Educational Administration: Theory and Practice
2024, 30(6), 3367-3381
ISSN: 2148-2403
https://kuey.net/
Research Article

Instrument To Measure Academic Commitment Of Secondary School Students In Science And Mathematics Subjects: Adaptation And Validation.

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Citation: Mtra. Anakaren León Oropeza, et al (2024), Instrument To Measure Academic Commitment Of Secondary School Students In Science And Mathematics Subjects: Adaptation And Validation. *Educational Administration: Theory and Practice, 30(6),* 3367-3381
Doi: 10.53555/kuey.v30i6.6106

ARTICLE INFO

ABSTRACT

Today's nations need professional training in the field of Science, Technology, Engineering and Mathematics to ensure the sustainable development of their countries. Careers such as data engineering, data analyst, programmers, developers, architects of the Internet of Things, defensive and offensive analysts in cybersecurity, are the careers of the future. This raises the urgent need to measure the academic commitment of high school students to subjects that are highly related to the careers of the future. This article presents the validation and adaptation of an instrument to measure the relationship between situated teaching, academic self-efficacy, achievement orientation and the academic commitment of secondary school students towards science and mathematics subjects. The validation process was carried out in two stages, the first: construct validity and reliability. The second, criterion validity, stability and performance, obtaining a moderate level of agreement (Kappa de fleiss = .43; W Kendal = .52) by expert judging; reliability (Cronbach's Alpha = .81) adjusted by six dimensions.

Keywords: validation, instrument, academic engagement, situated teaching, achievement orientation, academic self-efficacy, science, mathematics.

Introduction.

Nations are concerned and busy training professionals in STEM (Science, Technology, Engineering and Mathematics) disciplines because these areas are fundamental for innovation and technological development, which drives economic growth and increases global competitiveness.
The high demand for trained STEM professionals is crucial to meet the needs of key sectors, improve quality of life through advances in medicine and technology, and address global issues such as climate change and public health. In addition, STEM education fosters important skills such as critical thinking and problem-solving, which are essential in both everyday life and careers (Kennedy et al., 2014).
The ability to develop and maintain advanced technologies is also vital to national security, as areas such as cybersecurity and defense rely heavily on STEM experts. For these reasons, promoting education and training in STEM disciplines is a priority to ensure the sustainable development and competitiveness of nations in the future (Bybee, 2013).
According to De Toro et al. (2016), there are numerous programs and strategies in schools that focus on improving engagement and have shown positive results when implemented. Singh et al., (2002) suggest that achievement in mathematics and science in secondary school depends on many interrelated variables such as: students' academic engagement and knowledge of the role of achievements in mathematics and science in future career opportunities, which influence school performance.
Experts study academic engagement from a multidimensional perspective (Appleton et al., 2008; Newmann et al., 1992), made up of different dimensions or components that interact with each other, including three aspects: behavioral engagement, emotional engagement, and cognitive engagement (Finn et al., 1997; Fung et al., 2018 and Fredricks et al., 2004).
First, academic behavioral engagement is manifested through behaviors visible during learning and in the school environment (Finn et al, 1993), including participation in academic and extracurricular activities (Green

