


The Role of Metacognitive Strategies in Blended Learning: Study Habits and Reading Comprehension

El rol de las estrategias metacognitivas en la enseñanza semipresencial: hábitos de estudio y comprensión lectora



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ABSTRACT

Metacognitive strategies are essential, as they allow the learning process to be self-managed. This is especially important in higher education and blended learning because it requires greater independence. This study aims to determine the importance of metacognitive strategies as regards both study habits and reading comprehension in blended learning. For this purpose, metacognitive strategies are used through a digital tool in a blended learning context. SRSI-SR test was used to assess study habits and ARATEX-R was used to assess text reading before and after a master's degree course. The study sample included 112 students from various disciplines; half of them used the tool as part of the research group, and the other half did not use it as part of the control group. The results show that the use of the metacognitive strategies has particularly facilitated the organization of the task regarding study habits. In reading comprehension, metacognitive strategies especially promoted motivation management, comprehension assessment, and planning. It is concluded that the use of metacognitive strategies has proven to be significantly effective, so these findings suggest the inclusion of metacognitive strategies in blended learning in order to improve study habits and reading comprehension in students and, thus, improve their learning outcomes. The conclusions obtained allow us to broaden our scientific knowledge about how these strategies influence learning.

Keywords: text comprehension; study method; learning strategy; self-regulated learning; metacognitive strategies; blended learning.

RESUMEN

Las estrategias metacognitivas son fundamentales, ya que permiten gestionar el proceso de aprendizaje propio. Esto es especialmente importante en la educación superior y en la enseñanza semipresencial porque requiere una mayor independencia. Este estudio pretende determinar la importancia de las estrategias metacognitivas tanto en los hábitos de estudio como en la comprensión lectora en la enseñanza semipresencial. Para ello, se utilizan estrategias metacognitivas a través de una herramienta digital en un contexto de aprendizaje semipresencial. Se utilizó el test SRSI-SR para evaluar los hábitos de estudio y el ARATEX-R para evaluar la lectura de textos antes y después de un curso de maestría. La muestra del estudio incluyó a 112 estudiantes de diversas disciplinas; la mitad de ellos utilizó la herramienta como parte del grupo de investigación, y la otra mitad no la utilizó como parte del grupo de control. Los resultados muestran que el uso de las estrategias metacognitivas ha facilitado especialmente la organización de la tarea en cuanto a los hábitos de estudio. En la comprensión lectora, las estrategias metacognitivas favorecieron especialmente la gestión de la motivación, la evaluación de la comprensión y la planificación. Se concluye que el uso de estrategias metacognitivas tiene un peso significativo, por lo que estos hallazgos sugieren la inclusión de estrategias metacognitivas en la enseñanza semipresencial para mejorar los hábitos de estudio y la comprensión lectora en los estudiantes y, así, mejoran sus resultados de aprendizaje. Las conclusiones obtenidas permiten profundizar el conocimiento científico sobre cómo influyen estas estrategias en el aprendizaje.

Palabras clave: comprensión del texto; método de estudio; estrategia de aprendizaje; aprendizaje autorregulado; estrategias metacognitivas; enseñanza semipresencial.

INTRODUCTION

Self-regulated learning (SRL) enables students to manage their own learning process, this means that, according to Zimmerman (2002), students who can apply SRL strategies can learn autonomously. For this reason, SRL is essential for learning to learn competence in higher education, because it increases independence in learning (Lluch & Portillo, 2018).

The strategies that integrate SRL can be cognitive, metacognitive, and socio-emotional, and different theoretical models underline the importance of each of the strategies (Zimmerman, 2002; Winne, 1996; Pintrich, 2004, respectively). Of all the types of strategies, it is particularly useful to work with metacognitive strategies to improve learning outcomes, as these strategies promote the use of cognitive ones (Akamatsu et al., 2019).

Muijs and Bokhove (2020) reviewed the most important current studies on metacognitive strategies and found that all of them are primarily related to the planning (including goal setting and time management), monitoring, and self-assessment of learning.

Regarding planning strategies, more specifically time management, Fokkens-Bruinsma et al. (2020) have found that they have a strong impact on performance. Meanwhile, the study by Colthorpe et al. (2018) finds that students who adopt new planning and time management strategies are found to improve their future performance.

