General Metacognitive Strategies Inventory (GMSI) and the Metacognitive Integrals Strategies Inventory (MISI)

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Abstract

Introduction. When talking about knowledge itself, the way it is perceived, understood, learnt, remembered and thought, we are talking about metacognition. It is considered a crucial aspect in the development of reflective thought, autonomous learning and construction of knowledge. There exists several tools in literature to measure metacognitive aspects, however, there is no instrument related to metacognitive strategies in the area of mathematics. The objective of this study is to design two inventories, one on general metacognitive strategies and the other, for indefinite integrals from the inventory of metacognitive awareness of adults.

Method. This study is focused on the translation of metacognitive awareness of adults (MAI) to Spanish and its adaptation to the general metacognitive strategies and indefinite integrals to develop two inventories. Factor analyses were conducted using SPSS to analyze the validity and reliability of them.

Results. The results support the validity and reliability of inventories made from the Metacognitive Awareness Inventory (MAI).

Discussion and Conclusion. The modified versions of the MAI, called GMSI and MISI are valid and reliable for measuring general metacognitive strategies and metacognitive strategies specific for indefinite integrals, respectively.

Keywords: metacognitive strategies, inventory, validity, reliability, indefinite integrals.

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Inventario de estrategias meta-cognitivas generales (IEMG) e Inventario de estrategias meta-cognitivas en integrales (IEMI)

Resumen

Introducción. Al hablar del conocimiento sobre el propio conocimiento, sobre cómo se percibe, se comprende, se aprende, se recuerda y se piensa, estamos hablando sobre meta-cognición. La misma es considerada un aspecto decisivo en el desarrollo del pensamiento reflexivo, el aprendizaje autónomo y la construcción del conocimiento. En la literatura pueden encontrarse varios instrumentos destinados a medir aspectos meta-cognitivos, sin embargo, no ha podido hallarse algún instrumento que estuviera relacionado con las estrategias meta-cognitivas en el área de matemática. Por lo que este estudio tiene por objetivo diseñar dos inventarios, uno sobre estrategias meta-cognitivas generales y otro sobre estrategias meta-cognitivas para integrales indefinidas a partir del inventario de conciencia meta-cognitiva de adultos.

Método. El estudio se centró en la traducción al castellano del inventario de conciencia meta-cognitiva de adultos (MAI) y su adaptación a las estrategias meta-cognitivas generales y de integrales indefinidas para elaborar dos inventarios. Se realizaron análisis factoriales utilizando el programa SPSS para analizar la validez y confiabilidad de los mismos.

Resultados. Los resultados obtenidos apoyan la validez y confiablidad de los inventarios elaborados a partir de las adaptaciones del inventario de conciencia meta-cognitiva de adultos (MAI).

Discusión y Conclusión. Los inventarios elaborados, adaptados del MAI, llamados IEMG y IEMI, son válidos y confiables para medir estrategias meta-cognitivas generales y estrategias meta-cognitivas específicas de integrales indefinidas, respectivamente.

Palabras Clave: estrategias meta-cognitivas, inventario, validez, confiabilidad, integrales indefinidas.

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Introduction

Metacognition is knowledge about your own knowledge, about how it is perceived, understood, learnt, remembered and thought. Flavell (1970s), who first coined the term, described metacognition as one´s knowledge concerning to one´s cognitive processes and products. Metacognition also includes the ability to monitor, regulate and manage these processes in relation to the cognitive objects, data or information they normally influence, at the service of a relatively specific goal or target (Pérez, 2006). Carrasco (1997) refers to knowing *the why and the wherefore*, while Buron (1993) defines it as the knowledge we have of our mental operations. Delmastro and Salazar (2008) consider that, in education, metacognition can be defined as "a conscious activity of high-level thinking, which allows to investigate and reflect on the way people learn and control their own learning strategies and processes, in order to modify and/or improve them" (p. 45) .

Schraw and Moshman (1995), Brown (1996) and Baker (1991) proposed two components of metacognition: metacognitive knowledge and metacognitive regulation. Metacognitive knowledge or knowledge of cognition contains three kinds of knowledge: declarative knowledge, procedural knowledge, and conditional knowledge (Schraw & Moshman, 1995). The metacognitive declarative knowledge refers to knowing "about" things. The metacognitive procedural knowledge refers to "how" to do things. The metacognitive conditional knowledge refers to the "why" and "when" aspects of cognition. Regulation of cognition refers to the set of actions or activities that help control our own thought or learning. When referring to meta-cognitive regulation, skills like planning, information management, comprehension monitoring, error control and further self-evaluation are distinguished. Planning involves setting goals, selecting appropriate strategies and localizing resources needed for the task to be performed. The information management is the sequence of strategies used to process information efficiently. The comprehension monitoring refers to evaluation of one's own learning or the strategy used. Error control is the set of strategies used to correct understanding or performance problems. Self-evaluation refers to the evaluation of products and regulatory processes of one's own learning.