et al., 2008; Marks, 2000). Behaviorally engaged students have regular class attendance, work harder at schoolwork, and maintain appropriate behavior (National Research Council & Institute of Medicine, 2009).
Second, cognitive academic engagement involves the analysis of the student's internal processes, effort, and perseverance in a given task or topic (Fredricks et al., 2004; Mahatmya, et al., 2012; Walker et al., 2006), the quality or type of information processing, and the use of metacognitive strategies such as self-regulation of learning (Sandoval et al., 2019; Shernoff, 2013), so they have higher levels of academic performance (Greene et al., 2004; Sedaghat et al., 2011) perhaps, the interest in science or mathematics leads them to have greater academic commitment (Bal, 2013; Thiessen et al, 2008).
Thirdly, emotional academic commitment refers to the affective ties that students establish in the learning process and towards the school context (Finn et al, 1993; Skinner et al., 1993. This commitment encompasses all experiences involving positive and negative emotions related to relationships and activities in the school context (Faria et al., 2012; Sandoval et al., 2019) improving their orientation towards learning achievement (Buckley et al., 2004; Sanders, 2010).
In science and mathematics subjects, emotional commitment is essential since students who enjoy and feel proud of learning science or mathematics will have higher levels of performance and commitment (Frenzel et al., 2007). On the contrary, students who perceive these subjects as less interesting than others, perhaps, is because they have developed negative feelings and anxiety. (Grootenboer et al., 2016; Radišić et al., 2015).
Positive attitudes toward learning mathematics and science, as well as interest in these disciplines, are also correlated with educational and career aspirations in these fields (Singh et al., 2002). According to psychoeducational research (Hughes et al., 2008), student engagement significantly predicts both academic performance and future career decisions. Students with high levels of behavioral and emotional engagement tend to obtain better grades and show aspirations towards higher education (Wang et al., 2010).
The use of self-regulatory and metacognitive strategies is closely linked to academic achievement orientation (Pintrich et al., 1990) and are associated with high effort and persistence, within learning environments that foster autonomy, interaction, and growth mindset (Murphy et al., 2019). Those students who enjoy and feel competent in their social interactions, as well as those who solicit support for their academic pursuits, are more likely to develop academic self-efficacy (Wang et al., 2010).
In recent years, the teaching of mathematics in education has evolved from traditional methods to approaches based on active learning (Naik, 2015). According to Sesen and Tarhan (2011), active learning is defined as any instructional method that engages students in the learning process through meaningful activities that require active thinking.
Student-centred methodologies are at the heart of active learning, where situated teaching influences learning processes in various ways (Järvelä et al., 2014). Students acquire knowledge by applying it in specifically designed contexts, which has been shown to improve the effectiveness of teaching (Prince, 2004), benefiting attention, memory, cognitive performance, effort, and motivation.
By integrating the variables of situated teaching, academic self-efficacy and achievement orientation with the academic commitment of the students, a multidimensional approach is adopted based on three main theories of learning and two psychological theories of human development (see Table 1), which support the individual study of each variable with its main exponents.

Table 1
*T*heoretical relationships of independent variables with the dependent variable.

	Variables		
Relation	Situated teaching and academic engagement	Academic self-efficacy and commitment	Achievement orientation and academic engagement
Theories	Vygotsky's Sociocultural Theory (1978). Ausubel's (1963) Theory of Significant Learning. Dewey's Experiential Teaching Theory (1878).	Bandura's Sociocognitive Theory (1977).	Weiner's attributional theory (1986).
Authors / exponents	Baquero (2002). Brown et al. (1989). Díaz-Barriga (2006).	Díaz-Barriga (2006).	Aguilera & Perales (2019). Habig & Gupta (2021). Huang et al (2019).

Along the same lines, the effects of independent variables on the increase or decrease in students' academic commitment to STEM subjects are explained.

Development.

An exhaustive review of the literature was carried out in order to identify various instruments adapted for data collection and analysis. Instruments that include specific characteristics and categories were chosen to evaluate the impact of situated teaching, academic self-efficacy, achievement orientation and academic engagement among telesecundaria students, who are the focus of this research.

Validity and reliability of the selected scales.

For the development of the scale that measures the construct of *Situated Teaching*, the instrument validated by Méndez and González (2011) was taken as a reference. This scale is based on the theory of significant learning (Ausubel, 1978) and its application in teaching strategies by Díaz and Hernández (2002). The instrument is made up of 12 subscales; each of which contains indicators of the application of a teaching strategy that promotes meaningful learning. It has a Likert-type scale format, whose response options are: (5) Always, (4) Frequently, (3) Sometimes, (2) Almost never and (1) Never, all items are positive and report a Cronbach's alpha of .93, which denotes reliability.

To measure the variable of *Academic Self-efficacy*, the scale that was adapted was the one proposed by Luo et al. (2020). The scale refers to the framework developed by So et al. (2018), which has been validated through the analysis of reports on STEM project-based learning. The author reports a Cronbach's Alpha of .90 being a one-dimensional scale made up of 12 items measured on a 4-point Likert scale: (4) Very capable, (3) Capable, (2) Somewhat capable, (1) Not at all capable.

With respect to the scale to measure *Achievement Orientation* , the Anderman (2000) scale, which is based on the theory of goal orientation, was adapted to examine the relationship between the learning environment and student motivation, effect and behavior. A 5-point Likert scale is used: (5) Strongly agree, (4) Agree, (3) Neither agree nor disagree, (2) Disagree and (1) Strongly agree. In terms of reliability, it presents a Cronbach's Alpha of .94, being a one-dimensional scale made up of 11 items.

