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TEAMWORK ADAPTATION SCALE: PSYCHOMETRIC PROPERTIES IN STEM ACADEMICS

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ABSTRACT

This study presents the development of a scale (ATE scale) designed to measure teamwork adaptation among STEM academics in Peru and assessed its validity and reliability. This scale is based on the theoretical framework on adaptive competencies and teamwork development by Rico et al. (2020). The scale was administered to a total of 832 academics. To validate the instrument, we conducted content analysis, exploratory factor analysis, and confirmatory factor analysis. The final confirmatory model retained three factors with an optimal marginal fit and high internal consistency in a) interactive communication for cooperation, b) identification and synergy, and c) conflict and goal management. The scale demonstrated strong validity, reliability, and applicability to the context of Peruvian STEM academics. These findings enhance understanding of teamwork adaptation, providing insights into critical indicators, strengths, and areas for improvement in team development.

KEYWORDS: Teamwork Adaptation, STEM academics, Scale, Validity Analysis, Reliability Analysis.

1. INTRODUCTION

The soft skill set includes teamwork adaptation skills, which are essential to the profession and personal growth of scholars in science, technology, engineering, and mathematics (STEM) (Bawa et al., 2024; Fernandez et al., 2023; Ontiretse et al., 2025).No matter the industry, it is necessary to adapt to teamwork by continuously changing cognition and attitudes (Evans and Dion, 2012; Georganta et al., 2023; LePINE et al., 2008; Randall et al., 2011). The adaptability to teamwork skills required in such teams of STEM professionals should be transversal, balanced and sustained through time because this is an eminently multidisciplinary environment, which requires a reaction to the continuous and unpredictable organizational shifts (Adeinat & Abdulfatah, 2019; Bawa et al., 2024; Cheruvalath, 2024; de Campos et al., 2020; Mohd et al., 2023; Yoshizumi et al., 2020).

Although there is a plethora of investigation on the subject of adaptation to teamwork (Adeinat and Abdulfatah, 2019; Bawa et al., 2024; Cheruvalath, 2024; de Campos et al., 2020; Fernandez et al., 2023), limited work has been conducted on the topic of adaptability, balance, and flexibility to the context of soft skills in STEM teams (Evans and Dion, 2012; Georganta et al., 2023; Mohd et al., 2023; LePINE et al., 2008; Randall et al., 2011; Rico et al., 2020; Yoshizumi et al., 2020).Maynard et al. (2015) indicate in a literature review on the adaptation to work teamwork (1998-2013) that the performance of work teams requires the assessment of teamwork adaptation skills to propose team development programs and identify the important indicators that require specific interventions.The theoretical construct of Rico et al. (2020) demonstrates that the fundamental skills required to reach the stage of adaptation to teamwork are sufficient communication, flexibility, cooperation, sufficient management of interpersonal conflicts, and the comfort of adaptation to the achievement of team objectives. The indicators that make it possible to check whether the theoretical construct is applicable in the adaptation to teamwork are the indicators that are related to the perception of cooperation and coordination, as an example, when a mutual support among colleagues is observed, when the work in a team is stimulating and motivates to work in order to achieve better results, when this work is a synergy in achieving the goals and when they feel like a part of the team (Adeinat et al., 2019; Abdulfatah et al., 2024; Cheruvalath et al.,2024; de Campos et al., 2020; Mohd et al., 2023; Rico et al., 2020; Yoshizumi et al., 2020).

1.1 Teamwork Assessment Instruments

The various assessment scales on teamwork on international level (perceptual and attitudinal scales, self-assessment questionnaires, work climate inventories etc.) are available, but the majority of them are health care (or education and sport) specific. A review of the field of STEM academics and professionals in the database of the Scopus shows that there are not many psychometric studies.Health field. A questionnaire was developed and tested in Poland to determine the level of teamwork climate and safety culture among patients (TSCS questionnaire: 27 items, Likert type used, 5 options); 558 physicians and auxiliary staff members of 26 healthcare facilities took part (Switalski et al., 2023). Idoudi et al. (2024) in Tunisia tested how well the T-TPQ (French version) (35 items and 5 dimensions: communication, team structure, leadership, monitoring, and support) works in a hospital context (459 health professionals took part in the study to test the validity-reliability of the T-TPQ). Ali et al. (2024) created the TeamSTEPPS in the diagnostic scale of improvement of teamwork and communication in the USA (25 items, 5 areas of measurement: communication, team structure, leadership, listening, and mutual support); they involved 360 professionals working in nine health systems. Trigueiro et al. (2025) developed the scale of perception of interprofessional collaboration (one-dimensional and 3 dimensions, 13 items with 4 response options, IPC-BR) in Brazil and confirmed it; 4 translators, 14 experts and 686 health professionals took part. Charantola et al. (2016) also tested the 38-item Team Climate Inventory (TCI) in Brazil and found it validated using four dimensions (team participation, support new ideas, team objectives, task orientation); 453 health professionals in 47 health centers were used.Educational field. The Teamwork and Leadership Learning Scale (CSL) was also proven in Spain, a questionnaire that measures the outcome of clinical simulations on nursing students (3 transfer levels in 2 dimensions, 18 items) (Gonzalez-Moret et al., 2025); the sample was a group of 207 students. Gürsoy et al. (2025) experimentally established the Interprofessional Attitude Assessment Scale (UWE-PI) of 35 Likert-type items with 5 options and five subscales (communication and teamwork, interprofessional learning, interprofessional interaction, and relationships) in Turkey in 391 participants. The scale was tested on attitude and preparedness to interprofessional education among medical and nursing students (RIP-L of 19 items Likert type of 5 points testing communication and collaboration, negative

