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Engagement and Self-Regulation Scale for Higher Education Students (ES-R): Development and Psychometric Properties

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In the current university education scenario, various aspects are evident that negatively affect students' academic performance and increase dropout levels during the first year. In this context, one of the relevant factors is to analyze the engagement and self-regulation of learning as input for designing strategies with a clear intention of facilitating learning. Hence the importance to develop appropriate instruments to investigate how engaged the students are with their training process, a situation that affects self-regulation of learning, which is a crucial skill in a student's success. For this reason, this work aims to develop and analyze the scale's psychometric properties that allow knowing about the engagement and self-regulation of student learning in the face of schoolwork and their role in learning. The measures are based on a multidimensional perspective of the engagement-self-regulation construct through structural equations. The sample was recruited from a population of first-year college students. The results confirmed that students' engagement and self-regulation comprise multiple related but distinct dimensions. This is evidenced by the standardized factor loadings, which presented values above 0.6, and the calculated Average Variance Extracted, which presented values equal to or greater than 0.5. There was also empirical evidence supporting measurement invariance and predictive validity. Specifically, the differences in CFI and RMSEA were determined to be equal to or below 0.01 and 0.015, respectively. These findings demonstrate the robustness of the scale's psychometric properties.

Keywords: self-regulation, engagement, validation, homework, learning

INTRODUCTION

In higher education the activities students do outside the classroom play a fundamental role in the autonomy of their learning process. In this context, homework, which is part

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of the pedagogical work of professors, should enable a better understanding and comprehensive approach to a given object of study. The ultimate goal of homework should be to guide students to adopt a behavior that leads to academic autonomy (Fernández-Alonso et al., 2017; Bjork et al., 2013; Tempelaar et al., 2024). An important aspect of this situation is assessing students' engagement and self-regulation of learning, crucial for creating effective strategies to support learning. It is essential to create appropriate tools to assess students' level of commitment to their education, as this directly affects their ability to self-regulate their learning, a key skill for student achievement.

Therefore, this study aims to develop and analyze the psychometric properties of a scale that enables us to assess students' engagement and self-regulation in handling their academic responsibilities and learning roles. The measurements are grounded in a multidimensional view of commitment and self-regulation in learning, employing structural equations. The sample consisted of first-year university students from a higher education institution.

This research enhances the understanding of learning engagement and self-regulation among university students. It also provides a validated instrument for subsequent research and the development of effective educational interventions aimed at improving student success and permanence in the initial years of university.

Literature Review

Self-regulation of learning and academic engagement are essential components of students' educational process. Self-regulated learning involves students' capacity to manage, regulate, and guide their cognitive, motivational, and behavioral processes in the context of learning. This encompasses setting goals, monitoring progress, managing time, and employing effective learning strategies. Conversely, academic engagement pertains to the extent to which students actively engage in their learning, demonstrating interest, motivation, and commitment to academic tasks and educational goals. These two concepts are interconnected, as effective self-regulated learning enhances academic engagement, thereby fostering more efficient and meaningful learning.

Autonomous study and work are two modes of learning in which students are responsible for organizing their work and how they will acquire knowledge at their own pace. Therefore, learners should take the responsibility for and control of their learning process, as well as make decisions regarding planning, going through, and evaluating the learning experience (Tempelaar et al., 2024). In this context, doing homework is an adequate space for students to experience a positive mental state related to schoolwork and performance in terms of dedication, concentration, and immersion in the task at hand. These aspects favor the activation of strategies needed to achieve learning goals (Panadero, 2017).

Learning self-regulation is an educational concept that involves trust, motivation, and the ability to learn independently within the framework of a learning environment (Yamada et al., 2017). Students can be considered active participants in their learning process self-regulated from a metacognitive, motivational, and behavioral point of view. This is because self-regulation is the fusion of ability and will. It is related to the capacity to use various cognitive learning strategies such as inference and deduction, and metacognitive strategies like planning and monitoring. In this context, student motivation plays a significant role in setting learning goals; it is the driving force that engages us in task completion. Additionally, (Weinstein et al., 2000) propose that three essential components integrate learning strategies: first, "want," which refers to affective, motivational, and support elements, which is guaranteed through provisions and an adequate climate for learning; Second, "make decisions and evaluate them," which involves metacognitive aspects in the student to self-regulate her learning; Third, "power," which implies cognitive elements to handle strategies, skills, and techniques to process information. This notion presented by the authors for learning strategies-argue-unlike other notions collects concepts such as consciousness, intentionality, diverse resources management, self-regulation, and linking to the context.