In the case of monitoring or supervision of learning, it allows to improve the understanding of the process that one carries out oneself to learn, which also, according to Schumacher and Ifenthaler (2018) leads to improve planning. As strategies to perform learning monitoring, the effectiveness of using self-reporting (Pardo et al., 2016) and formative assessment (Hawe & Dixon, 2017) has been proven. On this point, studies on formative assessment show the usefulness of providing feedback (Adams et al., 2019), the use of assessment criteria (Fraile et al., 2020), and the use of forms (Bahri et al., 2021).

Combining various types of assessment is key. Chen and Bonner (2020) proposed a four-step model for improving monitoring strategies related to the SRL through assessment: (1) pre-assessment and forethought, (2) informal performances and interactive assessment, (3) formal assessment and performance, and (4) summary of evidence and formal reflection.

To develop monitoring strategies, it is recommended to include examples during teaching, as these examples can improve different aspects. One of them is perceived self-efficacy, according to Dixon et al. (2020), which is fundamental to practice good study habits. Another aspect that is improved is evaluative judgment, according to the study by Tai et al. (2018), crucial for reading comprehension.

Finally, with respect to metacognitive strategies related to self-assessment, the ability to judge work has shown a strong influence on SRL (Panadero et al., 2018;

Yan, 2020). In a study by Nieminen and Touhilampi (2020) they find that there is a strong relationship between self-assessment in higher education and student agency, which represents students' belief in their ability to act on their learning. On the other hand, Panadero et al. (2017) review relevant current research and confirm the relationship obtained between self-evaluation and self-efficacy.

We should develop self-assessment strategies using specific criteria, as pointed out by Carroll (2020), and focus on error detection, according to the study conducted by Zamora et al. (2018). In fact, in a study by Vasu et al. (2020), self-assessment has been shown to be more effective than expert teacher feedback. So, together with the evidence that self-assessment improves self-efficacy, it is essential to work on these strategies to enhance learning.

In blended learning (b-learning) contexts, SRL is particularly important, as it increases initiative and self-direction in the learning process (Onah et al., 2020). B-learning combines conventional and online learning in a mixed learning model (Bahri et al., 2021). In these cases, the use of metacognitive strategies is done through digital tools.

The lack of SRL strategies is precisely the reason many students are unwilling to participate in blended courses, because the online modality requires initiative and self-management of learning (Schwam et al., 2020). In non-face-to-face settings, SRL is associated with academic achievements (Broadbent, 2017; Kickert et al., 2019) as well as non-academic outcomes (Anthonysamy et al., 2020).

In b-learning it is convenient for the teacher to highlight the importance of SRL from the beginning of the course, according to Vanslambrouck et al. (2019). In this way, we can increase students' motivation, causing favorable attitudes towards the course, according to the results of Zhu et al. (2020). Thus, increasing initial motivation improves academic outcomes, according to the study by Broadbent and Fuller-Tyszkiewicz (2018).

According to Sáiz et al. (2017), the use of metacognitive strategies in b-learning is a strong predictor of the patterns used by students, such as the order in which they perform tasks or the strategies employed, as well as of the learning obtained.

In b-learning contexts, it is common to use a Learning Management System (LMS), like Moodle platform. An example of a design approach in LMS is the Open Learner Model (OLM; Bull & Kay, 2010), which involves presenting questions regarding four aspects related to the metacognitive strategies of SRL: what I know, how well I know a particular topic, what I want to know, and how I can learn it (Kay et al., 1997).

This model positively impacts students' thinking about their learning process in blended models in higher education (Hooshyar et al., 2019). The tools facilitated by this model help develop SRL, including goal setting and strategy implementation, as well as strategy and performance monitoring (Chou & Zou, 2020); thus, the results of using this approach will be of great interest for tool design.

Academic online environments, designed in LMS to promote SRL, often fit very well with other complementary approaches, such as the flipped-classroom approach (Blau & Shamir-Inbal, 2017; Ng, 2018; Wang, 2019). It is especially useful to add hands-on activities to achieve effective learning and increase satisfaction (Sáiz et al., 2019), such as problem-solving activities (Alzaid & Hsiao, 2019). Positive relationships have also been obtained with the use of open educational resources (Wong et al., 2019).

Given the importance of metacognitive strategies for managing learning in higher education, and especially in b-learning, according to the research reviewed, it is essential to know to what extent these strategies influence two fundamental issues for learning: study habits and reading comprehension.

METHODOLOGY

Participants

The study population included students in the process of obtaining a master's degree, which is required for teaching in secondary education in Spain. The 2020/21 course was conducted via a blended learning mode due to the COVID-19 situation. There were 112 students from various disciplines (30 from social sciences, 26 from physics and chemistry, 31 from mathematics, and 25 from computer science and technology).