professional identity, identity and roles) in the United Arab Emirates, Bahrain, Qatar, Kuwait, Oman, Saudi Arabia and Yemen (178 students) (El-Zubeir et al., 2006).Sports. Garalde et al. (2025) provided validation of the 33-item Likert-type 7-point Likert-S self-assessment questionnaire (CATME-S): measuring the contribution to teamwork, interaction with peers, team conservation, commitment to quality, and possessing the relevant knowledge, skills, and aptitudes; 949 students of primary education and physical-sports activity took part in Spain. Pereira and Morais (2023) tested the one-dimensional teamwork scale (10-item 5-point Likert-type TSY) in Brazil with 250 athletes that belonged to eight sport fields.The only content validity identified by Apaza and Ordonez (2023) in the Peruvian educational sector to measure the predisposition of university students to teamwork is the Scale of attitudes towards teamwork (AHTE of 28 items and 4 dimensions: communication and identity, regulation and execution): 23 experts (2 Peruvian) involved in the study in four Ibero-American countries. A review of the scientific literature published in the "Scopus" database shows that in the STEM, at the international level, the only tested tool is a 16-item 5-point Likert-type scale of two dimensions (exploration, commitment) to measure the training of scientific identity-SciID in high school and university students (Lockhart et al., 2022); 450 students, rural southeast Texas, USA, took part in the research.As we have narrated in the above paragraphs, the enormous majority of the research in adaptation to teamwork that is published in the specialized journals at an international level is oriented to the health, educational and sports context. In Peru, a content-validated instrument on teamwork is designed to measure the predisposition to teamwork of university students (Apaza and Ordonez, 2023), whereas a 4-item (4) Likert-type instrument is targeted at testing the viability of equipment in the context of municipal workers (Pilco-Pezo et al. (2025).The insufficiency of valid and reliable instruments designed to concentrate on the adaptation to teamwork in STEM academics and professionals does not permit a clear perception of the chances that may be made to enhance the work groups on the foundation of the crucial points. It is evident that assessment instruments should comply with the requirements to employ psychological tests (AERA, APA, and NCME; 2014) and enable standardization of the parameters of applying the results and interpreting them, as well as compare prevalences, confirm the corrective measures, and set baselines regarding adherence to working in teams within institutions.This study was aimed at creating a scale (ATE scale) which will enable us to measure the adaptation to teamwork in STEM academics in Peru, and verify the validity and reliability of the scale. In this regard, the formulation of focus groups and face-to-face and online surveys was created in 18 cities of the country.

2. RESEARCH METHODOLOGY

2.1 Design

The research is instrumental (Montero and Leon, 2007) and seeks to develop and test a psychometric instrument to determine adaptations to working in a team. We rely on the recommendations of Ferrando et al. (2022) and Muniz Fonseca-Pedrero (2019) both in the item analysis and in the content validation based on the expert judgment and the validation in relation to the internal structure based on the exploratory and confirmatory factor analysis and the reliability based on internal consistency.

2.2 Participants

The number of Peruvian scholars who attended the conference was 832 (n=18 in 18 cities of the country) (Figure 1); 130 scholarly individuals took part in the focus group and pilot study (2024) and 702 took part in the study in order to validate the scale in respect to the internal structure (2025). In order to choose the participants, the sampling criterion was based on judgment by the researcher and the size of the sample was calculated with the help of the rule of k20, k = number of items of the instrument (Hair et al., 2019; Lloret et al., 2024) and should be at least 440 participants (22 items x 20 subjects) to verify the internal structure. The method of data collection was both face-to-face and online.

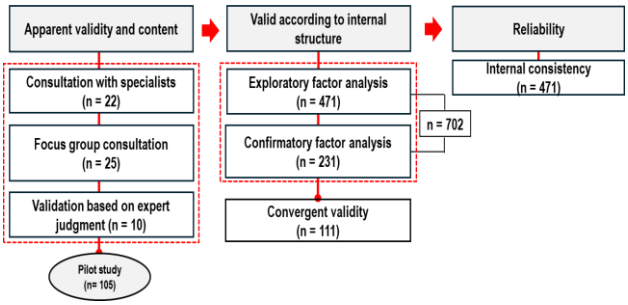

Figure 1: Participants according to evaluation stages.

2.3 Ethical considerations

The research ethics committees guideline (World Health Organization, 2004) and the ethical principles of the Declaration of Helsinki (World Medical Association, 2008) were considered in order to collect

data. The involvement was voluntary and anonymous. Informed consent letter was issued stating to the participants that their anonymity would be maintained, the information gathered would not be shared but used in statistical analysis and no single results were to be published.