A self-regulated learner is engaged and has positive emotions toward the academy and the spaces in which she develops her schoolwork. In other words, she prioritizes ethical work, perseverance, self-efficacy, and resilience. These feelings of well-being are usually stable. In other words, he is engaged. Engagement is a concept of positive psychology (Seligman & Csikszentmihalyi, 2000), which focuses on studying and researching individuals' positive qualities and emotions, especially optimism, interpersonal skills, faith, hope, and honesty (Seligman, 2008). Other authors define it as lasting feelings of happiness or well-being that are usually stable and independent from the surrounding context and circumstances (Furlong & Christenson, 2008; Fencl & Scheel, 2005). Engagement, in turn, is a positive mental state related to work and composed of three basic dimensions: (1) vigor, i.e., high levels of mental energy while working or studying; (2) dedication, i.e., involvement, enthusiasm, inspiration, pride, and challenge one experiences in relation to one's study or work; and (3) absorption, i.e., concentration in one's work (Oerlemans & Bakker, 2018; Xanthopoulou et al., 2009).

Other studies into engagement have examined the relationship between multiple levels of belonging and behavioral and emotional engagement (Wilson et al., 2015). Along these lines, according to Fredricks et al. (2004), engagement is a construct that includes several dimensions: behavioral (participation in activities outside the classroom), emotional (positive and negative reactions towards the school), and cognitive (efforts to understand complex ideas and develop difficult skills).

In addition, the literature has introduced scales to evaluate engagement. The Engagement or Utrecht Work Engagement Scale (UWES-S) proposed by Schaufeli & Bakker (2003) presents a model with 17 items grouped into three dimensions: vigor, dedication, and absorption. They found that this three-dimensional structure demonstrated better fit and reliability compared to a one-factor model. The literature reports versions of this scale, and its psychometric properties were evaluated. This adaptation was aimed at school environments in order to intervene in academic processes considering the results of the application of such scale (Loscalzo & Giannini, 2019; Jang & An, 2022; Wickramasinghe et al., 2021; Song, 2021). Other studies have reported the development, validation, and application of scales to measure engagement in mathematics and sciences based on a multidimensional model that includes cognitive, behavioral, emotional, and social aspects (Wilson, 2015; Wang et al., 2016; Alonso-Tapia et al., 2022).

In the United States and Canada, engagement has been studied using the National Survey of Student Engagement (NSSE). This instrument measures the degree of engagement of a student with activities promoted by an institution and comprises several dimensions: challenge, learning with peers, experiences with faculty, effective teaching practices, and experiences with the institutional environment. The validity and reliability of this survey have been demonstrated in several studies (Lutz & Culver, 2010; George et al., 2008).

More recent studies present the psychometric properties of scales referring to the engagement construct focused on higher education students and directed towards other components such as student retention, Online learning, and Orientation to achievement goals (Zhoc et al., 2019; Sinval et al., 2021).

Recent research shows the possible relationship between daily job crafting and daily work engagement through momentary need satisfaction and momentary engagement positively or negatively. Daily job crafting implies positive or negative aspects associated with the theory of self-regulation and self-determination (Bakker & Oerlemans, 2019).

Studies have established a synergy between learning design its impact on learners' educational practices including the incidence on learners' engagement and self-regulation (Banihashem et al., 2022). A self-regulated student feels motivated, a state that leads him to get involved with his learning. For this reason, we consider it relevant to focus on this construct. This study promotes research in this field because we intend to define and validate a multidimensional instrument representing the relationship between the commitment-self-regulation construct and the task. The goodness-of-fit indices of the four-dimensional model were examined using a sample of questionnaires answered by first-year higher education students. The specific validation procedure includes exploratory and confirmatory factor analysis, content validity, convergent and discriminant validity, measurement invariance, and predictive validity tests.

METHOD

The aim of this study is to develop a multidimensional instrument to evaluate the engagement-self-regulation higher education students with homework. This includes the investigation of the psychometric properties of such instrument.