Metacognitive strategies plan and monitor cognitive actions and have a double function of knowledge and control, (Beltran & Bueno, 1995). Metacognitive strategies are used to regulate and control the activities performed during learning. Regulation and control are performed through various actions like setting goals and learning objectives to be achieved, which require a conscious reflection to address problems and make decisions about resolutions. Then, by monitoring and evaluating the learning process, you will be able to redirect or regulate actions and, if necessary, modify the learning activities or plan actions. When the learning process is over, an assessment of one´s behavior is carried out, to determine whether any decision has been inappropriate or ineffective, in order to be corrected in future situations, and preserve those that have been useful and effective (Monereo, 2001, Sevillano, 1995). Regarding mathematics, it is important to use strategies to determine if the problem´s solution obtained was a correct solution, and if the steps in the solution process are also correct (Sevillano, 1995). Osses (2007) defines metacognitive strategies as actions directed to the acquisition of information about the person´s thinking processes (what), namely to get to know how to use them (how) and to readjust and/or change according to the task performed.

About measuring metacognitive strategies

Measuring metacognitive strategies can be somewhat difficult as they are part of the mental processes of the individual. In research literature, there have been several attempts to develop metacognitive inventories worldwide. Frequently applied to the research literature, Metacognitive Awareness Inventory was developed by Schraw and Dennison (1994) to measure adults` metacognitive awareness. This 52-item inventory includes metacognitive knowledge and regulation. O'Neil and Abedi (1996), University of Southern California, developed an inventory to assess metacognition in college regarding reading skills which has proved useful to assess and guide students.

In Chile, Peronard, Crespo and Velasquez´s team (2000) has validated an instrument to measure students` reading meta-comprehension in Basic General and Middle Education of the Fifth Region. Mokhtari and Reichard (2002), from the University of Texas, have designed and validated an inventory of metacognitive awareness of reading strategies (MARSI) for adolescent and adult readers. They identified three factors: reading strategies, global problem solving strategies and reading strategies support. Alarcón, Ureña and Cardenas (2008), from the University of Granada have managed to design and validate an instrument to measure declarative knowledge of basketball tactics in believing that it is necessary to properly develop skills in decision-making, and knowledge the player will use in game situations.

Pereira and Ramirez (2008) have evaluated the use of metacognitive reading strategies in college students in Venezuela, translating the Survey of Reading Strategies (SORS) (Mokhtari, et al., 2002) to Spanish. It was designed to determine the use of metacognitive strategies when reading academic textbooks in English. The results indicate that the strategies most widely used by the subjects are problem solving, and support and global strategies. In the Complutense University of Madrid (Spain), Jimenez, Puente, Alvarado and Arrebillaga (2008) have measured reading awareness` metacognitive strategies, using an instrument called ESCOLA. They have identified students with low reading awareness, and they sustain that intervention programs with specific metacognitive strategies for reading can be designed.

Dañobeitia and Ramirez (2011), from the University of Talca, Chile, have designed and validated an inventory of metalinguistic skills based on Gombert`s postulates. The purpose was to measure lexical, syntactic and semantic awareness. The instrument takes into account three factors that correspond to the three types of abilities evaluated. Guan Qun and Meng from China and Roehring and Mason from U.S. (2011) have studied the psychometric properties of the instrument to measure reading metacognitive awareness called MARSI (Mokhtari, et.al., 2002) and applied it to populations of the corresponding countries. They investigated the reading skills through self–report and standardized measures. Jaramillo and Osses (2012) validated an instrument on metacognition in terms of knowledge, metacognitive experiences and cognitive self-regulation in students of second cycle in Basic General Education in municipal schools on reading comprehension.