Letter 073-VRII-USMP (Feb 13, 2024) was used to approve the research project.

2.4 Instruments

Teamwork Adaptation Scale (Escala ATE)

The first ATE Scale item development was founded on the theoretical construct on adaptive competencies and teamwork development of Rico et al. (2020) and consisted of 25 Likert-type items of four gradations (never = 1 point; sometimes = 2 points; almost always = 3 points; always = 4 points).

The ATE Scale is used to evaluate the degree of adaptation of the members of STEM team in six fundamental dimensions namely: communication, mutual support, leadership and conflict monitoring, cooperation, goals and synergy, identification and autonomy (Abregú-Tueros et al., 2025). The last ATE Scale that was validated in the given study was shortened to 14 pieces and is expected to be filled out separately by members of a STEM team to measure on the level of an academic unit.

Job Satisfaction Scale (OJS Scale)

The OJS (Overall Job Satisfaction) Scale consists of 15 items which are divided into two subscales: intrinsic satisfaction (7 items) and extrinsic one (8 items). A pilot study of the Peruvian situation using the adapted version of the OJS scale (Abregú-Tueros et al., 2025) had a suitable content validity, according to expert judgment (V=0.81), and reliability, according to internal consistency (a= 0.75). The convergent validity was evaluated with the use of this scale and ATE Scale.

2.5 Procedure

ATE scale was administered using paper-pencil and using Google Forms. November 2024 through July 2025 was the period during which the responses of the, voluntarily participating, STEM scholars in the country were also obtained. In the pilot study (November 2024), 105 STEM academics in public and private country universities will be approached virtually to collect data. The statistics were processed by using two computer programs, one was called AFE and another was called AFC, and the programs were used: Jamovi v. 2.3.28, and IBM SPSS Amos v. 22.0.

2.6 Data analysis

In apparent validity and content

The first tool (ATE Scale) consisting of 25 questions was tested by 19 experts who had over 10 years of experience in managing team work (10 organizational psychologists and 9 human talent managers). The items were re-adjusted according to the recommendation of three language experts in order to enhance their understanding. Thereafter, the relevantness and gaps of the items were established (set 2024) with the help of a focus group among 25 STEM professionals and academics. The ATE scale was presented to the judgment evaluation of 10 STEM experts (in October 2024), who assessed each scale item using five criteria (clarity, coherence, quantity, organization, usefulness); Kendall has computed the rank agreement coefficient with Tau-B tie of the scale with each criterion.

Valid according to internal structure

In order to determine the rotation procedure of exploratory factor analysis (EFA), inter-item polychoric correlation coefficients were determined since the ATE Scale is composed of ordinal items of four response options (Ledesma et al., 2019), which were categorized as low polychoric correlation ($r \leq 0.70$) and high polychoric correlation ($r = > 0.70$). The index explained was estimated to determine whether it is poor (less than 50) or good (≥ 50), (Lloret et al., 2014; Coulacoglou and Saklofske, 2018).

At the initial level of the analysis (June 2025), an EFA was conducted on a hypothetical six-factor model, and considering five methodological considerations mentioned by Coulacoglou and Saklofske (2018): Da Silva et al. (2015) and Lloret et al. (2014):

1. Theoretical foundation organized into six factors or dimensions and 22 indicators (Mohd et al., 2023; Rico et al., 2020; Yoshizumi et al., 2020).
2. Minimum number of participants of 20 academics per item (21 items x 20, N= 420).
3. Preliminary reliability analysis to know if the predominant correlations are low or high and to define the rotation method.
4. Minimum explained variance at 50% (Lloret et al., 2014; Coulacoglou & Saklofske, 2018).
5. Minimum composition of three items per factor (Coulacoglou & Saklofske, 2018; Hair et al., 2019; Lloret et al., 2014).

The standardized factor loads were explained based on the following classification: > 0.71 excellent, > 0.63 very good, > 0.55 good, > 0.45 fair and < 0.32 low (Lloret et al., 2014; Schmitt, 2011). The second stage of the analysis (July 2025) involved content

validation, as per a confirmatory factor analysis (CFA), using the information available on 231 STEM academics who were not involved in the EFA of the first stage. Then, it was ensured whether the 21 items of the ATE scale are associated to the hypothetical base structure of six dimensions. To this end, five goodness of fit measures were assessed and they include variables Ratio X^2/gl; IFC; TLI; RMSEA and SRMR, and item-wise Tau-B item adjustment.

In reliability

In July 2025, reliability based on internal consistency of the final scale (14 items) and dimensions with the help of McDonalds omega coefficient (ω) were assessed.

3. RESULTS

3.1 Item Design

The semantic adaptation of the ATE scale was done in two steps. The initial step was used to assess the grammatical framework, which ought to constitute the 25 items that were offered (elements of the sentence: subject, verb and complement). The second step was used to test the semantics and the level of understanding of the items in the focus group (September 2024). On the final stage 22 definite items were written (4 response options with Likert-type grading 1= Never, 4=Always), three of which were actually written in the reverse order (P7, P8 and P17).