Population and sample

To define the sample size, we applied the criterion recommended by Mazor (1992), i.e., collecting at least 200 cases so that the analysis is statistically significant and the measurement is not altered by the sample. Accordingly, we used random sampling in a population of first-year students enrolled in academic programs in Antioquia, Colombia. In total, there were 306 participants, out of which 130 (42.5%) were women and 176 (57.5%) men. The average age of men and women was 19, with a standard deviation of 1.09 and 1.12, respectively. Fifty percent of the participating students also had a job. In this group, there were 204 (67%) low-income and 102 (33%) high-income individuals.

Instrument

In this study, we developed and validated an instrument called Engagement and Self-Regulation scale for higher education students (ES-R). To create it, we designed and administered a semi-structured interview for first-year university students, which were divided into two 50-participant focus groups. Based on the results of the interviews Li (2021), Schunk (2005), Zimmerman (1989), Zimmerman (2002), we identified four dimensions:

- Cognitive engagement-self-regulation: The anticipation of activities to favor the educational process, the use of cognitive strategies, and persistence are elements that evidence students' engagement with their learning because they are oriented to the purpose of homework in terms of cognitive improvement.
- Behavioral engagement-self-regulation: Focusing on carrying out academic activities (including dealing with errors or correcting and reviewing strategies used to achieve learning) is a behavior that fosters participation, control, and verification in the context of academic autonomy, which are factors that promote the commitment with activities that include doing homework.
- Engagement-self-regulation with the aim of the homework: The degree of involvement of students with the purpose of homework is part of its aim in terms of learning and achievement of academic goals.
- Engagement-self-regulation with learning goals: The expected outcome of the homework regarding learning goals guides the student toward a learning approach characterized by satisfaction caused by mastering the topic, fulfilling the task, searching for knowledge, and achieving academic objectives.

Based on the analysis of the previously mentioned dimensions, we designed a questionnaire composed of 22 items and Likert scales for each answer. At this point in the study, we sent the resulting scale to a group of professionals in the fields of education and psychology in order to discuss it with them and establish the set of items that should be included in the scale that will be validated.

Data collection and analysis

After we developed the instrument, a group of seven expert judges (i.e., specialists in education) evaluated the validity of its content. For that purpose, they used a validation instrument that included four aspects, i.e., sufficiency, clarity, coherence, and relevance, that could be rated (1) insufficient, (2) low, (3) moderate, or (4) high. Then, the Content Validity Coefficient (CVC) was applied to the obtained results to estimate content validity and the degree of agreement between expert judges regarding each one of the items and the instrument in general. The items were retained using the following levels: a CVC between 0.71 and 0.80 was inacceptable; between 0.81 and 0.90, good; and between 0.91 and 1, excellent (Hernández-Nieto, 2002).

An Exploratory Factor Analysis (EFA) was carried out to gain knowledge about the way the items are related to each other, the factors, and their fit to their previously defined conditions. Different statistical tests can serve this purpose. One of them is the Kaiser–Meyer–Olkin (KMO) test of sampling adequacy, which evaluates the strength of the relationship between two items based on partial correlations and represents their correlation after the effect of the other items has been removed. This measure takes values between 0 and 1. The EFA uses the principal component method with varimax rotation. Although the quartimax solution is analytically simpler, varimax seems to provide a clearer separation between factors (Hair et al., 1995). The weights from a statistical perspective are evaluated for their significance; the items with a factor loading greater than 0.45 were considered acceptable (Hogarty et al., 2005).

After the relationship between the constructs represented by the factors was established and the observable variables were measured based on the items in the scale, we estimated the parameters of the model using the R programming language (Team, 2014) and the Lavaan library (Rosseel, 2011). We obtained the goodness-of-fit measures of the model from a Confirmatory Factor Analysis (CFA), which, in this case, was applied with the Maximum Likelihood (ML) method. In such an application, we employed bootstrapping procedures because they enabled us to estimate the standard errors of the parameters in the model regardless of their distribution.

Two types of goodness-of-fit indices were considered in this study: global fit and incremental fit. The first type includes the Root Mean Square Error of Approximation (RMSEA) and the Standardized Root Mean Residual (SRMR). If the RMSEA is between 0.00 and 0.05, it is considered a good fit (Browne & Cudeck, 1992); and, under 0.08, it is acceptable (MacCallum et al., 1996). In terms of the SRMR, a value between 0.05 and 0.1 is acceptable; and, between 0.00 and 0.05, it is a good fit. The second type (i.e., incremental fit measures) comprises the Tucker–Lewis Index (TLI), also known as the Non-Normed Fit Index (NNFI), and the Comparative Fit Index (CFI) (Bentler & Bonett, 1980). These measures are based on the comparison of models. In particular, they were used in this study to evaluate the incremental fit of the proposed model compared with a null model (in which variables are not related). Such measures are acceptable if their value is approximately 0.90. We also utilized the chi-square (X^2) divided by the degrees of freedom (df), whose value should be between 0 and 2 for a good fit (Hair et al., 1995).

