theoretical clarity. The reduced model exhibited less cross-factor contamination, particularly between MR2 and MR5. Furthermore, as shown in Table 6, the reduced model exhibited improved parsimony and better overall fit than the full model. Mean item complexity decreased, indicating more distinct factor loadings. TLI increased, and RMSEA slightly decreased. Stability of the RMSEA confidence intervals was observed. Both models showed consistently low RMSR values. Likelihood chi-square values were statistically significant in both models, reflecting substantial model-data divergence as expected in large samples. In contrast, empirical chi-square values were non-significant, suggesting an acceptable fit based on sample-adjusted residuals. Despite a slightly higher BIC, the reduced model achieved greater clarity with fewer cross-loadings and a more coherent factor structure.

Table 6. Comparative model fit statistics for full and reduced EFA models.

Fit index	EFA full model	EFA reduced model
Mean item complexity	1.4	1.1
Likelihood χ^2; df; p-value	464.32; df = 100; p<2.6e-48	218.08; df = 50; p<7.2e-23
RMSR	0.02	0.02
TLI	0.899	0.922
RMSEA [90% CI]	0.085 [0.078–0.093]	0.082 [0.071–0.093]
BIC	−156.94	−92.55
Empirical χ^2 (p-value)	108.76 ($p < 0.26$)	40.14 ($p < 0.84$)

Confirmatory Factor Analysis

The CFA was conducted to validate the five-factor structure identified in the EFA. The reduced model demonstrated satisfactory fit, with all key robust indices meeting or exceeding conventional thresholds. Although the scaled chi-square statistic was statistically significant, which is a common outcome in large samples, all approximate fit indices, including the classical/robust CFI, TLI, RMSEA, and SRMR, indicated acceptable to good model fit. Table 7 presents the fit statistics.

Table 7. Summary of CFA results for the five-factor model

Model fit index	Value
Scaled χ^2 (df), p-value	294.51 (94), $p < 0.001$
CFI / Robust CFI	0.979 / 0.945
TLI / Robust TLI	0.973 / 0.929
RMSEA [90% CI]	0.065 [0.057–0.074]
Robust RMSEA [90% CI]	0.079 [0.068–0.091]
SRMR	0.037
Latent factor correlations (range)	0.35–0.79

Standardized factor loadings for the five-factor CFA model were all statistically significant, indicating strong convergent validity. The squared multiple correlations (R^2) showed that individual items explained substantial portions of their respective latent constructs. Inter-factor correlations suggested moderate associations while preserving discriminant validity. Full details are presented in Table 8 and visualized in Figure 3.

Table 8. Standardized factor loadings and squared multiple correlations (R^2) for the five-factor CFA model

Factor	Item	λ	R^2
F1	Q13	0.876	0.768
	Q14	0.835	0.698
	Q12	0.811	0.659
	Q22	0.869	0.755
F2	Q20	0.834	0.696
	Q19	0.849	0.721
	Q18	0.870	0.757
	Q17	0.868	0.754
F3	Q26_num	0.900	0.810
	Q27_num	0.733	0.538
F4	Q24	0.783	0.613
	Q23	0.710	0.505
	Q25	0.748	0.559
F5	Q28	0.740	0.548
	Q29	0.810	0.655
	Q30	0.816	0.665