The courses of the four disciplines have been directed by the same person, who has assigned the students to the two study groups (research group and control group) maintaining the same number of participants in each group (56).

All students in the same discipline had to perform the same tasks; thus, a quasi-experimental study was chosen. Students from two disciplines (social sciences, and physics and chemistry) used an OLM application to facilitate metacognitive strategies related to planning, monitoring, and self-evaluation for SRL (Ortega-Ruipérez & Castellanos, 2021). Students from the other disciplines (mathematics, and computer science and technology) constituted the control group.

Research Design

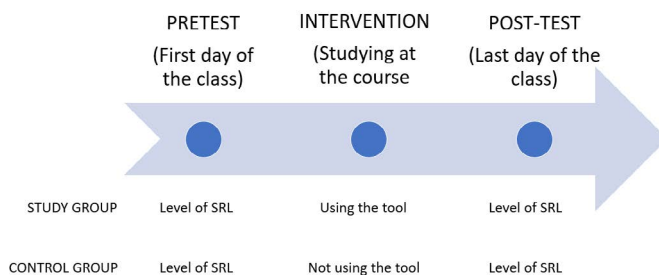
This study adopted a quasi-experimental approach because the study groups were already created (Creswell & Creswell, 2017); that is, participants had already been distributed, according to their chosen discipline.

The study aims to test whether the use of metacognitive strategies plays an important role in study habits and text comprehension. Therefore, the research group uses a tool designed under OLM principles that facilitate the use of metacognitive strategies, while the control group does not use the tool. Thus, the independent

variable (IV) of the study is the use of metacognitive strategies, while study habits and reading comprehension are the dependent variables (DV).

For this purpose, a pre-post study was carried out to evaluate the level of SRL. Additionally, to confirm these differences, half the study sample was used as the study group, and the other half was used as the control group. The latter did not use the SRL tool (Figure 1).

Figure 1
Research Design



The study was carried out over the course of one semester (15 weeks) and included four face-to-face sessions: the first, the fifth, the tenth, and the fifteenth weeks. The remainder of the sessions were online.

Instruments and materials

For the intervention, a tool has been created to facilitate the use of metacognitive strategies with the students. This tool consists of an application that helps students to plan the study of the learning objectives of the subjects, and subsequently to track the progress of the planned objectives each week. In addition, it has a final section to perform a self-assessment of the achievement of the objectives prior to the exams and thus be able to guide the pre-exam study. The tool has been designed following OLM principles, so that students are made to reflect through 4 types of questions: what I know, how well I know a particular topic, what I want to know, and how I can learn it.

For the SRL assessment, two standardized tests were used, that is, tests that have been validated through different psychometric studies.

First, Hernández and Camargo's (2017) adaptation of Cleary's (2006) Self-Regulation Strategies Inventory (SRSI-SR) for university students was used to measure study habits. All the items are described in Figure 2, including how the item is identified (ID) and the dimension to which it corresponds (D).

Figure 2

Adapted SRSI-SR test items based on Hernández and Camargo (2017)

ID	D	Item
SR1	I	When I do not understand a topic, I ask the teacher.
SR2	I	I avoid asking questions in class when I do not understand a topic.
SR3	I	I give up easily when I do not understand something.
SR4	I	When I am studying, I ignore subjects that are difficult to understand.
SR5	I	I am easily distracted when I am studying.
SR6	II	I try to study in a quiet place.
SR7	II	I try to study in a place without distractions (noise, people talking).
SR8	II	I make sure that no one distracts me when I am studying.
SR9	II	I allow people to interrupt me when I am studying.
SR10	II	I finish all my academic activities before starting other activities.
SR11	III	I do additional literature searches to help me understand class topics.
SR12	III	I look for complementary material to the topics covered in class.
SR13	III	I do research when I do not understand something about the assignments I am given.
SR14	IV	I plan the order in which I will carry out my academic activities.
SR15	IV	I coordinate my time according to the academic activities assigned to me.
SR16	IV	I make a timetable to organize my study time.
SR17	IV	I use some method to keep my class material in order.
SR18	IV	Before I start studying, I think about the best way to do it.

This scale measures the degree of agreement, with 18 items rated on a 5-point Likert scale, ranging from 1 (*never*) to 5 (*always*). This inventory has four dimensions (D): inadequate regulation habits (I), organization of the environment (II), search for information (III), and organization of the task (IV).