After the CFA, we calculated the convergent validity to confirm that the items were closely related to their construct (factor), which was evaluated considering the statistical significance of the factor loadings of the items in each latent construct (Hair et al., 1995).

Furthermore, the discriminant validity was obtained to determine that a construct measured a concept different to that of other constructs. This validity can be proven in different ways. One of them is the Average Variance Extracted (AVE) of each construct, which should be greater than the square of the correlations between that construct and each one of the other constructs (Fornell & Larcker, 1981).

The reliability measure of the instrument was obtained through the Composite Reliability Index (CRI), which may be better than Cronbach's alpha because it does not depend on the number of associated attributes (Hair et al., 1995). This coefficient is computed for each factor, and it is obtained from the standardized factor loading of each one of the indicators and the variance extracted associated with each one of the indicators (Fornell & Larcker, 1981). A minimum CRI of 0.7 is considered acceptable

(Anderson & Gerbing, 1988). We also calculated Cronbach's alpha, which can be used to estimate the reliability of the instrument. Similar to the CRI, this indicator is acceptable if its value is equal or greater than 0.7 (Cortina, 1993).

Moreover, we tested the measurement invariance of the instrument across the employment status (working students versus nonworking students), socioeconomic strata (high-income students versus low-income students), and gender (male students versus female students) groups. A multigroup CFA was performed to compare models with and without constraints imposed on factor loadings. In addition, the difference in the CFI and RMSEA values was examined to evaluate the model's goodness-of-fit. A difference greater than 0.01 in the CFI and above 0.015 in the RMSEA indicates a significant difference in the model fit to test measurement invariance. In other words, the less restricted model is accepted; and the other one, rejected (Chen, 2007).

To assess the predictive validity, a Spearman's correlation analysis was conducted between the cumulative Grade Point Average (GPA) obtained by students from proposed and graded evaluation activities and the dimensions in the ES-R.

After providing their informed consent and receiving the proper instructions from the professors assigned and trained to complete the questionnaire, students were interviewed online.

FINDINGS

Content validity

The Content Validity Coefficient (CVC) was estimated to define whether or not to validate the entire scale. This step allowed us to adjust the wording of some items and discuss on the relationship between each item and its corresponding category.

Based on the assigned rating, the global CVC was 0.92 for content validity and degree of agreement among expert judges. In addition, all items were rated above 0.78—a good result to continue with the validation of the scale. Regarding each validation criterion, the resulting coefficients were also satisfactory (0.89 for sufficiency, 0.93 for clarity, 0.95 for coherence, and 0.92 for relevance). According to these results, the proposed 22-item scale is adequate for its purposes (Hernández-Nieto, 2002).

Exploratory Factor Analysis (EFA)

The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy—which compares the magnitude of the observed correlation coefficients to that of the partial correlation coefficients—was .954; and the p-value obtained from the Bartlett's test of sphericity was below .05. Both values were found to be statistically significant (Hair et al., 1995). Based on the rotated component matrix (presented in Table 2), two items (I believe that my engagement has a positive impact on my performance and Even if homework is hard, one should try to complete it) were removed because their factor loadings did not allow us to determine under which factor they would fall (Floyd & Widaman, 1995). We reorder the remaining items.

Once those two items were removed and reordered the remaining items, an EFA was performed again. As a result, we obtained a KMO value of 0.950 and a p-value below 0.05. The EFA reported a total explained variance of 64% and four (4) factors or dimensions. Each factor explains a certain percentage of the total variance of the scale, as follows: cognitive engagement (48.42%), behavioral engagement (6.45%), engagement with the aim of the homework (4.97%), and engagement with learning goals (4.15%). Table 1 shows how items were grouped according to these factors.

