INCREASING CRITICAL THINKING THROUGH MOTIVATION AND METACOGNITION INTERVENTION

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Resumo

We report the results obtained in a recent innovative teaching project aimed at fostering Critical Thinking (CT) skills through a metacognitive and motivational intervention. We developed a program aimed at fostering Metacognition and Motivation for the most optimal development of such skills. Students participating in the study were 134. All were evaluated by PENCRISAL test, Modified Achievement Motivation Scale (AMS-M) and MAI pre-post intervention measurement. All students received instruction in CT but only half of the sample also participated in a Meta-Motivational program. The results show that the instruction in CT skills was successful, getting better performance in the group subjected to the Meta-Motivational program. Moreover, there were significant differences in favor of the experimental group in Motivation variable, but not in Metacognition. In conclusion, the Meta-Motivational intervention was successful to a large extent, it would thus be possible to acquire a pedagogical tool to study and work the motivational and metacognitive factors in skills training programs.

Keywords: Critical thinking, motivation, metacognition, instruction, assessment

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Introdução

The objective of this study is to describe an improved instruction program in Motivation, achieved thanks to the experience gained in a previous study (see Olivares, Saiz & Rivas, 2013). This motivational program was incorporated in an instruction program named ARDESOS which trains the main skills of Critical Thinking (CT). We developed and assessed the program for instruction in Motivation trying to improve the performance of these skills (reasoning, decision-making and problem-solving). The results obtained were promising but regarding some of them were unexpected. Accordingly, we have reformulated the program for instruction in Motivation, trying to maximize the aspects that worked well, add some aspects hitherto not taken into account and remove aspects that did not work in order to improve the efficiency of the program.

We confirm that in order to learn significantly, it is necessary to have certain capacities, but especially is necessary to want to learn (Brophy, 2013; Pintrich & Schunk, 2006). Want to learn involves a certain predisposition, interest and effort (Pérez, Costa & Corbi, 2012). Authors as Pintrich (2003b) argue that the integration of cognitive and motivational elements is necessary to have a complete view of the learning process in the academic context, and to understand all the difficulties encountered in the process instruction and achievement of learning. However, learning to become motivated to undertake an action and ensuring that such motivation will persist over time (even more costly), despite are not easy tasks (Boekaerts & Corno, 2005). Like others authors have confirmed (Ennis, 2013; Facione, 2011; Halpern, 2014), we also observed that Motivation plays a crucial role both at the time of students becoming instructed in the skills of CT (Olivares, Saiz & Rivas, 2013), and when they are transferring these skills to daily life (Saiz & Rivas, 2008). So, in light of the absence of a specific motivational program to meet this important need, we decided to elaborate and apply the instruction program in Motivation in CT within the sphere of university studies.

Conceiving CT as a theory of action, we reason and decide on things to solve our problems (Saiz & Rivas, 2011), we also understand that components of another order, like the Motivation and the Metacognition, must necessarily be drawn in. We need both of these to think critically in an efficacious and efficient manner (Facione, 2011; Saiz, 2015). This kind of

thinking requires large efforts and demands persistence over time, so being very costly, some kind of drive is necessary (Facione, 2011).

Given the lack of data on this issue, we decided to perform an initial study based on the theoretical model of Expectation/Value (Eccles & Wigfield, 2002; Wigfield & Eccles, 2000) owing to the advantages that it offers with respect to our intervention allowing us to operationalize motivational aspects, since other approaches is not possible (Olivares et al., 2013).

Why we not know what happens to the Motivation for CT if it is an essential component? An important number of people interested in CT argue that the ability to think critically is not enough, dispositions are also necessary (Ennis, 2013; Facione, 2011). But also not only when the "motor" starts up to drive an action is important, maintaining Motivation could become even more relevant in the process of achieving a goal (McCann & Turner, 2004). When we try to meet a goal we may encounter situations that hamper the action required to achieve that goal (in our case, thinking critically), as well as fluctuations in motivation due to attitudes and moods (Navarro, Curioso, Gomes, Arrieta & Cortes, 2013). Accordingly, with these imbalances students' skill in using strategies that will help to direct their motivation towards an action to win the goal proposed is a core aspect with respect to instruction and self-regulated learning (Pintrich, 2003b; Wolters & Rosenthal, 2000). Here, Metacognition comes into play. Flavell (1976) defined it as knowledge that a person has on their cognitive process and use that knowledge to the control of cognitive processes. This component aims at directing, monitoring, regulating, organizing and planning our skills in a profitable way once they have been activated (Boekaerts & Corno, 2005). This is a conscious activity of high-level thinking that allows us to explore and reflect on how we learn and control our own learning strategies and processes with a view to modifying and/or improving them (Holton & Clarke, 2006). In previous studies (Olivares et al., 2013), we have paid more attention to motivational component. Here, we address a direct intervention providing a first approach and filling the gap in our knowledge linking Metacognition within CT.