Additionally, the ARATEX-R test was used to assess self-regulation based on reading texts (Núñez et al., 2015) (see Figure 3).

Figure 3

Adapted ARATEX-R test items based on Núñez et al., (2015)

ID	D	Item
T1	2	Before I start working on a text, if I think the task is going to be boring, I encourage myself by telling myself that I will be able to do something I enjoy when I am done.
T2	5	Before I start studying, I make sure I have all the material I might need (dictionary, pencil, and paper, etc.) at hand.
T3	2	While I am studying, I encourage myself by reminding myself that understanding and learning the text depends on me trying hard enough.
T4	3	When I finish the text, I check whether I have understood everything correctly.
T5	3	If I have not managed to understand and learn the text well, I try to look for the causes to avoid the same thing happening to me next time.
T6	4	After working on a text, I use the experience of how I organized my time and the changes I had to make in my planning to decide in the future how to allocate time for a similar task (whether I was able to estimate how long it would take, whether it took longer than I had thought, etc.).
T7	4	Before I start studying, I stop to decide what activities and strategies I am going to use, planning how I am going to read and study.
T8	2	Before I start studying a text, if it seems useless or uninteresting, I try to motivate myself by reminding myself how important it is to learn it in order to pass the exam and the subject, and thus finish the course and the degree.
T9	4	Before I start studying, I plan how much time I may need to spend on understanding and learning the text, and how much time I am going to allocate to working on the different activities I must do.
T10	3	As I read, I notice if I have any problems understanding the text and I ask myself what I can do to solve them.
T11	2	While studying, when faced with difficulties that discourage me, I try to do something to make myself feel better, such as reminding myself how good I will feel when I manage to learn the text.
T12	4	While I am studying, I consider whether my time planning was correct, or whether I need to modify it (because I will need more time, because I will have more time to spare, etc.).
T13	3	When I finish the text, if I have not understood it well, I stop to think about what I did and what I could improve in order to understand it better next time.
T14	4	After attempting to study a text, I reflect on the effort I had to put into it and use this experience to plan my activities in future similar tasks.
T15	2	Before I start studying, if I find it difficult, I encourage myself by reminding myself that when I try I usually do well in understanding and learning written texts.
T16	5	Before I start studying, if there is too much noise or other aspects that prevent me from concentrating, I do something to provide a quiet environment without distractions.
T17	1	While I am trying to understand, if I cannot extract the idea from an important sentence, I do different activities to clarify its meaning.
T18	1	As I read, I try to relate the different ideas I get from the text.
T19	1	In order to understand the text I am reading, I try to discover the main ideas of the text.
T20	1	As I read, I try to relate the most important ideas to find the general organization of the text.
T21	1	To understand a text well, I try to link the new information it gives me with what I already know about the subject.
T22	3	When I am faced with a text, I ask myself whether I have the necessary background knowledge to be able to learn something from it.
T23	4	When I finish trying to study a text, I notice the things I have done that have worked for me and consider possible changes in the way I will do the task next time.

It measures the degree of agreement using 23 items on a scale ranging from 1 (*never*) to 5 (*always*), and it has five dimensions (D): cognition management (1), motivation management (2), comprehension assessment (3), planning (4), and context management (5).

Procedure

On the first day of the class, students were given a pre-test questionnaire to determine their situation regarding the use of SRL strategies. We then explained what self-regulated learning consists of the conditions for this type of learning management, and the importance of taking responsibility for the learning process in b-learning.

In the study group, on the first day, students were taught how to use the tool to employ metacognitive strategies. During the course, these students used the application on a weekly basis, outside school hours. The first week, they planned their study according to the learning objectives. During the following weeks, they supervised their planning and modified the objectives, as necessary. The last week, before the final exam, they self-assessed their progress and increased the study of their weakest objectives.

In the case of the control group, the questionnaire was administered on the first day of class. However, with control group, classes were conducted as usual: the importance of self-regulation of learning was not explained in the first class, nor did the students have to use the tool.

Both groups developed the course sessions in a similar manner: using flipped learning to understand the content and cooperative projects to apply the knowledge. These projects were accompanied by an evaluation rubric and had to be presented to their peers.

On the last day of class, a questionnaire was provided to all the groups. This questionnaire included the same questions as the pretest questionnaire.

All participants were informed of the use of anonymized data for the present study during the introduction of the questionnaire, and only those who agreed to participate in the study completed the questionnaire.