3.2 Item analysis

The item analysis of the instrument was conducted based on 471 surveys (with academics in 18 cities of the country) (Lima 38.9%, Huanuco 28.9% and Junin 5.3% and predominantly) and the results indicate that 28.7 percent of the academics had 1-10 work colleagues, 24.6 percent had 11- 20 work colleagues, and the rest had 21-500 work colleagues (Table 1).

Table 1: Statistical analysis of the items of the construct of adaptation to teamwork.

Item	Mean	SD	Asymmetry	Kurtosis	IHC	Communality (h^2)	Condition
P1	3.02	0.76	-0.13	-1.00	0.620	0.497	Suitable
P2	3.12	0.84	-0.55	-0.60	0.570	0.371	Suitable
P3	2.90	0.79	-0.13	-0.76	0.455	0.300	Suitable
P4	2.77	0.86	-0.25	-0.59	0.252	0.259	Deleted
P5	3.09	0.77	-0.52	-0.14	0.693	0.578	Suitable
P6	3.03	0.76	-0.46	-0.12	0.568	0.349	Suitable
P7	2.79	0.79	0.04	-0.79	0.671	0.544	Suitable
P8	3.01	1.07	-0.72	-0.78	0.339	0.329	Suitable
P9	2.96	0.75	-0.18	-0.62	0.602	0.414	Suitable
P10	2.89	0.83	-0.18	-0.79	0.590	0.439	Suitable
P11	2.87	0.94	-0.49	-0.65	0.471	0.676	Suitable
P12	2.96	0.81	-0.25	-0.71	0.702	0.563	Suitable
P13	3.07	0.72	-0.41	-0.05	0.608	0.411	Suitable
P14	3.04	0.76	-0.37	-0.40	0.648	0.537	Suitable
P15	2.76	0.88	-0.20	-0.71	0.463	0.263	Suitable
P16	3.18	0.69	-0.44	-0.14	0.556	0.366	Suitable
P17	3.04	0.77	-0.55	0.06	0.540	0.488	Suitable
P18	2.92	0.78	-0.61	0.30	0.599	0.606	Suitable
P19	3.18	0.68	-0.45	-0.01	0.580	0.385	Suitable
P20	3.09	0.75	-0.36	-0.52	0.579	0.393	Suitable
P21	3.05	0.79	-0.58	0.02	0.591	0.474	Suitable
P22	3.07	0.72	-0.69	0.79	0.589	0.483	Suitable

Source: Authors.

Table 2 provides the descriptive analysis of the items associated with the construct of the issue of being able to adapt to teamwork and the 22 items possess sufficient values of asymmetry and kurtosis (± 1.5) (Ferrando et al., 2022). The artificial homogeneity indices (IHC) were sufficiently satisfactory, except P4 (minimum acceptable value: IHC ≥ 0.30) (Kline, 2016). Lastly, the items had sufficient similarities (h^2), with the exception of items P4 and P15 that were not beyond the value of h^2 = 0.30 (Coulacoglou and Saklofske 2018; Hair et al. 2019; Lloret et al. 2014; Paniagua et al. 2022). Then, item P4 was discarded since it surpassed neither the minimum in IHC (Table 2).

The corresponding polychoric correlation was estimated (Figure 2), according to the property and type of distribution of items of the ATE Scale and depending on a sample larger than the recommended minimum of 200 subjects (Ledesma et al., 2019).

Table 2: Sociodemographic characteristics of the participants (N= 702).

Variables		Number	%
STEM Group			
	Science	161	22.9
	Technology	139	19.8
	Engineering	319	45.5
	Mathematics	83	11.8
Occupation			
	University academic	603	85.9
	University official/academic	36	5.1
	Scientific research in the private sector	63	9.0
Sex			
	Male	498	70.9
	Female	204	29.1
Age (years)			
	24-30	228	32.5
	31-40	174	24.8
	41-50	172	24.5
	51-60	103	14.7
	61 and over	25	3.5

Note: STEM = Science, Technology, Engineering, Mathematics.
Source: Authors.