Vallejos, Jaimes, Aguilar and Merino, from Universidad César Vallejos, Universidad Mayor de San Marcos and Universidad Nacional de La Selva in Perú (2012), have also been dedicated to validate a metacognitive strategies inventory in college students. Meanwhile Ramírez-Dorantes, Bueno-Álvarez and Echezarreta (2013) from Universidad Autónoma de Yucatán, have translated and validated the MSLQ (Motivated Strategies for Learning Questionnaire), a self-report instrument that measures the motivation, learning cognitive and metacognitive strategies of students. They have called it the Motivation Questionnaire and Learning Strategies instrument (MQSL).

All these instruments have been thought to measure general metacognitive strategies, some of them related to reading comprehension and one related to a sporting activity. Psychologists and educators consider that to get know meta-cognitive strategies is a crucial aspect in the development of reflective thought, autonomous learning and knowledge construction (Jimenez, et al., 2009). Referring to the development of mathematical thinking, Schoenfeld (1994) argues that the way in which the individual uses the information when he/she has to solve a problem, includes decisions with respect to which plan to use, goals and sub-goals selection, monitoring solution process and proceedings evaluation. Unfortunately, no instrument related to metacognitive strategies have been designed and validated for the mathematical area, of which we know in the literature.

Objective

This study aims to translate the inventory designed by Schraw and Dennison (1994) into Spanish. This inventory, called Metacognitive Awareness Inventory (MAI) is about metacognitive science. The aim is to adapt it to Calculus I students in the engineering program at the Universidad Tecnológica Nacional Facultad Regional Haedo (Argentina), regarding general metacognitive strategies and metacognitive strategies in indefinite integrals.

Method

Participants

The sample was made up of two groups consisting of 116 and 162 of students of Calculus I 'Facultad Regional Haedo' in the 'Universidad Tecnológica Nacional' in the province of Buenos Aires (Argentina). The group consists of 278 students, obtained from tracking two groups of students, with an average age of 20, who answered the survey, on a voluntary basis, of which 140 correspond to the morning shift and 138 to the evening shift.

Instruments and procedures

Schraw and Dennison's Inventory

The inventory designed by Schraw and Dennison in 1994, called *Metacognitive Awareness Inventory,* uses the technique of self-report and seeks to foresee awareness of respondents about knowledge and regulation of metacognition. The authors applied the instrument to two hundred students, and statistically verified the presence of these two factors. The validity was achieved by comparing the results to previous applications, monitoring activities and performance tests. They have achieved a reliability of $\alpha = 0.90$, establishing that the two factors are correlated by $r = 0.54$, $p < 0.05$. As the results were partially conclusive, the authors acknowledged the need for further studies (Peronard, Allende & Velasquez, 2000). While the majority of the metacognitive strategies measuring instruments are designed for being used with children and adolescents, this instrument was designed for being applied to adults. It has also been used in other studies of adult metacognition (Hammann & Stevens, 2001; Sperling, 2004).

Modifications carried out for this study

The Original Inventory has 52 items which have been translated into Spanish. In order to adapt this inventory to students of Calculus I in the engineering programs, regarding general metacognitive strategies and metacognitive strategies in indefinite integrals, such items were reorganized. Then an analysis of the psychometric properties was carried out, and as a result of it, some items were discarded, taking 33 items for exploring the general metacognitive strategies and the remaining 16 for the evaluation of metacognitive strategies in indefinite integrals. So we designed two instruments: the General Metacognitive Strategies Inventory (GMSI) and the Metacognitive Integrals Strategies Inventory (MISI).

Results

Psychometric properties of the instruments

According to Salkind (1999) the construct validity refers to the degree to which results can legitimately be made from the operational research in the study of the theoretical constructs on which they were based. In order to verify the validity, factor analysis were carried out. The indexes of Bartlett's test of sphericity, which tests whether the correlation matrix is an identity matrix, would indicate that the factor model is inappropriate, were significant in both cases, allowing us to reject the null hypothesis from which the sample matrix comes from a population where the variables are uncorrelated. The Kaiser-Meyer-Olkin measure of sampling adequacy, which is an index for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients, were significant for the two inventories, they support the hypothesis that the variables can be explained by a lower number of factors. After an inventory is constructed, it is mandatory to carry out a reliability analysis. A reliable measure is one that yields consistent results. We used Cronbach's alpha coefficient, which measures the internal consistency of the inventory items to determine if they, in the context of the investigation were reliable or not (Martin & Cabero, 2008). The following summarizes the methodology followed for the two instruments

General Metacognitive Strategies Inventory (GMSI)

The data gathered through the inventory were processed through a statistical software program, SPSS, and Oblimin rotation was performed, obtaining the best solution which yields eight factors with 42% percentage of variance explained by them (Morosini, 2012).