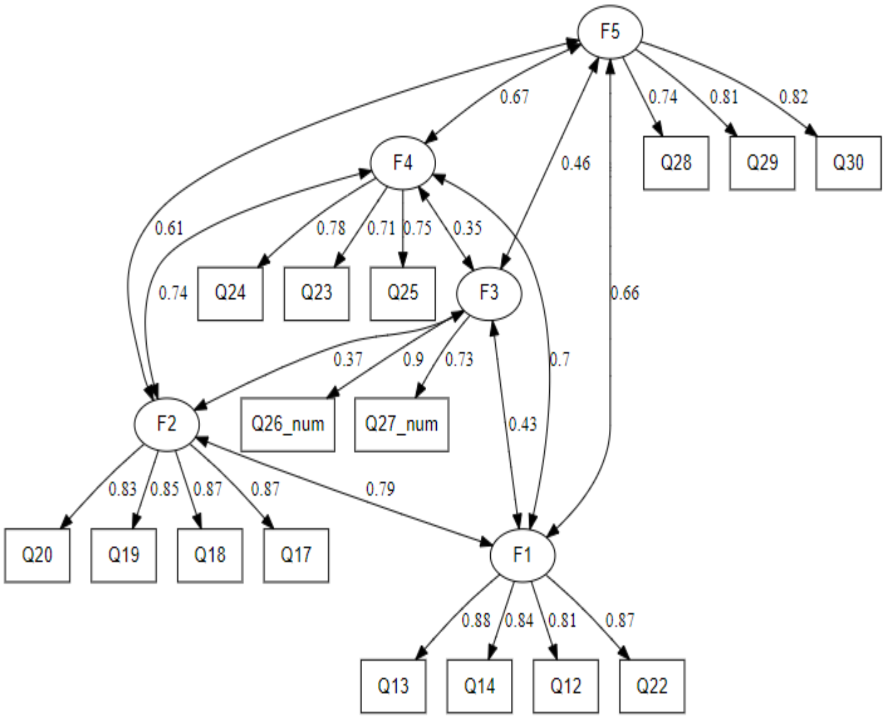

Figure 3. Path diagram of the five-factor CFA model with standardized loadings and inter-factor correlations.

As summarized in Table 9, internal consistency and convergent validity were examined for each of the five latent constructs. Cronbach's alpha values demonstrated satisfactory to excellent reliability for the ordinal-item factors, and the KR-20 coefficient indicated acceptable reliability for the binary-item factor. The overall Cronbach's α was 0.91, confirming the internal coherence of the full scale. Composite reliability and average variance extracted values indicated convergent validity across all factors.

Table 9 Summary of internal consistency and construct validity across factors.

Factor	Items	Type	Cronbach's α / KR-20	Mean inter-item correlation ($\bar{r}$)	CR	AVE
F1	Q13, Q14, Q12, Q22	Ordinal	0.885	0.66	0.911	0.720
F2	Q20, Q19, Q18, Q17	Ordinal	0.884	0.66	0.916	0.732
F3	Q26_num, Q27_num	Binary	0.617 (KR-20)	0.45	0.804	0.674
F4	Q24, Q23, Q25	Ordinal	0.731	0.48	0.791	0.559
F5	Q28, Q29, Q30	Ordinal	0.794	0.56	0.832	0.623

Table 10 Discriminant validity assessment using the Fornell–Larcker criterion

Factor	F1	F2	F3	F4	F5
F1	**0.848**				
F2	0.788	**0.856**			
F3	0.434	0.372	**0.821**		
F4	0.695	0.738	0.351	**0.748**	
F5	0.660	0.606	0.459	0.670	**0.789**

Note 2. Diagonal elements represent the square roots of the average variance extracted ($\sqrt{AVE}$), while the off-diagonal elements indicate latent factor correlations.

As shown in Table 10, discriminant validity was confirmed using the Fornell-Larcker criterion. For each factor, the square root of the average variance extracted exceeded the corresponding inter-factor correlations, indicating satisfactory discriminant validity across all constructs.

Collectively, the evidence from model fit indices, standardized loadings, reliability coefficients, and validity assessments confirms that the reduced 16-item, five-factor model possesses strong psychometric properties. These findings provide robust support for the instrument's factorial structure and measurement quality.

Discussion

This study established and validated a five-factor structure explaining upper-secondary students' orientation toward STEM pathways in the Albanian context. Confirmed through exploratory and confirmatory analyses, it was found to be coherent with SCCT (see Table 11). All factors showed adequate internal consistency, and the instrument evidenced convergent and discriminant validity.