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22
P1	1.000																					
P2	0.589	1.000																				
P3	0.383	0.369	1.000																			
P4	0.250	0.201	0.322	1.000																		
P5	0.656	0.591	0.471	0.317	1.000																	
P6	0.507	0.359	0.373	0.230	0.548	1.000																
P7	0.567	0.539	0.408	0.225	0.620	0.432	1.000															
P8	0.234	0.276	0.232	-0.090	0.332	0.302	0.410	1.000														
P9	0.480	0.412	0.355	0.132	0.546	0.403	0.582	0.364	1.000													
P10	0.537	0.481	0.279	0.238	0.499	0.447	0.498	0.184	0.423	1.000												
P11	0.289	0.353	0.224	0.250	0.449	0.432	0.314	0.117	0.351	0.517	1.000											
P12	0.521	0.562	0.371	0.219	0.600	0.491	0.596	0.271	0.537	0.593	0.568	1.000										
P13	0.453	0.411	0.357	0.275	0.551	0.500	0.524	0.306	0.493	0.454	0.408	0.556	1.000									
P14	0.562	0.464	0.321	0.238	0.626	0.422	0.609	0.387	0.581	0.471	0.393	0.584	0.605	1.000								
P15	0.341	0.302	0.260	0.170	0.418	0.338	0.437	0.151	0.350	0.425	0.373	0.434	0.425	0.398	1.000							
P16	0.436	0.510	0.255	0.174	0.462	0.470	0.423	0.375	0.398	0.365	0.376	0.489	0.404	0.445	0.296	1.000						
P17	0.475	0.377	0.444	0.246	0.458	0.386	0.473	0.236	0.419	0.372	0.211	0.463	0.432	0.375	0.274	0.429	1.000					
P18	0.400	0.430	0.367	0.155	0.471	0.468	0.431	0.308	0.512	0.488	0.514	0.538	0.421	0.408	0.371	0.542	0.553	1.000				
P19	0.542	0.378	0.314	0.256	0.499	0.384	0.536	0.310	0.456	0.414	0.304	0.551	0.443	0.465	0.317	0.423	0.460	0.489	1.000			
P20	0.478	0.491	0.350	0.147	0.491	0.393	0.542	0.339	0.444	0.414	0.285	0.549	0.392	0.455	0.365	0.385	0.482	0.403	0.478	1.000		
P21	0.441	0.348	0.318	0.123	0.440	0.436	0.485	0.370	0.460	0.440	0.414	0.530	0.482	0.495	0.233	0.486	0.456	0.581	0.561	0.521	1.000	
P22	0.436	0.396	0.328	0.059	0.520	0.487	0.530	0.456	0.511	0.386	0.279	0.532	0.502	0.539	0.444	0.521	0.442	0.439	0.476	0.564	0.490	1.000

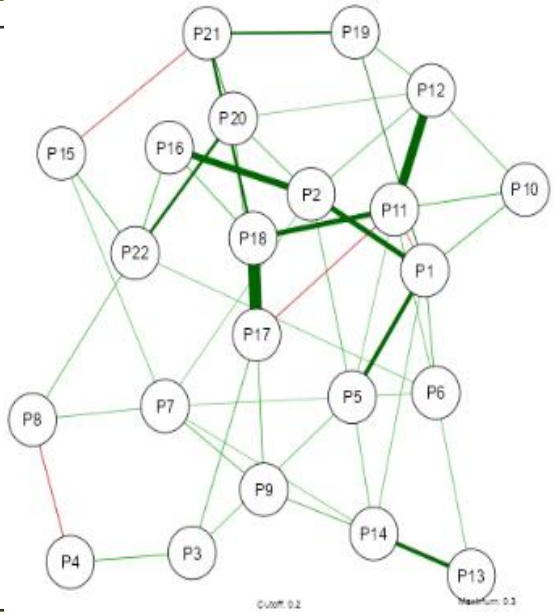

Figure 2: Polychoric inter-item correlation of the ATE Scale (N= 471).

3.3 Validity according to internal structure

Exploratory factor analysis (EFA)

A sam ple of 471 academics out of 702 was used in the first phase of testing of the construct validity of the ATE scale (Table 1). Approximately fifty percent of participants were engineers (45.4%), 91 percent academics of various universities, 71 percent men and 32 percent were between 24-30 years old (Table 1).

Adaptation of data to the AFE. To determine the sufficiency of the data, the Kaiser-Meyer-Olkin index (KMO) was determined, the index value is 0.947, which means that the correlations between the items are adequate to analyze data using exploratory factor analysis; the value of the Bartlett test of sphericity was p = 0.001 (df = 210), which confirms that the correlations between the items are excellent to conduct exploratory factor analysis (Table 3). According to the EFA, the construct of "adaptation to teamwork" dimensions were established.

Total variance explained. In EFA, eight components with eigenvalues above 1,000 were considered, which after oblimin rotation, account up to 52.5 percent of the total variance. This explains the first factor which is as much as 11.7 percent of the variance (Table 3).

Table 3: KMO and Bartlett Test.

Testing	Value
KMO (global)	0.947
Chi-square (Bartlett)	3.877
Degrees of freedom (df)	210
Significance (p)	0.001

Source: Authors.

Identification of factors. A sample of 471 academics out of 702 was used in the first phase of testing of the construct validity of the ATE scale (Table 1). Approximately fifty percent of participants were engineers (45.4%), 91 percent academics of various universities, 71 percent men and 32 percent were between 24-30 years old (Table 1).Adaptation of data to the AFE. To determine the sufficiency of the data, the Kaiser-Meyer-Olkin index (KMO) was determined, the index value is 0.947, which means that the correlations between the items are adequate to analyze data using exploratory factor analysis; the value of the Bartlett test of sphericity was p = 0.001 (df = 210), which confirms that the correlations between the items are excellent to conduct exploratory factor analysis (Table 3). According to the EFA, the construct of "adaptation to teamwork" dimensions were established.Total variance explained. In EFA, eight components with eigenvalues above 1,000 were considered, which after oblimin rotation, account up to 52.5 percent of the total variance. This explains the first factor which is as much as 11.7 percent of the variance (Table 3).

Table 4: Total variance explained (after rotation).