Table 1. **GMSI First factorial analysis**

Variables	Fac1	Fac2	Fac3	Fac4	Fac5	Fac6	Fac7	Fac8
Intelectual knowledge on strength and weaknesses	0.414							
Motivation Knowledge	0.320							
Anxiety Level Knowledge	0.374							
Knowledge of Organizational Skills of Information	0.458							
Learning Control Knowledge	0.339							
Different ways of studying knowledge		0.559						
Use of the different ways of studying		0.498						
Resources localization knowledge		0.378						
Material organization study		0.388						
Classmates studying in groups		0.343						
Confidence in own capacities			0.503					
Adapting the way of studying to the situation			0.518					
Self-motivation			0.317					
Level of anxiety control			0.588					
Using strengths to compensate weaknesses			0.630					
Previous Analysis				0.543				
Generalized reading				0.230				
Objectives setting				0.496				
Time organization				0.458				
Speed of studying setting					0.640			
Atenttion to important concepts					0.398			
Translation into own language					0.473			
Creation of own examples					0.136			
Relation with previous knowledge					0.356			
Use of diagrams					0.462			
Partial Achievement Control of Goals Proposed						0.347		
Pauses realization to control understanding						0.309		
Revision of class explanations							0.655	
Books reviewing							0.589	
Search of external help							0.369	
Self-evaluation of objectives achieved								0.641
Self-evaluation learning								0.652
Self-evaluationPerformance								0.594

The second-order factor analysis was conducted with the eight primary factors. Oblimin rotation was performed, converging in three iterations, obtaining the best solution with 52% of variance explained by the factors.

Table 2. GMSI Second factorial analysis

Variables	Fac1	Fac2
Declarative Metacognitive Knowledge	0.66	
Procedural Metacognitive Knowledge	0.71	
Conditional Metacognitive Knowledge	0.40	
Planning		0.56
Information Management		0.75
De-bugging		0.62
Comprehension monitoring		0.77
Post Evaluation		0.89

Metacognitive Integrals Strategies Inventory (MISI)

The factor analysis was conducted with the remaining 16 items of the scale and we obtained a solution with 72% of variance explained by the eight factors.

Table 3. MISI First factorial analysis

Variables	Fac1	Fac2	Fac3	Fac4	Fac5	Fac6	Fac7	Fac8
Knowledge of every algebraic procedure							0.76	
Knowledge of every integration method							0.78	
Knowledge of the application of every algebraic procedure								0.46
Knowledge of the application of every integration method								0.86
Knowledge of when to apply every algebraic procedure				0.80				
Knowledge of when to apply every integration method				0.83				
Previous Analysis on several ways of Integral solution		0.86						
Previous analysis on different algebraic procedure		0.87						
Division Study by Method	0.85							
Summary of integration methods learnt	0.83							
Considering several integral resolution alternatives						0.53		
Usefulness of analysis on the selected Integration Method						0.47		
Changing Algebraic Procedure when facing non-satisfactory results					0.83			
Changing Integration Method when facing non-satisfactory results					0-85			
Self-evaluating selected Algebraic Procedure			0-74					
Self-evaluating selected Integration Method			0.88					

With a second order factorial analysis, two factors are obtained with 40% of variance explained by the factors using Varimax rotation which converges in three iterations.

Table 4. MISI Second factorial analysis

Variables	Fac1	Fac2
Declarative Metacognitive Knowledge of Integrals	0.69	
Procedural Metacognitive Knowledge of Integrals	0.70	
Conditional Metacognitive Knowledge of Integrals	0.71	
Planning of Integrals		0.36
Information Management of Integrals		0.72
De-bugging of Integrals		0.60
Comprehension Monitoring of Integrals		0.47
Post Evaluation of Integrals		0.30

Validity

The values of KMO and Bartlett test, used to identify the validity of inventories, were significant, which proved to be suitable for the factor analysis. The number of the factors identified was 8 for both instruments. The values of the first inventory were *KMO* = 0.72; x^2 = 2273.51; $p < 0.001$, and *KMO* = 0.66; x^2 = 719.6; $p < 0.001$ for the second.