For the measurement of *Academic Commitment* , the instrument designed by Wang et al. (2016) was adapted since it is built from a multidimensional perspective of commitment and participation of secondary school students in science and mathematics subjects, through the use of a two-factor modeling approach. The instrument contains four subdimensions of engagement: cognitive, behavioral, emotional, and social engagement. For the purposes of this study, only intrapersonal subdimensions were taken into account. The instrument is answered on a 5-point Likert scale: (5) Always, (4) Frequently, (3) Sometimes, (2) Almost never, and (1) Never. Cronbach's alpha for each subdimension was: .93 in cognitive engagement, .94 in behavioral engagement, and .85 in emotional engagement.

In each of the instruments, an adaptation was made (see Tables 2, 3, 4, and 5) in terms of the students' level of comprehension and language, considering the Mexican context and the translation of the items into Spanish.

Table 2

Operationalization of situated teaching variable.

Name/Author of the Scale	Luo, T., et al., (2020).
Construct	Teaching style in the learner. Experiential and problem-based learning and reflection; considering community contexts in which the teaching-learning process takes place. (Díaz, 2006).
Dimension	Unidimensional. The scale measures teaching situated in STEM activities that emphasize learning STEM practices in students.
Items **Items** *(continued...)*	1. Relate math and science topics to topics in other subjects. 2. Teach math and science topics using real-life examples. 3. Relate science and math projects to problems in my community. 4. Present several examples related to the topics of science and mathematics. 5. Ask questions related to topics covered in past science and math classes. 6. It proposes the realization of activities that relate the topics covered in science and mathematics classes to solve problems in the community. 7. Use different materials (games, videos, graphic organizers) to explain science and math topics.

Note. 5-level Likert scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neither Agree nor Disagree; 4 = Agree; 5 = Strongly Agree

Table 3
Operationalization of academic self-efficacy variable.

Name/Author of the Scale	Thibaut et al (2018)
Construct	Efficacy: A significant factor that contributes to the choices a student makes, learning (Zimmerman, 2000).
Dimension	Unidimensional The scale measures students' self-efficacy in STEM activities that emphasize learning STEM practices.
Items	1. I can propose ways to search for science and math information. 2. I know ways or steps to carry out the search for information in science and mathematics. 3. I carry out on my own, research information in science and mathematics. 4. I classify the information I find in science and mathematics. 5. I use technological tools to study science and mathematics. 6. I understand the problems to be solved in science and mathematics. 7. I propose different solutions to science and mathematics problems. 8. I compare the different solutions to science and math problems. 9. I take notes on data and solutions to science and math problems. 10. I represent in graphs the data obtained in the solutions to science and mathematics problems.
Items *(continued…)*	

*Note***.** 4-level Likert scale: 1 = Not at all capable; 2 = Not very capable; 3= Somewhat capable; 4= Very capable

Table 4
Operationalization of the achievement-oriented variable.

Name/Author of the Scale	Anderman, L., (2000)
Construct	Achievement orientation: It refers to students' reasons or purposes for engaging in academic behavior (Anderman, 2000). The focus is on how students think about themselves, their tasks, and their performance. (Ames, 1987).
Dimension	Mastery: Learning is perceived as inherently interesting, in short, in itself. It focuses attention on the task and is aimed at developing its understanding with adaptive learning patterns (Anderman, 2000).
Items	1. I like science and math work because I learn new things. 2. I like the work in my science and math class when it challenges me to think. 3. A big reason I do my work in science and math classes is because I want to improve my skills in these subjects. 4. I do my science and math school work because I'm interested. 5. I do my science and math school work because I enjoy it. 6. It's important for me to learn new science and math concepts this year. 7. I try to learn as much as I can about science and math in class. 8. I try to master new skills in science and math. 9. It's important for me to understand what I'm doing in my science and math activities.
Items *(continued…)*	10. It's important for me to improve my skills in science and math.

Note. 5-level Likert scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neither Agree nor Disagree; 4 = Agree; 5 = Strongly Agree

Table 5
Operationalization of academic commitment variable.

Name/Author of the Scale	Wang et al., (2016).
Construct	Academic commitment: It refers to the observable and unobservable qualities of students' interactions with learning activities (Deci & Ryan, 2000).