Data analysis

It is important to note that the data obtained for the dependent variables are ordinal, both for the text reading questionnaire (ARATEX-R) and for the study habits questionnaire (SRSI-SR). Therefore, the analyses carried out throughout the study were specifically chosen for use with ordinal variables. That is, instead of using mean scores and standard deviations, response frequencies were used for descriptive statistics, and instead of using ANOVA for inferential statistics, the Mann-Whitney U test was used. The analysis strategy followed the steps described below.

An inferential analysis was first performed to test whether significant differences existed between the scores of the two groups, in terms of the two questionnaires. The Mann-Whitney U test was used to test whether the differences were significant, considering the ordinal data.

Once it had been verified that both groups started from the same level in both the tests, reliability tests were conducted, specifically internal consistency tests using Cronbach's alpha, to determine the consistency of the study data, obtaining an alpha of 0.9, which shows a very high consistency.

Subsequently, and following the theoretical justification of the test design, the results of each of the scales studied were grouped together. As mentioned earlier, there are five dimensions for text reading—cognition management, motivation management, comprehension assessment, planning, and context management—whereas for study habits, there are four—inadequate regulation habits, organization of the environment, search for information, and organization of the task.

With the data related to each dimension, the Mann-Whitney U test was reconducted to check for significant differences between the study group, which used the tool, and the control group, which did not. If the differences are significant, it can be confirmed that the improvement in this scale is due to utilization of the tool that facilitates the use of metacognitive strategies for self-regulated learning.

Finally, for the dimensions in which no significant differences were found, the relative frequencies (in percentages) of each Likert score (from 1 to 5 points) were obtained and grouped to compare two groups: high score (scores of 4 and 5 on the Likert scale) and low and medium score (scores of 1, 2 and 3 on the Likert scale). In this way, the trend in each of the items related to each questionnaire can be checked for both the study and the control group in a way that allows for interpretation of the results.

RESULTS

First, to confirm that both groups began at the same level of self-regulation, we analyzed whether there were significant differences between the groups in the pre-test. For this purpose, the Mann-Whitney U test was used to compare the ordinal variables between two independent groups.

Regarding self-regulation in text reading, Table 1 shows that there were no significant differences between the groups for any of the items. Therefore, it can be affirmed that both groups had similar self-regulation levels, and the differences found in the post-test were due to the intervention.

Table 1*Pre-test results for items with Mann-Whitney U test*

Study Habits			Reading Text		
ID	U de Mann-Whitney	Sig.	ID	U de Mann-Whitney	Sig.
SR1	1414.5	.335	T1	1482.5	.604
SR2	1451.5	.477	T2	1498.8	.672
SR3	1527.5	.790	T3	1560.5	.964
SR4	1515.0	.728	T4	1414.5	.324
SR5	1555.0	.935	T5	1477.0	.582
SR6	1467.5	.474	T6	1457.5	.508
SR7	1467.5	.482	T7	1452.5	.483
SR8	1426.5	.376	T8	1515.0	.750
SR9	1435.0	.398	T9	1495.5	.663
SR10	1517.0	.749	T10	1479.0	.576
SR11	1471.0	.541	T11	1534.0	.839
SR12	1551.5	.916	T12	1567.0	.995
SR13	1549.0	.902	T13	1491.0	.636
SR14	1492.0	.628	T14	1402.5	.320
SR15	1494.0	.631	T15	1503.0	.696
SR16	1506.0	.708	T16	1393.0	.261
SR17	1509.0	.722	T17	1523.0	.785
SR18	1436.0	.411	T18	1440.0	.406
			T19	1439.0	.415
			T20	1382.0	.238
			T21	1448.0	.450
			T22	1526.0	.801
			T23	1476.0	.572

In the case of study habits, there were no significant differences between the two groups during the pre-test (Table 1). Therefore, it can be confirmed that any differences observed in the post-test were due to the intervention performed.

To check the effect of the intervention, we first obtained the significant differences between the groups for each of the dimensions studied, both in terms of regulation of text reading and in terms of regulation of study habits (Table 2).

Table 2*Post-test results for dimensions with Mann-Whitney U test*

Dimension of Study Habits	U de Mann-Whitney	Sig.
Inadequate regulation habits	1461.5	.530
Organization of the environment	1290.5	.103
Search for information	1531.0	.827
Organization of the task	1150.5	.014
Dimension of Reading Texts	U de Mann-Whitney	Sig.
Cognition management	1422.0	.392
Motivation management	1069.0	.004
Comprehension assessment	1204.5	.034
Planning	1030.5	.002
Context management	1355.0	.203

When analyzing the results by dimension (Table 2), both instruments were consistent in their findings: planning showed significant differences in both tests (planning and organization of the task), while context showed no significant differences in any test (context management and organization of the environment). Another result that could be equated would be that of the management of cognition and inadequate regulation habits. In both cases, there were no significant differences.