For *GMSI*, Factor I includes items 26, 15, 20, 18, 13, Factor II, 23, 32, 19, 24, 22, Factor III, 25, 14, 31, 29, 12, Factor IV, 9, 17, 11, 5, Factor V, 8, 30, 28, 27, 3, 2, Factor VI, 21, 1, Factor VII, 7, 16, 10 and Factor VIII, 6, 33, 4. (See the appendix for the inventory). For *MISI*, Factor I includes items 8, 9, Factor II, 7, 6, Factor III, 4, 3, Factor IV, 2, 16, Factor V, 15, 5, Factor VI, 12, 11, Factor VII, 10, 1 and Factor VIII, 14, 13. (See the appendix for the inventory).

After the second factorial analysis we obtained *KMO*=0.81; x^2=475.51; p<0.001 corresponding to the *GMSI,* and *KMO*=0.68; x^2=170.6; *gl* 28, p<0.001, to the *MISI*. In *GMSI* Factor I includes the previous factors I, II, III and, Factor II, the previous IV, V, VI, VII, VIII. Para el *MISI* the Factor I includes the previous factors VII, VIII, IV and Factor II, the previous II, I, VI, V, III.

The solution obtained for the first inventory is congruent with the theory, where the first factor groups the *Metacognitive Knowledge* variable, and the second factor corresponds to the *Metacognitive Regulation* one. The solution for the second inventory also results in two factors, thus leaving a grouping similar to theory but applied to indefinite integrals, which is why the factors in this case are called *Metacognitive Knowledge of Integrals* and *Metacognitive Regulation of Integrals*, respectively.

Reliability

The values of Cronbach's alpha coefficient, used to determine whether the inventories in the context of several research were reliable or not, turned on to be significant. The *GMSI* reliability analysis yielded $\alpha = 0.69$ for the 15 items corresponding to metacognitive knowledge and $\alpha = 0.76$ for the 18 items related to self-regulation. The corresponding analysis for MISI proved to be $\alpha = 0.60$ for items of metacognitive knowledge and comprehensions α=0.58 for the items corresponding to self-regulation on integrals.

The values obtained were higher than 0.50, which indicates that the inventory was observed to display high alpha scores. The two modified inventories consisted of two parts with four Likert scale options. For the first: "I never do it," I rarely do it ", "I do it often" " I do it always". And for the second: "Never", "Sometimes", "Almost all the time", "Always".

Discussion and conclusion

The motivation of this study came from the need to measure general metacognitive strategies and metacognitive strategies in indefinite integrals that students of Calculus I of the ‘Universidad Tecnológica Nacional, Regional Haedo’ were using. Since the incorporation of the term metacognition by Flavell (1970s) and its measuring instrument by Schraw & Dennison (1994) several new instruments, to collect data on the subject, have been designed. Many of them related to reading comprehension and metacognitive strategies, O'Neil & Abedi (1996), Peronard et.al. (2000), Mokhtari et.al.(2002), Pereira et.al. (2008), Jiménez et.al (2009), Dañobeitía et.al. (2011), Qun Guan et.al.(2011), Jaramillo et.al, (2012), others on general metacognitive strategies, Vallejos et.al. (2012), Ramírez et.al. (2013) and one on metacognitive strategies in the area of sports, Alarcón et.al. (2008). However, none of them specifically related to mathematics and particularly about indefinite integrals.

The development and design of General Metacognitive Strategies Inventory (GMSI) and Metacognitive Strategies Integrals Inventory (MISI) were guided by the importance of metacognitive strategies in the area of mathematics and problem solving (Schoenfeld, 1994) and the two major components of metacognition: metacognitive knowledge and metacognitive regulation (Schraw & Moshman, 1995, Brown, 1996, Baker, 1991), with its corresponding dimensions. The results of the validation analysis support the existence of both dimensions of metacognitive strategies for both general and specific for indefinite integrals.

After having translated into Spanish the original inventory of 52 items in order to adapt it to measure a general metacognitive strategies and metacognitive strategies indefinite integrals, we proceeded to an analysis of the psychometric properties and to the removal of certain items. We took 33 of them for exploring the general metacognitive strategies and the remaining 16 for the evaluation of metacognitive strategies indefinite integrals. In both cases, the data was processed using SPSS statistical software, for a first factor analysis and to check the existence of eight factors, consistent with the dimensions of the components of the metacognition, which could be verified by a second factorial analysis. We consider relevant to highlight a dimension of metacognitive knowledge of comprehensive cognition and another on the regulation of cognition of integrals.