Table 1
Classification of items according to the dimensions of engagement-self-regulation construct

Dimensions	Item
Cognitive	1. I try to learn from my mistakes.
	2. I believe that regularly going over the topics seen in class facilitates homework completion.
	3. I try to connect what I learn when doing homework with the topics explained by professors.
	4. I do my homework and make sure they are right.
	5. I believe that clarifying doubts with professors during classes facilitates homework completion.
	6. Before classes, I consider it important to analyze the topics required for homework completion.
	7. I believe that one must try harder to improve one's performance based on one's results.
Behavioral	8. I talk about homework completion with my classmates.
	9. I believe that the activities in homework assignments should be carried out completely.
	10. I consider it necessary to go over the topics before each class.
	11. I believe that the activities proposed by professors encourage me to explore other learning strategies
	12. I believe that homework completion is a personal study strategy to keep me focused on school.
Aim of the homework	13. I believe that homework is an activity proposed by professors to delve into and learn more about what is discussed in class.
	14. I believe that homework is an activity proposed by professors to contextualize the contents covered in class.
	15. I believe that homework is an activity proposed by professors to strengthen our skills to solve mathematical operations.
	16. If my grades are not good enough, my time spent on homework should be longer.
	17. Consulting physical or digital tools makes it easier to understand the topics necessary for homework completion.
Learning goals	18. If my grades are not good enough, I use a different study method.
	19. I believe that homework encourages me to investigate further.
	20. After classes, I do exercises to make sure that I actually learned the topics and procedures covered in class.

Table 2 presents the rotated component matrix, which displays all the items classified under the corresponding factor, along with their factor loading.

Table 2
This is a table. Tables should be placed in the main text near to the first time they are cited

Items	Factor 1	Factor 2	Factor 3	Factor 4
1	0.746	data		
2	0.726			
3	0.713			
4	0.650			
5	0.625			
6	0.618			
7	0.595			
8		0.710		
		0.697		
		0.588		
		0.559		
		0.522		
			0.757	
			0.658	
			0.565	
			0.553	
			0.532	
				0.694
				0.652
				0.650

The results shown in Table 2 are satisfactory. From this table, it is observed that each factor groups three or more items, whose factor loadings are above the minimum value required so that they can be retained. Hence, all factor loadings meet the specified conditions.

Confirmatory Factor Analysis (CFA)

Based on the model resulting from the EFA, a CFA was performed to evaluate the relationship between the factors. Figure 1 illustrates the flow diagram of the proposed model and the parameters estimated via the Maximum Likelihood (ML) method.

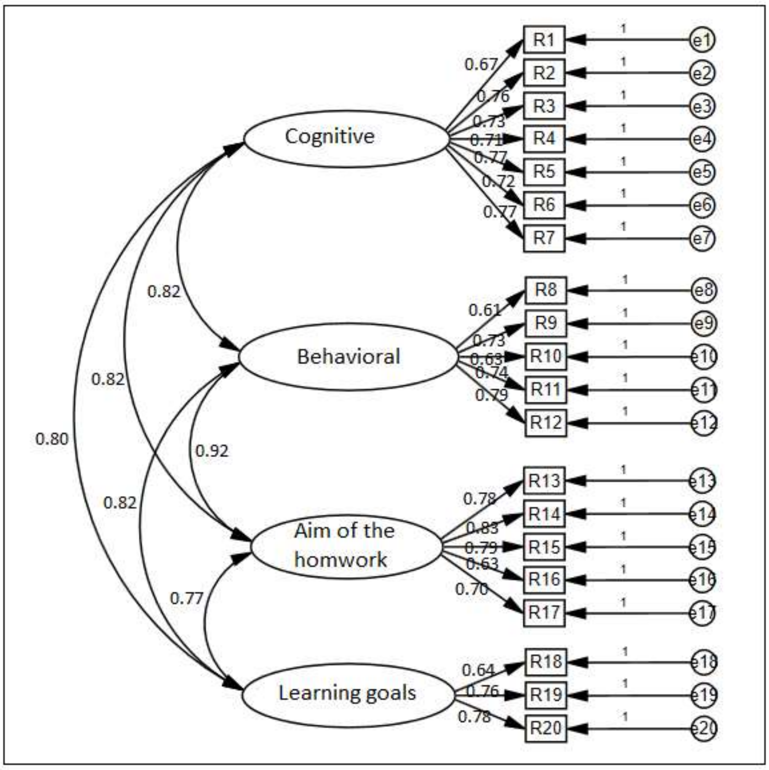

Figure 1
Flow diagram of the proposed model
Source: Created by the authors.