In the previous study mentioned (Olivares et al., 2013), we carried out an intervention that combined instruction in CT skills through the ARDESOSv.2 program and instruction in Motivation, where the utility of the knowledge to be learned prevailed. Following the same line, in this study we add the Metacognition. One of the principles promoted by the Bolonia Declaration (1999) is the independent learning. We wish students to be active participants in their own learning processes so that they can become independent thinkers, and able to self-

motivate themselves (Jones & Dexter, 2014). Therefore, the self-regulation of learning (or metacognitive strategies) is configured as an essential component to become good critical thinkers. Further, this self-regulation is also necessary for the maintenance of the Motivation and Interest of our students in learning these skills (Jones & Dexter, 2014). Metacognitive strategies that include planning, supervision and regulation help students in the control and regulation of their cognition and promote independent learning (Wolters & Rosenthal, 2000), in addition to promote the application the knowledge they have learned to real-life situations (Saiz & Rivas, 2011). Despite this, students often find it difficult to carry through their intentions to reach their learning goals, even when such goals been accepted for them and they have become committed to achieving them (Komarraju & Nadler, 2013). When motivation declines, the ability of students to the use strategies that will help them to maintain their motivation to learn and control/regulate both their thoughts and their emotions in difficult situations or act in the direction of the target set, becomes a central aspect of self-regulated learning having an enormous impact on academic performance (Mega, Ronconi & De Beni, 2014).

According to our theoretical approach, the aim of this paper is to present a training program which combines intervention in *Metacognition, Motivation* and *CT*. Hence, the working hypothesis is that we expect to see improvements in *CT* skills after the intervention, observing better performance in the group receiving instruction in *Metacognition* and *Motivation*. Likewise, we foresee an increase in scores on *Motivation* and *Metacognition* after the intervention.

Methods

Participants

We used a sample of 134 students from the first year of the degree in Psychology offered at the University of Salamanca (Spain). The sample comprised 112 women (84%) and 22 men (16%), with a mean age of 19.14 years (SD=2.180 years).

Instruments

PENCRISAL, a test of CT. As is typical of the different studies we have been conducting recently (Butler, Dwyer, Hogan, Franco, Rivas, Saiz, & Almeida, 2012; Olivares, Saiz & Rivas, 2013; Rivas & Saiz, 2016; Saiz & Rivas, 2011,2012, 2016; Saiz, Rivas & Olivares, 2015), the PENCRISAL test developed by Saiz and Rivas was implemented to measure the magnitude of the effect and thus determine in which of the groups the greatest improvement in *CT* skills would occur. We offer a brief description of the test (more details in, Rivas and Saiz, 2012; Saiz and Rivas, 2008). PENCRISAL is a test that comprises 35 problem situations with an open response format and it is structured around five factors: Practical Reasoning, Deduction, Induction, Decision-Making and Problem-Solving (Cronbach α=.632; test-retest: r=.786). We opted for a collectively implemented computerized version application because offers considerable advantages in test correction and actually giving it out to the students. The standardized values of correction are between 0-2 points, depending on the quality of the response. As it is a powerful psychometric test we considered running it in different sessions to reduce effects of fatigue, such that no time limit was set. The mean duration estimated for test completion was 60-90 min.

Modified Achievement Motivation Scale of Massanero and Vázquez (AMS-M). In order to determine in which of the groups the greatest increase in improvement in academic Motivation took place, we applied the original AMS-M test (Morales-Bueno & Gómez-Nocetti, 2012) of Massanero and Vázquez (1998). With six dimensions, this questionnaire measures the level of motivation to achieve goals within the learning context of an academic subject taught in university education courses in which collaborative learning strategies are implemented. It consists of 30 items that assess students' production on a 6-point Likert scale, in which the higher the score on each of the items, the greater the motivation for academic achievement. Since the maximum score is 6 and the minimum one 1, score between 30-180.

It contains six motivational factors: Interest and Effort motivation (IE); Interaction with Professor motivation (IP); Task/Capacity motivation (TC); Peer Influence for Learning skills motivation (PIL); Exam motivation (E), and Collaborative Interaction with Peers motivation (PI) (Cronbach α=.902). It is important to take into account that these types of motivation are not mutually exclusive and that they only express attributions, such that a student may deploy more than one of them. Again, we chose the digital version together with collective application in different classrooms of the School of Psychology.

Metacognitive Activities Inventory (MCAI). With the aim of determining in which of the two groups the greatest increase in improvement of Metacognition occurred, we applied the MCAI (Cooper & Sandi, 2009). The self-reporting instrument includes 27 items with a 5-point Likert scale aimed at exploring the regulatory component of metacognition (planning, monitoring and evaluation) that the students make use of in the context of problem-solving. That is, the students report on what they do when they solve problem/task. Thus, a broader use of metacognitive strategies would be associated with high scores on the test. Accordingly score between 27-131 (Cronbach α=.920). Its application is computerized and administered collectively.

Design

In order to analyze the efficacy of the intervention, we performed a quasi-experimental design, with pre-post-treatment measurements, an intervention group and an equivalent quasi-control group (67 subjects/group). We performed an intentional sampling in which half of the sample was chosen for inclusion in the experimental group and the other half in the quasi-control group. Accordingly, both groups received equal instruction in *CT* skills, while only the experimental group also received instruction in *Meta-Motivation*.