For the first case, which corresponded to the inventory of the metacognitive strategies in general, we have been able to establish a total of 33 items, 15 corresponding to the knowledge of the metacognitive cognition and 18 to the regulation of metacognitive cognition. For the second case, we established a total of 16 items, 6 of which are knowledge of cognition comprehensive metacognitive and 10 correspond to the regulation of metacognitive cognition. These two inventories were administered to 278 students to test their validity and reliability. The values obtained in both studies support the validity and reliability of the instruments obtained, the GMSI and MISI from MAI inventory designed by Schraw and Dennison in 1994.

To conclude, this study revealed that modified versions of the MAI, called MISI and GMSI possess good reliability and validity estimates. Thus, it can be used both as a diagnostic and research tool to measure general metacognitive strategies and specific integrals metacognitive strategies of students of Calculus I. Both inventories added to our knowledge of the nature of the metacognitive strategies confirmed the two dimensions of metacognition: knowledge of cognition and cognition regulation. Despite these results, further research is needed in the future to validate the structure of the instruments with larger and varied samples.

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Appendices

1. General Metacognitive Strategies Inventory (GMSI)

Part 1

1 = I never do it, 2 = I occasionally do it, 3 = I often do it, 4 = I do it

1. I find myself pausing regularly to check my comprehension				
2. I make tables or diagrams to help myself understand while learning				
3. I ask myself if what I am reading is related to what I already know				
4. I ask myself if I made enough effort after studying				
5. I organize my times to best accomplish my goals				
6. I ask myself if I accomplished my goals once I'm finished				
7. I review the classes when I'm confused				
8. I slow down when I encounter difficulties				
9. I think of what I need to learn before beginning to study				
10. I ask for other people's help when I don't understand				
11. I set specific goals before I begin a task				
12. I use my intellectual strengths to compensate for my weaknesses				
13. I ask myself if I know how to control my learning				
14. I adapt my way of studying according to the situation				
15. I ask myself if I am motivated				
16. I reread from the book when I'm confused				
17. I do a general reading before I begin studying				
18. I ask myself if I'm good at organizing the information				
19. I ask myself if I know how to find the information in the library or on the Internet				
20. I ask myself if I'm anxious				
21. I stop and ask myself if I'm achieving my goals				

Part 2

1 = Never, 2 = Sometimes, 3 = Almost all the time, 4 = Always

22. I study with a group of friends				
23. I ask myself if I know different ways of studying				
24. I organize the study material				
25. I trust my skills				
26. I understand my intelectual strengths and weaknesses.				
27. I create my own examples to understand what I'm studying				
28. I try to use my own words to express what I study				
29. I can control my level of anxiety				
30. I consciously pay attention to the explanation of important concepts				
31. I can motivate myself to learn when needed				
32. I use different ways of studying				
33. I ask myself if I've learnt enough after studying				

2. Relationship between inventory items to indicators and the dimensions of the variables.

Dimensions	Indicators	Ítem in GMSI
DECLARATIVE METACOGNITIVE KNOWLEDGE	Intelectual knowledge on strength and weaknesses	26 I understand my intelectual strengths and weaknesses
	Motivation Knowledge	15 I ask myself if I am motivated.
	Anxiety Level Knowledge	20 I ask myself if I'm anxious
	Knowledge of Organizational Skills of Information	18 I ask myself if I'm good at organizing the information
	Learning Control Knowledge	13 I ask myself if I know how to control my learning
PROCEDURAL METACOGNITIVE KNOWLEDGE	Different ways of studying knowledge	23 I ask myself if I know different ways of studying
	Use of the different ways of studying	32 I use different ways of studying
	Resources for knowledge localization	19 I ask myself if I know how to find the information in the library or on the Internet
	Study material organization	24 I organize the study material
	Classmates studying in group	22 I study with a group of friends
CONDITIONAL METACOGNITIVE KNOWLEDGE	Confidence in own capacities	25 I trust my skills
	Adapting the way of studying to the situation	14 I adapt my way of studying according to the situation
	Self-motivation	31 I can motivate myself to learn when needed
	Level of anxiety control	29 I can control my level of anxiety
	Using strengths to compensate weaknesses	12 I use my intellectual strengths to compensate for my weaknesses
PLANNING	Previous Analysis	9 I think of what I need to learn before beginning to study
	Generalized reading	17 I do a general reading before I begin studying
	Objectives setting	11 I set specific goals before I begin a task
	Time organization	5 I organize my times to best accomplish my goals
INFORMATION MANAGEMENT	Speed of studying setting	8 I slow down when I encounter difficulties
	Atenttion to important concepts	30 I consciously pay attention to the explanation of important concepts
	Translation into own language	28 I try to use my own words to express what I study
	Creation of own examples	27 I create my own examples to understand what I'm studying
	Relation with previous knowledge	3 I ask myself if what I am reading is related to what I already know
	Use of diagrams	2 I make tables or diagrams to help me understand while learning
DE-BUGGING	Partial Achievement Control of Goals Proposed	21 I stop and ask myself if I'm achieving my goals
	Pauses realization to control understanding	1 I find myself pausing regularly to check my comprehension
COMPREHENSION MONITORING	Revision of class explanations	7 I review the classes when I'm confused
	Books review	16 I reread from the book when I'm confused
	Search external help	10 I ask for other people's help when I don't understand
POST EVALUATION	Self-evaluation of objectives achieved	6 I ask myself if I've accomplished my goals once I'm finished
	Learning self-evaluation	33 I ask myself if I've learnt enough after studying
	Self-evaluation Performance	4 I ask myself if I've made enough effort after studying