The standardized factor loadings of the indicator variables ranged from 0.830 to 0.612 (see Table 4). These two values correspond to the standardized factor loadings of I14 and I8, respectively. All the average factor loadings of the items in each latent variable were above 0.7. In particular, the engagement-self-regulation with the aim of the homework construct was found to have the highest value, making it the best-defined construct. Regarding the correlations between the constructs, their values ranged from 0.92 to 0.77. The highest value corresponds to the correlation between Behavioral engagement-self-regulation and engagement-self-regulation with the aim of the homework, while the lowest value corresponds to the correlation between engagement-self-regulation with the aim of the homework and engagement-self-regulation with learning goal.

The model's goodness-of-fit was evaluated using the chi-square (X^2) divided by the degrees of freedom (df), the Tucker–Lewis Index (TLI), the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Residual (SRMR). These indices are presented in Table 3.

Table 3
Model's goodness-of-fit indices

X^2	df	X^2/ df	TLI	CFI	RMSEA	SRMR
373.245	168	2.28	0.93	0.94	0.06	0.04

The resulting goodness-of-fit indices confirm that the model fits the data well. The value obtained by dividing the chi-square (X^2) by the degrees of freedom (df) was close to 2. The TLI and the CFI were above 0.9. Likewise, the RMSEA and SRMR values indicate a good fit.

Convergent validity

Convergent validity was evaluated considering the statistical significance of the standardized factor loadings of the items associated with each factor. In convergent validity, the sufficient value for a standardized factor loading is 0.6; and for the Critical Ratio (CR), 1.96 ($p < .05$). As observed in Table 4, the standardized factor loadings and their corresponding critical ratios meet this condition.

Table 4
Standardized factor loadings and critical ratios

Factor	Item	Factor loading	CR	Sig.
Cognitive engagement-self-regulation	I1	0.67		***
	I2	0.76	11.84	***
	I3	0.73	11.46	***
	I4	0.71	11.23	***
	I5	0.77	12.01	***
	I6	0.72	11.28	***
	I7	0.77	12.07	***
Behavioral engagement-self-regulation	I8	0.61		***
	I9	0.73	10.35	***
	I10	0.63	9.25	***
	I11	0.74	10.44	***
	I12	0.79	10.86	***
Engagement-self-regulation with the aim of the homework	I13	0.78		***
	I14	0.83	15.70	***
	I15	0.79	14.80	***
	I16	0.63	11.37	***
	I17	0.70	12.82	***
Engagement-self-regulation with learning goals	I18	0.64		***
	I19	0.76	10.57	***
	I20	0.78	10.74	***

*** $p < 0.001$

In this study, we developed and validated an instrument called Engagement and Self-Regulation scale for higher education students (ES-R). To create it, we designed and administered a semi-structured interview for first-year university students, which were divided into two 50-participant focus groups.

Discriminant validity

Discriminant validity was assessed in two different ways. It was obtained from the correlations between the factors, and then, with these data, the confidence intervals between each pair of factors were calculated. The information in Table 5 confirms the discriminant validity of the scale because none of the confidence intervals around the correlations includes 1 at a confidence level of 95% (Fornell & Larcker, 1981).

Table 5
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Pairs factors	Confidence intervals
Cognitive–Behavioral	(0.29, 0.43)
Cognitive–Aim of the homework	(0.30, 0.44)
Cognitive–Learning goals	(0.26, 0.40)
Behavioral–Aim of the homework	(0.31, 0.44)
Behavioral–Learning goals	(0.27, 0.40)
Aim of the homework–Learning goals	(0.25, 0.39)

Table 6
Discriminant validity. Square of the correlations between the factors and average variance extracted

Cognitive	Behavioral	Purpose of the assignment	Learning goals
0.54	0.35	0.36	0.29
	0.50	0.44	0.35
		0.57	0.32
			0.53

Table 6 shows the square of the correlations between the constructs and the AVE (in diagonal). According to this, the discriminant validity between the constructs is confirmed because the AVE was found to be equal to or greater than 0.5 and higher than the squared correlations.

Measurement invariance

Given the sensitivity of X^2 to sample size and non-normality (Hair et al., 1995), we decided to consider the difference in CFI (ΔCFI) and in RMSEA (ΔRMSEA) to determine whether the compared models were equivalent. Since the difference in CFI and in RMSEA was found to be equal to or below 0.01 and 0.015, respectively, all constraints held (see Table 7). The four-factor model fitted the data well for the entire sample and for each group. The metric invariance of the scale held across the employment status, socioeconomic strata, and gender groups as the restricted model with equal factor loadings. Unrestricted (baseline) models with higher CFI and TLI are a better fit.