Table 11 Summary of factor interpretations

Factor	Label	Items	SCCT Dimension	Interpretation
F1	Cognitive engagement with STEM	Q12: I like my STEM classes. Q13: I am able to get a good grade in my STEM classes. Q14: I am able to complete my STEM coursework/homework. Q22: I feel actively engaged during STEM classes.	Self-efficacy beliefs/learning experiences	It represents the cognitive–affective component of engagement, integrating perceptions of competence with motivation to learn.
F2	Outcome expectations and career utility	Q17: I plan to use STEM in my future career. Q18: If I do well in STEM classes, it will help me in my future career. Q19: The chances of finding a job with a satisfying income are higher in careers related to STEM. Q20: The chances of finding a job are higher in careers related to STEM.	Outcome expectations / perceived utility	This factor reflects instrumental motivation, in which STEM is perceived as a strategic pathway toward social mobility and financial stability.
F3	Behavioral exposure to STEM activities	Q26_num: In the last three years, I have participated in at least one STEM (related to physics, mathematics, biology, chemistry, TIK, or their applications) extracurricular activity organized within my school. Q27_num: In the last three years, I have participated in at least one STEM extracurricular activity organized outside my school.	Behavioral engagement / experiential learning	This factor adds behavioral depth to the model, linking self-perceptions and intentions to concrete experiences.
F4	Social and family support for STEM	Q23: I know someone in my family/social circle who uses STEM in their career. Q24: I have a role model in a STEM career. Q25: My parents would like it if I chose a STEM career.	Contextual supports and social modeling	This factor serves as a key enabler, transforming academic interest into career intention.
F5	Instructional and career guidance environment	Q28: My teachers use digital tools, experiments, and practical projects that make STEM understandable and more engaging. Q29: At least one of my teachers of STEM-related courses (physics, mathematics, biology, chemistry, TIK) have encouraged me at least once to choose a future career related to STEM. Q30: The career-guidance coordinator at my school provides effective guidance that helps me choose educational pathways aligned with my aptitudes and talents.	Environmental supports / institutional facilitation	This factor underscores the institutional dimension of STEM orientation.

Note 3. All items in the table are 5-point Likert scale items, except Q26_num and Q27_num, which are coded as binary items (1 = Yes, 0 = No).

These psychometric results are consistent with prior work that operationalizes SCCT in relation to STEM intentions. In particular, science motivation, conceptualized as self-efficacy, self-determination, intrinsic motivation, academic achievement, and career utility, has been linked to the formation of STEM aspirations [41]. Context-sensitive components in the instrument capture mechanisms through which environments shape intentions. Findings for F5 align with evidence that hands-on instruction and teacher-led experimentation foster engagement and career intentions [11]. Social influences in F4 further suggest that positive perceptions of STEM professionals and the presence of role models contribute to aspirations, especially among students with a stronger STEM self-concept, highlighting the need to cultivate self-belief while broadening awareness of attainable STEM occupations [42]. STEM cultural capital and perceived parental support are positively associated with STEM-related hopes and goals, with parental support exerting both direct and indirect effects on career intentions [43].

In [44], it is reported that positive associations exist between learning experiences, self-efficacy, perceived career utility, participation in STEM activities inside and outside school, and interest in pursuing STEM in higher education.

Limitations and Future Research

While the study yielded strong psychometric evidence, several limitations must be noted. Its cross-sectional nature prevents causal interpretation of the relationships between the latent factors. The use of self-reported data may have introduced social desirability bias. Furthermore, although the sample was representative of the Fier-Vlora region, the findings may not generalize to the broader national population.

Future studies should apply longitudinal or multi-group confirmatory approaches to assess the model's stability across demographic groups such as gender, school type, or geographic location. Additionally, further research should model students' intentions to pursue university-level STEM studies as a dependent variable, examining how the current five latent constructs (F1-F5) and demographic variables shape educational and career trajectories.

Conclusion

This study identified and validated a five-factor latent structure that enhances the understanding of STEM orientation among upper-secondary students in Albania. The resulting structure aligns with key dimensions of Social Cognitive Career Theory and encompasses: cognitive engagement with STEM; outcome expectations and career utility; behavioral exposure to STEM activities; social and family support; and instructional and career guidance. The instrument demonstrated strong psychometric properties and provides a contextually grounded tool for assessing STEM-related orientations in this population. These findings offer a foundation for future research that models STEM-related intentions and career aspirations as dependent variables and explores how the identified latent dimensions interact with demographic characteristics to shape students' educational trajectories.

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