Dimension	Cognitive Engagement: Using deep learning strategies to learn and understand material, self-regulation, and persistence (Greene, 2015) Behavioral Compromise: Participation in academic and classroom activities, presence of positive behavior, and absence of disruptive behavior (Fredericks et al., 2004). Emotional Engagement: Presence of positive emotional reactions to teachers, peers, and classroom activities, as well as appreciation of learning and interest in learning content (Finn, 1989).
Items	Cognitive Engagement: 1. I review the topics I saw before science and math class. 2. I know different ways to solve a science and math problem. 3. I try to relate what I'm learning in science and math to things I've learned before. 4. I'd rather be told the answer than have to do the science and math work. 5. I think a lot when I'm doing work for science and math class. 6. When activities are hard, I only study the easy parts of science and math. 7. I do enough to pass the science and math subject. Behavioral Compromise: 8. I stay focused in science and math class. 9. I strive to learn science and math. 10. I finish my science and math homework on time. 11. I talk about science and math outside of class. 12. I participate in science and math class. 13. I get distracted by other things when I'm supposed to be paying attention in science and math class. 14. If I don't understand science and math class, I give up right away.
Items *(continued...)*	Emotional Engagement: 15. I look forward to science and math class. 16. I enjoy learning new things about science and math. 17. I want to understand what is learned in science and math class. 18. I feel good when I'm in science and math class. 19. I often feel frustrated in science and math class. 20. I think science and math class is boring. 21. I want to be in science and math class. 22. I care about learning science and math. 23. I get excited when I learn new things about science and math.

Note. 5-level Likert scale: 1 = Never; 2 = Almost never; 3 = Sometimes; 4 = Frequently; 5 = Always

Content validity and reliability.

In October 2022, a pilot of the instrument designed to measure the academic commitment of third-year high school students in telesecundaria modality, specifically in STEM subjects, was carried out.

This pilot included the application of 100 surveys in three complete telesecundaria schools located in the municipalities of Cárdenas, Centro, and Jalapa in the state of Tabasco, Mexico, as a feasible sample for multivariate analysis (Álvarez et al., 2006). For one week, the pilot was carried out, with prior authorization from the educational authorities and with the consent of the tutor of each student surveyed.

The purpose of the study and the structure of the questionnaire were explained to the students, guaranteeing the confidentiality of the data. The surveys were conducted in the classroom and each student spent approximately 25 minutes completing them.

Validity of content by expert judgment.

To ensure the relevance and representativeness of the items of the measurement instrument with respect to the investigated constructs (Ding et al., 2002; Mitchell, 1986), an assessment was carried out through the informed opinion and judgment of eight experts. These experts were selected based on (1) their experience in research and publications related to the constructs under study, (2) their experience in psychometrics, and (3) their training and professional career in relevant areas.

The individual aggregate method was used to obtain the participation of the judges in the validation of the instrument (Escobar-Pérez & Cuervo-Martínez, 2008a). A request was sent by e-mail to eight experts requesting their collaboration in evaluating the instrument through an expert judgment card (Escobar-Pérez & Cuervo-Martínez, 2008a). The judges evaluated the items according to the criteria of (a) sufficiency, indicating whether the items of the same dimension or construct were adequate to measure it; (b) clarity, ensuring that the items were syntactically and semantically understandable; (c) coherence, evaluating the logical relationship of the items with the dimension or indicator they intended to measure; and (d) relevance, determining the importance of the items and whether they should be included in the instrument. The ratings were made using a 4-level Likert scale: 1. Does not meet the criteria; 2. Low level; 3. Moderate level; and 4. High level.

The validation cards were returned individually by email, with a receipt period of 15 days from the sending of the card. Two stages of analysis were carried out: the first consisted of a qualitative interpretation of the observations made by the judges, while the second stage used Fleiss's Kappa coefficient as an analysis statistic of agreement between evaluators, using the SPSS software (version 26) (Escobar-Pérez & Cuervo-Martínez, 2008b). This coefficient generates a measure of agreement among the evaluators, with values ranging from 0

to 1. To interpret the results, the scale proposed by Landis and Koch (1977) was used: a value of 0.00 indicates poor agreement, .1 to .20 slight, .21 to .40 acceptable, .41 to .60 moderate, .61 to .80 considerable, and .81 to 1.0 almost perfect.
In the first analysis, items with double or reverse intention were identified, which could be complex since they can be applied differently in specific disciplines. In addition, items containing two verbs with different levels of proficiency were observed, as well as wording that was difficult to understand.
In the second analysis, a Kappa index of 0.43 was obtained with a significance level of 0, indicating a moderate degree of agreement among the judges.
Given the results of the second analysis, a third analysis was carried out using Kendall's W coefficient of agreement through the SPSS software (version 26), in order to determine the degree of agreement among the experts (Siegel & Castellan, 1995). This coefficient is especially useful when experts are asked to assign ranges to items, as in this case, from 1 to 4. In addition, the same interpretation scale according to Landis and Koch (1977) was used to evaluate the results.
A level of agreement of 0.52 was obtained with a level of significance of 0, indicating that there is a moderate degree of agreement between the scores assigned by the judges. According to Escobar-Pérez and Cuervo-Martínez (2008b), a significance level greater than 0.05 confirms that there is agreement between the assigned ranges and a homogeneous relationship in the data.
After the previous analysis, it was determined to exclude three items from the initial survey that were considered redundant with other items within the investigated constructs: (1) Achievement orientation, item 19: "An important reason why I do my science and math work is because I like to learn new things." (2) Academic engagement, cognitive subdimension, item 38: "I keep trying in science and math even if something is difficult." (3) Academic engagement, emotional subdimension, item 52: "I often feel depressed when I am in science and math class."
The final survey was composed of 50 items distributed as follows: 7 items of Situated Teaching, 10 items of Academic Self-Efficacy, 10 items of Achievement Orientation and 23 items of Academic Commitment.