Table 7
Measurement invariance of the scale

	CFI	TLI	RMSEA	ΔCFI	ΔRMSEA
Employment status					
Configural	0.907	0.900	0.057 (0.051, 0.63)		
Metric	0.906	0.900	0.56 (0.050, 0.063)	0.001<0.01	0.001<0.015
Socioeconomic strata					
Configural	0.912	0.900	0.056 (0.049, 0.062)		
Metric	0.909	0.900	0.055	0.003<0.01	0.001<0.015
			(0.049, 0.062)		
Gender					
Configural	0.918	0.905	0.052 (0.046, 0.059)		
Metric	0.915	0.906	0.052 (0.045, 0.058)	0.003<0.01	0.0<0.01

Predictive validity

We selected mathematics as the class to test the predictive validity of the scale. All correlations were found to be positive and statistically significant at the 0.01 level. This means that students who got a higher score in the ES-R were more likely to obtain a higher score in the GPA. As observed in Table 8, all coefficient values were moderate.

Table 8
Data of the sample by class and area of knowledge

Engagement-self-regulation dimensions	Evaluation activities			
	Cognitive	Behavioral	Aim of the homework	Learning goals
Cognitive	0.504**			
Behavioral		0.420**		
Aim of the homework			0.479**	
Learning goals				0.529**

** $p < 0.01$

Moreover, each specific engagement-self-regulation factor or dimension predicted the average GPAs, which were, in turn, ranked by the very dimensions of the scale. For instance, the Engagement with learning goals factor was found to be the strongest predictor of the average GPA in mathematics when the evaluation activities were directed towards such dimension. Conversely, the weakest predictor was found to be the Cognitive engagement factor with respect to the corresponding dimension.

Reliability

As shown in Table 9, the reliability of the scale was estimated using Cronbach's alpha and the Composite Reliability Index (CRI). For both coefficients, a value within the range of 0.70 to 0.79 is considered moderate, whereas a value equal to or greater than 0.80 is considered high (Bonett & Wright, 2015; Cheung et al., 2023). The Cronbach's alpha and CRI of the Engagement-self-regulation with learning goals factor were moderate, while those of the other dimensions were high.

Table 9
Cronbach's alpha and composite reliability index of each dimension in the scale

Engagement-self-regulation	Items	Cronbach's Alpha	CRI
Cognitive	I1, I2, I3, I4, I5, I6, I7	0.890	0.891
Behavioral	I8, I9, I10, I11, I12	0.827	0.830
Aim of the homework	I13, I14, I15, I16, I17	0.861	0.866
Learning goals	I18, I19, I20	0.770	0.771

DISCUSSION

The overall CVC obtained was 0.92, indicating a high degree of agreement among expert judges and validating the scale in terms of content. This result supports the robustness of the included items. Additionally, each item surpassed the threshold rating of 0.78, considered the minimum acceptable level to proceed with scale validation, reaffirming the quality of the selected items. These findings indicate that the proposed 22-item scale suits its intended purposes (Ferraz et al., 2023; Hernández-Nieto, 2002). The high content validity and strong consensus among expert judges ensure that the scale is reliable for measuring the construct of interest. This provides a solid foundation for its use in future research and educational practice, facilitating accurate and comprehensive assessment of the studied phenomenon (Hernández-Nieto, 2002).

The EFA results establish a strong foundation for the scale's validity, with a total explained variance of 64% and four dimensions identifying specific percentages of the total scale variance (San Martín et al., 2024). This confirms the scale's multidimensional structure and the representativeness of the identified dimensions for the intended theoretical constructs. The significance of cognitive engagement's explained variance underscores its importance within the scale, while other dimensions, though explaining smaller variances, significantly contribute to overall scale validity. These robust findings support the scale's use in assessing engagement and self-regulation in educational settings, demonstrating its potential for future research and practical applications among higher education students (Doo & Bonk, 2020).