Thus, the tool was useful for the improvement of planning but not as useful for the improvement of the regulation of cognition and context. Furthermore, in the case of text reading, significant differences were observed in the management of motivation and in the evaluation of comprehension.

For the dimensions in which no significant differences were observed, the response percentages for each item were obtained, both in the pre- and post-test, grouping the higher scores (4 and 5 on the Likert scale) and the low and medium scores (1-3 on the Likert scale) to allow for observation of the trend of responses within each group (study and control) to interpret whether the intervention had an impact, even if minimal.

With respect to study habits, the percentages were also grouped for the items for which no significant differences were observed, corresponding to three of the four dimensions.

Table 3 shows the same scores on the pre- and post-test for the control group, while for the study group, the post-test revealed higher scores for all items, excepting SR2, which showed similar values. This item corresponds to voicing doubts in class, something that may be influenced by the mindset that the use of the tool should provide them with strategies to resolve these doubts on their own.

Table 3

Results of grouped percentages for the dimensions (without significative differences) of study habits

Item	PRE-TEST				POST-TEST			
	Study Group		Control Group		Study Group		Control Group	
INADEQUATE REGULATION HABITS								
	1-3	4-5	1-3	4-5	1-3	4-5	1-3	4-5
SR1	44.7%	55.3%	53.5%	46.5%	32.2%	67.8%	53.5%	46.5%
SR2	62.5%	37.5%	58.9%	41.1%	62.5%	37.5%	58.9%	41.1%
SR3	96.4%	3.6%	94.6%	5.4%	89.2%	10.8%	94.6%	5.4%
SR4	94.6%	5.4%	94.6%	5.4%	92.8%	7.2%	94.6%	5.4%
SR5	46.4%	53.6%	46.4%	53.6%	35.7%	64.3%	46.4%	53.6%
ORGANIZATION OF THE ENVIRONMENT								
	Study Group		Control Group		Study Group		Control Group	
Item	1-3	4-5	1-3	4-5	1-3	4-5	1-3	4-5
SR6	8.9%	90.9%	14.3%	85.7%	7.1%	92.9%	12.5%	87.5%
SR7	10.7%	89.3%	16.1%	83.9%	8.9%	91.1%	14.3%	85.7%
SR8	17.9%	82.1%	23.2%	76.8%	19.6%	80.4%	21.4%	78.6%
SR9	75%	25%	67.9%	32.1%	64.2%	35.8%	71.5%	28.5%
SR10	48.3%	51.7%	50%	50%	39.3%	60.7%	51.8%	48.2%
SEARCH FOR INFORMATION								
	Study Group		Control Group		Study Group		Control Group	
Item	1-3	4-5	1-3	4-5	1-3	4-5	1-3	4-5
SR11	35.7%		64.3%		32.1%		67.9%	
SR12	41.1%		58.9%		41.1%		58.9%	
SR13	16%		84%		16%		84%	

Table 3 indicates a slight increase in high post-test scores of the study group, except for SR8, which decreased. This may be because while SR6 and SR7 refer to the preparation of the study environment, SR8 refers to the time of study. If the preparation is greater and distracting places are avoided, there should be fewer distractions during the study period. In the case of the control group, an increase in high scores was observed for the first three items (SR6-SR8); however, there was a decrease in SR9 and SR10 (allowing other people to interrupt them during study and starting other tasks before finishing the current ones). Not using the tool may have caused their commitment to dedication to be weaker in the absence of planning, compared to the group that used the tool.

The search for information (Table 3) yielded interesting results, especially because it was not worked on directly through the tool. If they developed this skill, it was due to the application of metacognitive strategies that enabled them to improve in this regard. For the study group, the high scores on the post-test increased for SR13 (search for information to understand the contents of the evaluable tasks). However, they decreased slightly for SR11 (seek additional information to understand the topics) and more strongly for SR12 (seek complementary material on what has been seen in class).

This seems to indicate that if the students understood the topic (SR12), even if only in an essential way (SR11), they did not delve deeper into it. If they did not understand it, they searched for information, and more so if this topic was part of an evaluation task (SR13). The tool allowed them to monitor and reflect on the learning objectives; therefore, they prioritized spending more time searching for information regarding the objectives that they did not achieve, than for those that they had already mastered.