Factor	Initial eigenvalues	% Variance	% Accumulated
1	1.885	8.97	8.97
2	1.525	7.26	16.24
3	1.448	6.90	23.13
4	1.469	6.99	30.13
5	1.342	6.39	36.52
6	1.491	7.10	43.62
7	1.191	5.67	49.29
8	1.088	5.18	54.47
9	0.446		

Source: Authors.

Accordingly, in the conclusion instrument, the fundamental dimensions of adaptation to teamwork among STEM academics are trust-based communication (item 14, 9, 13, 7 and 8), autonomy (18, 17 and 21), mutual support (20, 19 and 22) and identity and synergy (11, 10 and 12). The dimensions found in the AFE are the dimensions that capture the construct that is adaptation to teamwork (Rico et al., 2020), which validates the structural validity of the ATE scale.

Confirmatory factor analysis (CFA)

The second step in assessment was following the restructuring of the initial arrangement of the six dimensions as four dimensions, a theoretical model of the model using empirical data regarding construct validity of the ATE scale was assessed with an AFC used on a sample of 231 academics. The adjustment indices were brought to the optimum values, which justifies the inner structure of the instrument (Table 5).

Table 5: Rotated component matrix after removing items with factor loadings <.30 (N = 471).

Item	Component								h^2
	1	2	3	4	5	6	7	8	
14. All communication among members of the work group is open and authentic.	.718								0.605
9. There is mutual trust among members of the work group.	.526								0.453
13. Within a climate of camaraderie, members of the work group show satisfaction.	.491								0.459
7. The level of trust among members of the work group is characterized by suspicion.	.468								0.549
8. Communication among work colleagues is defensive and cautious.	.322								0.322
18. Members adapt easily to the demands of the work group.		.786							0.716
17. Control methods within the work group are imposed.		.416							0.502
21. All members of the work group practice self-control.		.338			.307				0.497
1. Members of the work group consistently contribute their best skills.			.946						0.459
2. The goals of the work group are clearly understood by all members.				.912					0.919
20. All members of the work group show concern for others.					.614				0.858
19. Mutual support among members of the work group is genuine.					.324				0.523
22. The management of interprofessional conflicts within the work group is resolved and accepted.					.317				0.429
11. All members perceive a sense of belonging to the work group.						.640			0.511
10. To improve outcomes, individual effort encourages other members of the work group to make greater efforts.						.375			0.591
12. Members of the work group perceive a strong group identification.					.314	.350			0.464
6. Members adapt easily to the demands of the work group.							.576		0.616
3. There is full cooperation and coordination among members of the work group.								.303	0.530
Explained variance (%)	11.68	8.43	7.27	6.64	7.73	5.30	5.44	1.80	
Total explained variance: 52.50 %									
Overall KMO test:.942. Bartlett's test: X^2=3382; gl=171; p .001									

Note: h^2 = communality; * items eliminated; extraction method: Minimum Residuals; rotation method: Oblimin.

According to the AFC, the model is strong in explaining the key dimensions of adaptation to teamwork (Tables 5). During the restructuring of the original design with 21 items, seven items were removed that led to a debugged and calibrated version with 14 items (Table 6). The model suggests a sound methodological foundation of future theoretical and practical developments as indicated by AFC. The standardized factor weights indicate that the corresponding factors have considerable loading of the items, which validates the coherence between the items and dimensions of the first factor analysis (Onde and Alvarado, 2022), and reinforces the validity of the initial model (Figure 3; Table 7; Table 8).

Table 6: Rotated Component Matrix After Factor Elimination with <3 Items.

Ítem	Component		
	1	2	3
14. All communication among members of the work group is open and authentic	0.672		
9. There is mutual trust among members of the work group	0.443		
7. The level of trust among members of the work group is characterized by suspicion	0.387		
13. Within a climate of camaraderie, members of the work group show satisfaction	0.372		
5. There is full cooperation and coordination among the members of the working group	0.319		
11. All members perceive a sense of belonging to the work group		0.718	
10. To improve outcomes, individual effort encourages other members of the work group to make greater efforts		0.369	
12. Members of the work group perceive a strong group identification		0.334	
22. The management of interprofessional conflicts within the work group is resolved and accepted			0.702
16. The goals of the working group: they are not understood ... they are clearly understood			0.314
15. Within the working group. Interprofessional conflicts are accepted and worked on thoroughly to resolve them			0.312

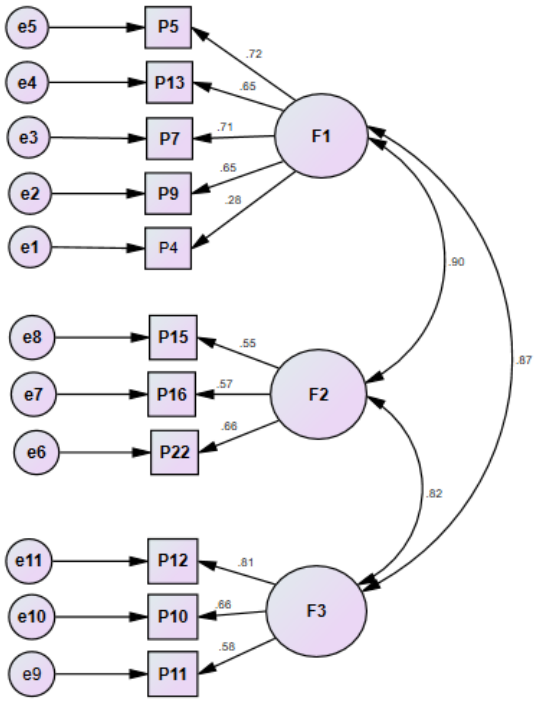

Figure 3: Adaptation to Teamwork Scale Roadmap. (ATE Scale)