Based on the results of the CFA, the standardized factor loadings of the indicator variables ranged from 0.830 to 0.612. Importantly, all average factor loadings for items within each latent variable exceeded 0.7. The correlations between the constructs ranged from 0.92 to 0.77. The obtained goodness-of-fit indices confirm the model's strong fit with the data. These high-quality fit indices reaffirm the validity of the proposed model, establishing a robust foundation for its application in future research and educational contexts (Park & Kim, 2022; Cheung et al., 2023).

For convergent validity to be met, standardized factor loadings must have a minimum value of 0.6, and the Critical Ratio (CR) must be equal to or greater than 1.96 with a significance level of $p < .05$. This indicates that the items are significantly correlated with their respective factors, which reinforces the convergent validity of the scale and its ability to measure the theoretical constructs of interest (Cheung et al., 2023).

Discriminant validity was assessed through two distinct methods. Initially, correlations between the factors were analyzed, followed by the calculation of confidence intervals for each pair. The findings affirm the scale's discriminant validity, as none of the confidence intervals around the correlations encompassed the value 1 at a 95% confidence level. These outcomes underscore that the factors assessed by the scale are suitably distinct from one another, thereby bolstering the instrument's accuracy and utility in measuring commitment and self-regulation in educational settings (Broadbent et el., 2023; Doo & Bonk, 2020; Fornell & Larcker, 1981).

Positive and significant correlations were identified between scores on the Engagement and Self-Regulation scale (ES-R) and GPA in mathematics. The coefficients were moderate, suggesting a reliable yet not exceptionally strong association. Each factor of commitment and self-regulation predicted GPAs, highlighting Commitment to learning objectives as the most robust predictor and Cognitive engagement as the weakest. These results underscore the predictive utility of the scale (Bakker & Wang, 2020).

Cronbach's alpha and the Composite Reliability Index (CRI) are crucial indicators of internal consistency reliability. The Engagement-self-regulation with learning goals factor exhibited moderate reliability coefficients, indicating satisfactory internal consistency. Conversely, the other dimensions showed high reliability coefficients, suggesting robust internal consistency across those factors. This analysis assures that the scale is reliable for measuring engagement and self-regulation constructs in educational contexts, supporting its validity and applicability in research and practice (Cheung, et al., 2023).

CONCLUSIONS

After the Engagement and self-regulation scale for higher education students (ES-R) was developed and validated, we obtained a new 20-item instrument to evaluate student engagement-self-regulation with homework based on four dimensions: cognitive engagement, behavioral engagement, engagement with the aim of the homework, and engagement with learning goals. This demonstrates that, when it comes to homework completion, there is a clear relationship between engagement-self-regulation and learning strategies.

Using differentiated and specific measures of engagement-self-regulation is essential to determine the extent to which students assume their responsibility in achieving academic autonomy. To guide us through this process, we used the dimensions that emerged from the answers provided by the participating students during the semi-structured interviews and the appropriate theoretical foundations.

The purpose of this study was to develop an instrument that, when applied, can serve as input for professors to propose homework or activities considering how involved students are in their learning processes. The proposed scale may help professors to identify students' learning strategies and their perception of and engagement-self-regulation with homework and, thus, propose activities that favor their academic autonomy. It should be noted that validation is a continuous process that demands further analysis in similar spheres; in addition, it requires subscales that consider other constructs which could provide insights into self-regulated learning processes and their relationship with engagement-self-regulation engagement.

Future work could focus on including a wide sample of surveyed professors to enrich the research with their perception and experience and developing instruments with a multilevel factor structure to address possible clustering effects in a broader manner. Finally, we consider it important to determine whether ratings change over time and whether the scales are sensitive to changes in the learning environment.

RECOMMENDATIONS

The Scale (ES-R) can be useful in higher education institutions, because when applied regularly to students, educators can gain valuable insights into the levels of cognitive and behavioral engagement, and use this information to tailor instructional methods and support strategies that better meet the needs of their students. Furthermore, integrating regular training sessions for faculty on the interpretation and application of ES-R results can improve the overall effectiveness of the tool, ensuring that it is used to its full potential. Using differentiated and specific measures of engagement-self-regulation is essential to determine the extent to which students assume their responsibility in achieving academic autonomy. To guide us through this process, we used the dimensions that emerged from the answers provided by the participating students during the semi-structured interviews and the appropriate theoretical foundations.

Another recommendation is to conduct longitudinal studies to track student engagement and self-regulation changes over time. This would provide a deeper understanding of how these constructs evolve throughout a student's academic career and allow for assessing the long-term impact of specific educational interventions.

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