In the control group, there was a decrease for those who, even if they understood the topic in an essential way, did not seek additional information (SR11), while the score for the rest of the items did not vary in the post-test.

Regarding reading comprehension, percentages for cognition management and context management dimensions in text reading are shown in Table 4.

Table 4
Results of grouped percentages for the dimensions (without significative differences) of reading comprehension

	PRE-TEST				POST-TEST			
	COGNITION MANAGEMENT							
	Study Group		Control Group		Study Group		Control Group	
Item	1-3	4-5	1-3	4-5	1-3	4-5	1-3	4-5
T17	46.5%	53.5%	48.2%	51.8%	44.7%	55.3%	48.3%	51.8%
T18	7.2%	92.8%	12.5%	87.5%	7.1%	92.9%	14.3%	85.7%
T19	14.3%	85.7%	17.9%	82.1%	7.1%	92.9%	19.7%	80.4%
T20	10.7%	89.3%	17.9%	82.1%	8.9%	91.1%	19.7%	80.4%
T21	14.3%	85.7%	19.7%	80.3%	10.7%	89.3%	21.5%	78.5%
	CONTEXT MANAGEMENT							
	Study Group		Control Group		Study Group		Control Group	
Item	1-3	4-5	1-3	4-5	1-3	4-5	1-3	4-5
T2	32.2%	67.8%	32.2%	67.8%	19.6%	80.4%	35.8%	64.2%
T16	12.5%	87.5%	16.1%	83.9%	17.8%	82.2%	14.4%	85.6%

For management of cognition pertaining to text reading, in the study group, the general trend was that the management of cognition increased slightly across all items (except for T18, which essentially remained the same), as the percentage of responses among the higher scores of the scale (4 and 5) increased by between 2% and 7%, while the percentage of responses among the lower scores of the scale (1-3) decreased. In the case of T18, the high scores hardly increased on the post-test. This may be because the score was relatively high on the pre-test in relation to the rest of the items, and also in comparison to the control group.

In the control group, the general trend showed a slight decrease (approximately 2%) across all items (except for T17, which showed no change). This decrease was not significant and was maintained for all items. This result may be because, along with the students in the control group, we also worked on the importance of self-regulation in learning, although no guidelines were provided to improve it. In this sense, by knowing the importance of the subject, the students were more aware of their weaknesses and revealed them on the post-test.

Therefore, although the differences between the groups were not significant, the trend was different between them. Had the intervention lasted longer, it is likely that there would have been significant differences between the groups.

In the case of context management, as part of text reading, Table 3 also shows the same trend for item T2 (the study group increased its high scores on the post-test, while the control group showed a slight decrease). However, item T16 showed the opposite results (for the study group, the high scores decreased on the post-test, whereas they increased for the control group).

The item T16 refers to seeking a peaceful working environment before the start of the study. One possibility is that the students in the study group, who have more internal abilities that facilitate better studying, are not as affected by external aspects; another may be that at the time of planning, they consider which places will be more appropriate for studying and not encounter this inconvenience before commencing studying.

DISCUSSION AND CONCLUSION

The use of metacognitive strategies by the students has had a positive impact regarding students' study habits and reading comprehension, in this particular case in a blended learning context. We began with groups that had no significant differences, and those who have used metacognitive strategies for SRL, have seen improved reading comprehension as well as study habits.

In the regulation of inappropriate habits during the study, a very slight improvement trend was observed when students use metacognitive strategies, except regarding asking questions in class; this, however, may have been influenced by the misconception that using the tool should help students address their queries on their own.

Similarly, there was an increase in the management of the context or environment whether they employ metacognitive strategies, except in the search for quiet environments in case of reading texts, to ensure that they are not distracted while studying. These results should be further examined, because they do not follow the trend of the other items.

The search for information item produced interesting results—this ability seemed to worsen after using the application. However, if each item is analyzed, it becomes evident that this worsened in terms of delving deeper into the topics being worked on; the results, in fact, improved regarding the search for information when a topic was not understood. This result can be considered positive, as the planning improvement can help students prioritize the search for information to achieve the learning objectives they did not master.

In general, the dimensions in which no significant improvement was observed tended to increase when students use metacognitive strategies, except for some specific items. There may be an explanation for these, which should be investigated further. Long-term studies can confirm this trend, and significant improvements may be obtained in these dimensions as well.