Source: Own elaboration

Tabla 7: Goodness of fit indices

Fit Index	Value	Standard of acceptance	Interpretation
Chi-square/df ratio (84.5/41)	2.061	< 3,000	Proper fit
CFI (Comparative Fit Index)	0.972	> 0.90	Proper fit
TLI (Tucker-Lewis Index)	0.962	> 0.90	Proper fit
RMSEA (Root Mean Square Error of Aproximation)	0.047 *	< 0.080	Good fit
SRMR (Standardized Root Mean Square Residual)	0.033	< 0.080	Good fit

Note: * (90% CI: 0.033 – 0.062)

Source: Authors.

Table 8: Final dimensions of the ATE Scale

Factor		Definition	Linked items Coding	
			Original	Final
F1	Interactive communication for cooperation	Perception of open communication that generates trust and interest in the members and perception of satisfaction that allows good cooperation.	P14	1
			P9	2
			P7	3
			P13	4
			P5	5
F2	Identification and synergy	Perception of feelings of belonging and synergy through group identification.	P11	6
			P10	7
			P12	8
F3	Conflict and Goal Management	Perception of an adequate management of interprofessional conflicts and understanding of goals.	P22	9
			P16	10
			P15	11

Source: Authors.

Parsimony indices. Table 9 presents parsimony indices that prove the effectiveness of the model in connection with the clearness of the estimated parameters (i.e. PRATIO, PNFI and PCFI).

Table 9: Final dimensions

Table of Contents	Value	Interpretation
PRATIO	0.745	Model with good relative parsimony
PNFI	0.706	Proper fit with balance and simplicity of the model (≥ 0.50)
PCFI	0.725	Proper fit and parsimonious pattern (≥ 0.50)

Source: Authors.

3.4 Convergent validity

Having simultaneously applied the ATE Scale (X) and the Intrinsic Job Satisfaction Scale (Y) and examined the data as normal distribution, which was unmet according to the Shapiro-Wilk test (n=111 academics), we have found that the data were asymmetric ($p<0.001$). The Spearman rho correlation index of the two variables, i.e., "X" and Y" indicate a positive convergence ($r = 0.571$; $p<0.010$), i.e., as the level of job adaptation is improved, the level of intrinsic job satisfaction is also improved, conversely.

3.5 Reliability according to internal consistency

Indeed, we have already considered the symmetry of the distribution of data (471 STEM academics). The obtained reliability coefficients of the ATE Scale, as well as of the three factors (Table 10) reveal that the omega coefficient of the scale and at the level of factors (F1, F3) is equivalent to high reliability ($\omega = 0.72$ to 0.99), and the omega coefficient of the F2 factor is situated in the moderate reliability region ($\omega = 0.60$ to 0.71) (Da Silva et al., 2015).

Table 10: Four-factor reliability.

Factor	Omega coefficient (MacDonald)	Level
F1	.778	High reliability
F2	.678	Moderate reliability
F3	.734	High reliability
ATE Scale	.921	High reliability

4. DISCUSSION

This study aimed at creating a scale (ATE Scale) that will enable us to measure the adaptation to teamwork in STEM academics in Peru, and to test the scale in terms of validity and reliability. These psychometric properties make this scale have a validity, and they include: a) sufficient apparent and content validity, b) sufficient internal-structure based validity, c) sufficient related-to-another-variable (convergent) validity, and d) high internal-consistency based reliability.On the other hand, on validity based on internal structure, we established that the first factor (F1, Tables 3, 4, 6) in the context of adaptability to teamwork accounts the highest variance (cumulative variance: 52.5) that accommodates the highest number of elements (5/14 items). This aspect signifies the dimension "trust-based communication" associated with the open communication perception yielding trust and satisfaction among the members of the STEM team of the construct "Adaptation to teamwork" (Table 6) and is complemented by the aspect of autonomy, mutual support and identity and synergy.We could affirm the presence of the simple structuring principle of the ATE scale (Tables 3, 7; Figure 3); that is, in cases when a group of items with the greatest factorial weights are largely clustered into a core factor. According to authors such as Lloret et al. (2014) and Coulacoglou and Saklofske (2018) and three institutions (AERA, APA and NCME; 2014), this is one of the proper psychometric properties of assessment instruments.