Instrument reliability with pilot test data.

The results obtained were interpreted using IBM SPSS version 26 software. First, the standard deviation of the data was calculated in order to know the variability between the responses of each of the surveys.

Normality tests.

In order to determine the nature of the data distribution and select the appropriate statistical tests, the Kolmogorov-Smirnov goodness-of-fit (K-S) test was carried out on the instrument. This evaluation was carried out to verify whether the data collected during the pilot exhibit a normal distribution, a relevant condition for continuous quantitative variables and samples that exceed 50 cases (Romero, 2016).

Table 6 *Statistical goodness-of-fit test*

	Kolmogorov-Smirnova			**Shapiro-Wilk**		
	Statistical	**Gl**	**Gis.**	**Statistical**	**gl**	**Say.**
IS	.057	100	.200	.987	100	.448
AA	.070	100	.200	.980	100	.122
HE	.123	100	.001	.920	100	.000
CA	.074	100	.200	.981	100	.164

Note. a. Correction of meaning by Lilliefors. This is a lower limit of true significance. ES-Situated Teaching, AA- Academic Self-Efficacy, OL- Achievement Orientation, CA-Academic Engagement

The results of the Kolmogorov-Smirnov goodness of fit test showed that the statistic obtained a value of 0.057 for the variable of Situated Teaching, 0.070 for the variable of Academic Self-efficacy and 0.074 for the variable of Academic Engagement, all with a value of statistical significance (p) of 0.200, which is higher than the threshold of true significance. In the case of the Achievement Orientation variable, the statistic was 0.123 with a statistical significance value (p) of 0.001. Given that all the statistical significance for the aforementioned variables obtained values less than 0.05, it can be inferred that the results suggest a normality in the distribution of the scores.
Taking into account the above, a descriptive analysis of the data was carried out to determine the degree of symmetry of the probability distribution of the study variables, reviewing asymmetry and kurtosis. According to Darlington and Hayes (2017), as well as Heck et al. (2014), asymmetry values between -1 and +1 indicate normality. Bandalos and Finney (2019) suggest that asymmetry values less than 5 and kurtosis values less than 7 do not significantly affect statistical estimates. Based on these criteria, the normality of the data was checked, allowing them to continue with their analysis.
In addition, internal consistency was calculated using Cronbach's alpha reliability coefficient and McDonald's Omega test for each dimension of the constructs: Situated Teaching (SE), Academic Self-Efficacy (AA),

Achievement Orientation (OL), and Academic Engagement (AC). According to Cortina (1993) and Campo-Arias and Oviedo (2005), the correlation between the items that make up the dimensions is acceptable when the values are equal to or greater than 0.70 and less than or equal to 0.90, which indicates good internal consistency; values less than 0.60 are considered unacceptable (see Table 7).

Table 7 Piloting reliability values for situated teaching, academic self-efficacy, achievement orientation, and academic engagement constructs

Variable	Dimension	Cronbach's Alpha	Omega de McDonald
Situated Teaching	Unidimensional	.727	.740
Academic self-efficacy	Unidimensional	.844	.851
Achievement orientation	Unidimensional	.893	.895
Academic Engagement	Cognitive	.554	.455
	Behavioral	.507	.510
	Emotional	.682	.738

According to the results obtained from the calculation of Cronbach's Alpha and McDonald's Omega, the reliability values in the dimensions of Situated Teaching (SE), Academic Self-Efficacy (AA), Achievement Orientation (OL) and Academic Emotional Engagement (CAE) are quite good. However, a weakness was detected in the factorial weight of two subdimensions of Academic Engagement: Cognitive Academic Engagement (CAC) and Academic Behavioral Engagement (DCC), which are below the acceptable value. Because of this, the items (see Tables 8, 9 and 10) of the Academic Commitment dimension that generate weakness in these subdimensions were reviewed, using the correlation matrix in the exploratory factor analysis.