3. Metacognitive Integrals Strategies Inventory (MISI).

Part 1

1 = I never do it, 2 = I occasionally do it, 3 = I often do it, 4 = I do it

1. I change the algebraic procedure if I can't solve the integral				
2. I think of different ways of solving an integral before solving it				
3. I ask myself if I know when to apply each algebraic procedure				
4. I ask myself if I know when to apply each integration method				
5. I summarize each of the integration methods learnt				
6. I ask myself how to apply each algebraic procedure				
7. I ask myself how to apply each integration method				
8. I ask myself if I know each integration method				
9. I ask myself if I know each algebraic procedure				

Part 2

1 = Never,, 2 = Sometimes, 3 = Almost always, 4 = Always

10. I change the integration method if I can't solve the integral				
11. I analyze if the used integration method is useful				
12. I consider various alternatives when solving an integral.				
13. I can determine if the chosen algebraic procedure was the appropriate				
14. I can determine if the chosen integration method was the appropriate				
15. I practice solving integrals by integration methods				
16. I think of different algebraic procedures before solving an integral				

4. Relationship between inventory items to indicators and the dimensions of the variables.

Dimensiones	Indicadores	Ítem en IEMI
DECLARATIVE META-COGNITIVE KNOWLEDGE OF IN-TEGRALS	Knowledge of every algebraic procedure	8 I ask myself if I know each integration meth-od
	Knowledge of every integration method	9 I ask myself if I know each algebraic proce-dure
PROCEDURAL META-COGNITIVE KNOWLEDGE OF IN-TEGRALS	Knowledge of the application of every algebraic procedure	7 I ask myself how to apply each integration method
	Knowledge of the application of every integration method	6 I ask myself how to apply each algebraic procedure
CONDITIONAL META-COGNITIVE KNOWLEDGE OF IN-TEGRALS	Knowledge on when to apply every algebraic proce-dure	4 I ask myself if I know when to apply each integration method
	Knowledge on when to apply every integration method	3 I ask myself if I know when to apply each algebraic procedure
PLANNING OF INTE-GRALS	Previous Analysis on several ways of Integral solu-tion	2 I think of different ways of solving an inte-gral before solving it
	Previous analysis on different algebraic procedure	16 I think of different algebraic procedures before solving an integral
INFORMATION MAN-AGEMENT OF INTE-GRALS	Division Study by Method	15 I practice solving integrals by integration methods
	Summary of integration methods learnt	5 I summarize each of the integration methods learnt
DE-BUGGING OF INTE-GRALS	Considering several integral resolution alternatives	12 I consider various alternatives when solving an integral.
	Usefulness of analysis on the selected Integration Method	11 I analyze if the used integration method is-useful
COMPREHENSION MONITORING OF IN-TEGRALS	Changing of Algebraic Procedure when facing non-satisfactory results	10 I change the integration method if I can't solve the integral.
	Changing Integration Method when facing non-satisfactory results	1 I change the algebraic procedure if I can't solve the integral
POST EVALUATION OF INTEGRALS	Self-evaluating selected Algebraic Procedure	14 I can determine if the chosen integration method was the appropriate
	Self-evaluating selected Integration Method	13 I can determine if the chosen algebraic procedure was the appropriate