In our example of the "ATE Scale," it was summarized into three dimensions or components.It is necessary to note that the comparative analysis of adaptation to teamwork in terms of the ATE Scale, as well as other scales which assess such issues like, attitudes towards teamwork, scientific identity and team viability, cannot be directly related. As an example, the SciID scale targets North American university students (Lockart et al., 2022), the AHTE scale targets Peruvian students (Apaza and Ordonez, 2023), and the TVS scale targets a group of Peruvian municipal workers (Pilco-Pezo et al. (2025) and not at STEM academics.The ATE Scale suggests three dimensions of adaptation to teamwork. Other tools that measure variables concerning teamwork in the education sector implicate 2-4 dimensions, such as the T-TPQ questionnaire (El-Subeir et al., 2006), the UWE-IP scale (Gursoy et al., 2025) and the CATMES-S questionnaire (Garalde et al., 2025). It is the same in the sphere of healthcare labor, where the T-TPQ questionnaire (Idoudi et al., 2024), the TAT scale (Ali et al., 2024) and the TCI inventory (Charantola et al., 2016) and the IPC-BR scale (Trigueiro et al., 2025) are involved. Shared by all of these tools is the key component of adjusting to teamwork namely, "communication" and its complementary nature with autonomy, mutual support, and identity (Rico et al., 2020). This overlap is ratified by the sphere of STEM scholars, as it establishes that communication is a transversal axis and an intangible asset to the organizations in adjusting to teamwork (Adeinat and Abdulfatah, 2019; Bawa et al., 2024; Cheruvalath, 2024; de Campos et al., 2020; Fernandez et al., 2023; Mohd et al., 2023; Ontiretse et al., 2025; Yoshizumi et al., 2020).In terms of the item count, the final variant of the ATE Scale contains 12 less items than the SciID scale (Lockhart et al., 2022), 26 less items than the RIP-L scale (El-Zubeir et al., 2006) and 60 less items than the UWE-IP scale (Gürsoy et al., 2025). The significance of this disparity in the number of the items in the instruments is that the measurement is parsimonious, and has its merits in decreasing cognitive load, providing more incentive to respond, decreasing rejection rate among high workload groups since it takes less time in its application and it also suits periodic assessments and follow-ups of interventions. The positive aspect of our research is that the psychometric characteristics of the ATE scale were tested in the sample, which was 89 percent larger than the set minimum sample (833/440) (Hair et al., 2019; Lloret et al., 2014), and our sample size was far greater than the samples in other studies in Spain (Gonzalez-Moret et al., 2025), Turkey (Gursoy et al., 2025) and seven countries in the Middle East (El-Zubeir et al., 2006) and the USA (Lockhart et al., 2022).

Considering the indexes of validity and reliability, the views of use of the ATE scale are to ensure the assessment of the adaptation to teamwork in a valid and reliable manner, the identification of intervention topics through it alone or in the combination with other tools of organizational and educational psychology evaluation, the establishment of a baseline and monitoring of responses on the basis of the framework of organizational and educational psychology.

Limitations. The potential limitation of the study is associated with the quality control of the application of the interviewers being limited. The research on its part, being cross sectional, got a given point of perception of adaptation to teamwork, a point that is subject to change over time, in the presence of external factors. Another limitation is the use of self-reports which will create biases of social desirability. Future research and when the one-dimensionality of the ATE scale has been assessed, normative scores ought to be established based on sex, age and the number of the work colleagues.

5. CONCLUSION

The ATE scale of measuring adaptation to work in STEM teams recorded positive indexes of validity and reliability, thus it can be used in various academic and scientific institutions in the nation.

Informed Consent

To collect data, the Declaration of Helsinki and WHO Guide for Research Ethics Committees were applied. Thus, the researchers received informed consent of the subjects, which was written in Spanish, and was explained to them prior to the study. This allowed the subjects to posed questions concerning consent and confidentiality in the study. The little risks assumed by the subjects given that the research has a great contribution to institutional academic cohesion and productivity can be considered worth it.

Declaration of Conflicting Interests

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ANNEXES

APPENDIX 1: COMPARISON OF RESULTS TO DETERMINE THE NUMBER OF FACTORS OF THE ATE SCALE FINAL VERSION (N=471)

Criterion "A"						**Criterion "B"**				
Correlation Matrix: Polychoric Number of factors: According to parallel analysis Extraction method: According to minimal residues Rotation Method: Oblimin						Correlation Matrix: Polychoric Number of factors: According to eigenvalues Extraction method: According to minimal residues Rotation Method: Oblimin				
Factor	Number of items		% Variance	BIC Index		Factor	Number of items		% Variance	BIC Index
1	8	1, 5, 2, 7, 3, 10, 12, 20	16.4			1	5	14, 9, 13, 7, 8	11.7	
2	5	22, 8, 14, 9, 13	13.0			2	3	18, 17, 21	8.4	
3	1	11	7.9			3*	1	1	7.3	
4	4	18,17,21,16	7.8	- 586		4*	1	2	6.6	
% cumulative variance for factor load ≥ 1,000			45.2 Inadequate (<50.0)			5	3	20, 19, 22	7.7	
						6	3	11,10, 12	5.3	- 246
Nota: N° ítems= 18; BIC = Bayesian Information Criterion						7*	1	6	5.4	
						8*	1	3	1.8	
						% cumulative variance for factor load ≥ 1,000			52.5 Adequate (>50.0)	
						Note: No. of items= 18; BIC = Bayesian Information Criterion; * Eliminated for AFC				