Table 8 *Matrix of Item Correlations: Cognitive Academic Engagement Subdimension*

Correlation	I28CAC	I29CAC	I30CAC	I31CAC	I32CAC	I33CAC	I34CAC
I28CAC	1.00	.47	.45	-.25	.28	-.26	.37
I29CAC	.47	1.00	.32	.06	.17	.03	.27
I30CAC	.45	.32	1.00	-.07	.33	.08	.20
I31CAC	-.25	.06	-.07	1.00	.03	.36	.009
I32CAC	.28	.17	.33	.03	1.00	.05	.17
I33CAC	-.26	.03	.08	.36	.05	1.00	.02
I34CAC	.37	.27	.20	.009	.17	.02	1.00

From the analysis of the values obtained in Table 8, three weak items were identified in the subdimension of Cognitive Academic Engagement (CAC): I31CAC, "I prefer to be told the answers than to have to do science and mathematics work"; I33CAC, "When activities are difficult, I only study the easy parts of science or mathematics"; and I34CAC, "I do enough to pass the science or math subject." These identified items will be re-evaluated in the confirmatory factor analysis.

Table 9 *Matrix of Item Correlations: Behavioral Academic Engagement Subdimension*

Correlation	I35CCD	I36CCD	I37CCD	I38CCD	I39CCD	I40CCD	I41CCD
I35CCD	1.00	.55	.44	.11	.27	-.14	-.20
I36CCD	.55	1.00	.42	.06	.35	-.21	-.29
I37CCD	.44	.42	1.00	.24	.46	-.14	.03
I38CCD	.11	.06	.24	1.00	.30	-.04	.20
I39CCD	.27	.35	.46	.30	1.00	-.21	-.05
I40CCD	-.14	-.21	-.14	-.04	-.21	1.00	.36
I41CCD	-.20	-.29	.03	.20	-.05	.36	1.00

From the analysis of the values obtained in Table 9, three weak items were identified in the subdimension of Academic Behavioral Engagement (CCD): I38CCD, "I talk about science and mathematics outside of class"; I40CCD, "I get distracted by other things when I'm supposed to pay attention in science and math class"; and I41CCD, "If I don't understand science and math class, I'll give up right away." These identified items will be re-evaluated in the confirmatory factor analysis.

Table 10 *Matrix of Item Correlations: Behavioral Academic Engagement Subdimension*

Correlation	I42 FALLS	I43 FALLS	I44 FALLS	I45 FALLS	I46 FALLS	I47 FALLS	I48 FALLS	I49 FALLS	I50 FALLS
I42CAE	1.00	.39	.04	.31	.07	-.21	.50	.31	.42
I43CAE	.39	1.00	.41	.52	-.01	-.37	.39	.48	.51
I44CAE	.04	.41	1.00	.41	.08	-.13	.40	.39	.38
I45CAE	.31	.52	.41	1.00	-.21	-.18	.48	.42	.41
I46CAE	.07	-.01	.52	-.21	1.00	.17	.04	.06	.14
I47CAE	-.21	-.37	-.01	-.18	.17	1.00	-.31	-.13	-.23
I48CAE	.50	.39	-.37	.48	.04	-.31	1.00	.42	.44
I49CAE	.31	.48	.39	.42	.06	-.13	.42	1.00	.39
I50CAE	.42	.51	.38	.41	.14	-.23	.44	.39	1.00

From the analysis of the values obtained in Table 10, three weak items were identified in the subdimension of Emotional Academic Engagement (EAC): I44CAE, "I want to understand what is learned in science and mathematics class"; I46CAE, "I often feel frustrated in science and math class"; and I47CAE, "I think science and math class is boring." These identified items will be re-evaluated in the confirmatory factor analysis.

Construct validity. Exploratory Factor Analysis (EFA)

It was calculated from the method of maximum likelihood and rotation of direct Oblimin in the statistical program SPSS version 26. The results obtained according to the selected scales are as follows.

Situated teaching.

The results obtained from the Bartlett sphericity test indicated that it is significant ($\chi^2 = 151.626$, df = 21, $p < .001$), and the Kaiser-Meyer-Olkin (KMO) value was 0.69, suggesting a moderate adequacy of the sample (Cea, 2004; De Vellis, 2003; Martínez et al., 2006). For the inclusion of the items, factorial weights of 0.30 or greater were considered in at least one of the factors, which evidences the theoretical strength of the item (Hair et al., 1999; Valdés-Cuervo et al., 2019). The seven items of the scale were grouped into a single factor that together explains 54.9% of the variance of the scale's scores (see Table 10).