Regarding text reading, there was a significant improvement in the study group's motivation management compared to the control group. Attitude toward coping with the learning process in blended learning courses was found to improve if students are supported in using metacognitive strategies (Zhu et al., 2020), and improve motivation to use SRL strategies can improve their academic outcomes (Broadbent & Fuller-Tyszkiewicz, 2018).

The assessment of comprehension during text reading is also a key aspect of SRL, as pointed out by authors of previous studies, such as Tai et al. (2018) with monitoring strategies, and Panadero et al. (2018) and Yan (2020) with self-assessment strategies. A significant improvement was observed in this dimension with the use of the digital tool. This has led to an improvement in the students' reading comprehension.

The combination of various types of assessment while using of the application has been a key aspect, as Chen and Bonner (2020) noted. First, a prior evaluation of their knowledge was performed based on specific criteria, following Carroll's (2020) proposal. Subsequently, according to the proposal of Panadero, et al. (2018), a continuous evaluation in a reflective way was performed and included improvement strategies through forms, according to Bahri et al. (2021) proposal. Finally, following the proposal of Fraile et al. (2020), a self-assessment of the evaluation criteria was completed.

Furthermore, self-regulation through task planning and organization showed improvement in both text reading and study habits when students use metacognitive strategies, which is consistent with the findings of Fokkens-Bruinsma et al. (2020) and Colhorpe et al. (2018). The planning managed by the students with the tool, has

facilitated goal setting and strategy implementation, in line with the findings of Chou and Zou (2020).

As previously mentioned, b-learning requires greater preparation of metacognitive strategies (Schwam et al., 2020), because it requires greater initiative and direction of the process (Onah et al., 2020). Furthermore, according to Sáiz et al. (2017), the use of metacognition is related to better learning patterns, making the component of planning an essential aspect of a metacognitive strategy.

However, some of the dimensions evaluated did not show significant improvements, even with the use of the tool. When analyzing the items individually, we were able to identify which aspects of these dimensions improved owing to the tool.

In case of the management of cognition for reading texts improved slightly across practically all aspects, except in the ability to separate the ideas of a text, a factor that may also influence reading comprehension. Further research needs to be done in this area.

These results confirm that metacognitive strategies aimed at self-regulated learning play an important role in study habits, especially in the organization of the task, and in reading comprehension, especially in the management of motivation, comprehension evaluation and planning. For self-regulated learning, in the case of study habits, the organization of the task is essential to improve and optimize the learning process by oneself. In the case of reading comprehension, it is important that a learner who self-regulates his or her learning process is able to manage his or her motivation to initiate this process properly, as well as requiring good planning to continue with the process, and to carry out an evaluation of his or her comprehension to ensure that the process has been successful.

It is recommended to explain to students the importance of these strategies, and especially in b-learning contexts, according to Vanslambrouck et al. (2019). To work on metacognitive strategies in these contexts we should consider models such as OLM (Bull & Kay, 2010; Kay et al., 1997), to improve thinking and academic outcomes, according to the findings of several authors (Broadbent, 2017; Hooshyar et al., 2019; Kickert et al., 2019).

The inclusion of an OLM tool in the virtual classroom would allow students to visualize their progress-related data in their usual tools; and thus, the tool facilitates the study of the subjects (Pardo et al., 2016; Schumacher & Ifenthaler, 2018).

Future studies should add another study group in which students have to plan, monitor, and self-assess their learning process manually instead of using the tool. In this way it can be confirmed that the improvement in study habits and reading comprehension is due to the use of metacognitive strategies, and not to the motivation that could be caused by the use of a digital tool to manage these strategies, as the influence of motivation can be a limitation of study.

The main limitation of the study was its four-month duration. Therefore, in the future, we hope to be able to apply this tool in long-term studies, for example, during

a full university course. Another possible limitation was the quasi-experimental design of the study, given the characteristics of the groups formed by disciplines. In this line, the inclusion of the OLM could be done randomly among the students.

As standardized instruments were used, the data obtained were ordinal in nature, which meant that inferential analyses had to be carried out, which frequently provide limited information on the differences between groups. For this reason, in order to interpret the results in a more specific way, we have had to use grouped frequency data. In future studies, it is recommended that an additional instrument be used whose data can be analyzed quantitatively and provide the option of better interpretations. Also, if an intervention is carried out over a longer period, it is possible that the inferential analysis (Mann-Whitney U test) may provide more explanatory results.

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Fecha de recepción del artículo: 30/11/2021

Fecha de aceptación del artículo: 17/03/2022

Fecha de aprobación para maquetación: 23/03/2022