Table 11 *Mean, standard deviation, factor load and communalities for the situated teaching variable.*

Item	M	OF	Factor load 1	h^2
I01ES. Relate math and science topics to topics in other subjects.	2.62	1.354	.705	.473
I02ES. Teach math and science topics using real-life examples.	3.36	1.202	.369	.468
I03ES. Relate science and math projects to problems in my community.	2.92	1.269	1.052	.998
I04ES. Present several examples related to the topics of science and mathematics.	3.49	1.251	.389	.456
I05ES. Ask questions related to topics covered in past science and math classes.	3.82	1.140	.317	.147
I06ES. It proposes the realization of activities that relate the topics seen in science and mathematics classes to solve problems in the community.	2.55	1.234	.483	.306
I07ES. Use different materials (games, videos, graphic organizers) to explain math and science topics.	3.79	1.297	1.018	1.000

Note. h^2 = communalities.

Academic self-efficacy.

The results obtained in the Bartlett sphericity test indicated that it is significant ($\chi^2 = 311.167$, df = 45, $p < .000$), and the Kaiser-Meyer-Olkin (KMO) value was 0.850, suggesting a high adequacy of the sample (Cea, 2004; De Vellis, 2003; Martínez et al., 2006). For the inclusion of the items, factorial weights of 0.30 or greater in at least one of the factors were considered, which evidences the theoretical strength of the item (Hair et al., 1999; Valdés-Cuervo et al., 2019). The ten items of the scale were grouped into a single factor that together explains 42.5% of the variance of the scale scores (see Table 12).

Table 12 *Mean, standard deviation, factor load and communalities for the variable of academic self-efficacy.*

Item	M	OF	Factor load 1	h²
I08AA. I can propose ways to search for science and math information.	2.51	.823	.674	.464
I09AA. I know ways or steps to carry out the search for information in science and mathematics.	2.79	.868	.531	.500
I10AA. I carry out on my own, research information in science and mathematics.	2.85	.880	.639	.412
I11AA. I classify the information I find from science and mathematics.	2.40	.853	.572	.333
I12AA. I use technological tools to study science and mathematics.	2.81	1.032	-.559	.321
I13AA. I understand the problems to be solved in science and mathematics.	2.61	.751	.470	.522
I14AA. I propose different solutions to science and mathematics problems.	2.26	.848	.600	.465
I15AA. I compare the different solutions of science and math problems.	2.49	.969	.577	.465
I16AA. I take notes on solutions to science and math problems.	2.86	.985	.573	.348
I17AA. I represent the data obtained in the solutions of problems in science and mathematics in graphs.	2.26	.860	.608	.417

Note. h² = communalities.

Achievement orientation.

The results obtained in the Bartlett sphericity test indicated that it is significant ($\chi^2 = 440.062$, df = 45, $p < .000$), and the Kaiser-Meyer-Olkin (KMO) value was 0.874, suggesting a high adequacy of the sample (Cea, 2004; De Vellis, 2003; Martínez et al., 2006). For the inclusion of the items, factorial weights of 0.30 or greater in at least one of the factors were considered, which evidences the theoretical strength of the item (Hair et al., 1999; Valdés-Cuervo et al., 2019). However, Comrey (1973) states that in rotated factors the values are usually lower and can be considered significant from 0.30 to 0.20 (Nunnally, 1994; Morales, 2011). The ten items of the scale were grouped into a single factor that together explains 46% of the variance of the scale's scores (see Table 13).

Table 13 *Mean, standard deviation, factor load and communalities for the variable of academic self-efficacy.*

Item	M	OF	Factor load 1	h²
I18OL. I like science and math work because I learn new things.	3.82	.978	.655	.430
I19OL. I like the work in my science and math class when it challenges me to think.	3.53	1.039	.588	.346
I20OL. A big reason I do science and math homework is because I want to improve my skills in these subjects.	4.23	1.004	.673	.453
121OL. I do my science and math school work because I'm interested.	3.98	1.073	.668	.447
122OL. I do my science and math schoolwork because I enjoy it.	3.55	1.067	.659	.434
I23OL. It's important for me to learn new concepts in science and math.	4.06	1.003	.724	.525
I24OL. I try to learn as much as I can about science and math in class.	4.27	.863	.729	.532
I25OL. I try to master new skills in science and math.	3.96	.984	.699	.488

Item	M	OF	Factor load 1	h²
I26OL. It's important for me to understand what I'm doing in my science and math activities.	4.02	1.054	.712	.507
127OL. It is important for me to improve my skills in science and mathematics.	4.35	.978	.663	.440

Note. *h²* = communalities.

Academic commitment.

The results obtained in the Bartlett sphericity test indicated that it is significant (χ^2 = 964.280, df = 253, p < .000), and the Kaiser-Meyer-Olkin (KMO) value was 0.772, suggesting a moderate adequacy of the sample (Cea, 2004; De Vellis, 2003; Martínez et al., 2006). For the inclusion of the items, factorial weights of 0.30 or greater in at least one of the factors were considered, which evidences the theoretical strength of the item (Hair et al., 1999; Valdés-Cuervo et al., 2019). The 23 items of the scale were grouped into three factors that together explained 51.2% of the variance of the scale scores. The first factor, made up of seven items, accounted for 8.9%; the second factor, composed of seven items, accounted for 14%; and the third factor, made up of nine items, explained 28.4% of the variance (see Table 14).

Table 14 *Mean, standard deviation, factor load and communalities for the variable of academic commitment.*

Item	M	OF	Factor load			h²
			1	2	3	
I28CAC. Review the topics seen before science and math class.	2.75	1.048	.435			.499
I29CAC. I know different ways to solve a science and math problem.	3.13	.950	.377			.345
130CAC. I try to relate what I am learning in science and mathematics to things I have not learned before.	3.32	1.238	.416			.408
131CAC. I'd rather be told the answer than have to do the science and math work.	2.01	1.020	-453			.373
I32CAC. I think a lot when I'm doing work for the science and math class.	3.43	1.139	.313			.228
I33CAC. When activities are hard, I only study the easy parts of science and math.	2.87	1.143	.369			.429
I34CAC. I do enough to pass the science and math subject.	3.98	1.155	.585			.456
I35CCD. I stay focused in science and math class.	3.84	.961		.582		.518
I36CCD. I strive to learn science and math.	4.07	1.094		.865		.993
I37CCD. I finish my science and math homework on time.	3.61	1.091		.436		.548
I38CCD. I talk about science and math outside of class.	2.24	1.120		.352		.251
I39CCD. I participate in science and math class.	3.26	1.292		.391		.560
I40CCD. I get distracted by other things when I'm supposed to be paying attention in science and math class.	2.32	.963		-.506		.328
I41CCD. If I don't understand science and math class, I give up right away.	1.95	1.095		.489		.546
I41CCD. I look forward to science and math class.	2.51	1.078			.811	1.000
I43CAE. I enjoy learning new things about science and math.	3.47	1.096			.541	.597
I44CAE. I want to understand what is learned in science and math class.	3.93	1.047			.517	.537
I45CAE. I feel good when I'm in science and math class	3.22	1.106			.453	.429

Item	M	OF	Factor load			h²
			1	2	3	
I46CAE. I often feel frustrated in science and math class.	2.80	1.239			.320	.224
I47CAE. I think science and math class is boring.	2.12	1.166			-.541	.517
I48CAE. I want to be in science and math class.	3.18	1.123			.576	.535
149CAE. I care about learning science and mathematics.	4.03	1.020			.812	1.000
I50CAE. I get excited when I learn new things about science and math.	3.63	1.203			.503	.495

Note. Factor 1 = Academic cognitive engagement; Factor 2 = Academic behavioral engagement; Factor 3 = Emotional academic engagement; h^2 = communalities.

Conclusions.

In conclusion, exploratory factor analysis of the data empirically validated the relationship between academic engagement and situated teaching, academic self-efficacy, and achievement orientation. Despite the presence of items with weaknesses in some constructs, the global fit indices were considered excellent and acceptable (Litterwood & Bernal, 2014; Valdés-Cuervo et al., 2019). It is recognized that the original scales (Méndez & González, 2011; Luo et al., 2020; Anderman, 2000; Wang et al., 2016) were not specifically designed for the Mexican context, especially for the telesecundaria modality in the Mexican Educational System. Therefore, it is proposed to keep the weak items for confirmatory factor analysis and to study their behavior in a larger sample.

Initially, the instrument represents an interesting contribution because its results can support community educational diagnosis, the development of analytical plans, pedagogical projects, and teacher training in STEM, in accordance with the guidelines of the New Mexican School (Ministry of the Interior, 2022).

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