Intervention Program

The method used for the intervention covered the two crucial aspects for the improvement of *CT*: the cognitive components (argumentation, decision making and problem solving) and the metacognitive and motivational components. The intervention designed incorporates on one hand a consolidated active learning methodology called ARDESOSv.2 for the acquisition of skills in *CT* (Olivares et al., 2013) and, on the other, a program of actions aimed at the supervision and monitoring of the process of *Metacognition* and *Motivation* of the students.

The ARDESOSv.2 Program

We used version v.2 of the program (for details, see Saiz, Rivas & Olivares, 2015). Briefly, its duration is 60 hours of face-to-face instruction distributed over 15 weeks and applied in classrooms of 30-38 students working in groups of four. The activities are planned meticulously as from the start of the course, supported by rubrics for each of them. The classroom work focuses on the development of these guided activities, helped by the instructor, whose true mission is to clarify the students' doubts when they are carrying out the task in hand, but not to help in its solution. Evaluation is performed on a weekly basis and feedback is given out 2-3 days later, indicating the solution of each activity. This evaluation is quantitative, as established in each rubric. The methodology used is governed by cooperative work groups, direct teaching, learning from the limitations, along with an integrated learning guided by rubrics and projects. The tasks that students perform are both production and comprehension. The materials used are real situations (Problem-Based Learning), TV series, professional cases or opinion that simulate reality.

Metacognitive and Motivational Help Program

To carry out the intervention we based ourselves on a previous study in which the motivational program was applied for the first time (Olivares et al., 2013). We have improved this program, perfecting and emphasizing everything that was found to work and removing, when necessary, or reforming in other cases, all the aspects that either did not work or did not work in the way we had expected them to. In the present work we report the main changes that occurred in this second intervention.

We consider that there are two aspects that are essential to be able to deliver instruction in *CT* that will maintain the motivation of the students as much as possible. The first is the *utility* of the material to be learned through organized experiences, a component very important of the motivational process (Wigfield & Eccles, 2002). Knowing the utility of what we are going to learn is an essential aspect to encourage a meaningful learning in our students; when we are unable to find any sense in something, we tend to discard it from our interest. Accordingly, through our motivation program we attempt to make explicit everything that our students omit/miss along the instruction and we provide information about the practical uses (*utility*) of each of the planned educational experiences they will have to undertake, attempting

that educational experience makes sense to them and allows them better facing their everyday life situations. In the same way, we try to create strategies which promote the students the need to achieve a certain learning, because if the object of study is pleasant and interesting to them, this will increase their need, creating a consistent and strong internal force in which the individuals seek their own personal gratification (Carreira, 2012). The aim is that the students get to conceive to learn to think critically is useful because it helps them cover their needs or satisfy it an easier way.

The second one has to do with the *offer of opportunities*, where students can feel that they have achieved something. For a student can learn to teach himself, the educational context should promote discovery strategies, planning and regulation of the action itself (Zimmerman, 2013). Along the instruction, multiple tasks are offered in which the students can test themselves. When a student gets an achievement, she/he feels capable to develop an activity and will be to persist in it, and in turn, have her/him the feeling of success or improvement and help them keep motivated (Brophy, 2013). Learning to think with rigor is an arduous task and requires the students to make many mistakes for their thinking to become perfected and this has many repercussions on their performance. It is required to remember that the students will feel the need to protect their self-esteem, so it is very important to seek experiences that generate feelings of pride and satisfaction, to offer positive feedback about their strengths and weaknesses to help them pay attention to their individual characteristics and to take responsibility for their own actions (Brophy, 2013). It is obviously that this type of learning must be motivated and we consider the support received by the students through the motivation program to be crucial in this.

Perhaps one of the most relevant aspects of this new application is that it incorporates direct instruction in *Metaknowledge* in the motivation program. We consider that this is an inherent component essential for the learning process and that it completes and complements our motivation program. We contend that there are three types of metacognitive knowledge that must be differentiated: *declarative,* or knowing "about"; *procedural*, or knowing "how", and *conditional*, involving activities for controlling thought or learning (Brophy, 2013). Once these have been differentiated, and with the help of examples from daily life, we explain the sequence of the different phases required for the regulation of cognition (Zimmerman, 2013): *planning* (determination of the necessary aims, strategies and resources); *the handling of information* (sequence of strategies used to process information efficiently); *monitoring understanding;*

evaluation of learning; control of errors (strategies used to correct a problem of understanding or performance) and later *self-evaluation* (assessment of the results and regulatory processes of learning itself). We provide examples in which these phases are involved and how the students should proceed: 1)they must determine what the learning objectives pursued are and accompany this with conscious reflection about how to face the challenge and how make the necessary decisions to solve it; 2)if there is some imbalance in these goals, they must be able to reorient or regulate the action, which involves permanent observation of the learning process at different times and planning the actions to be performed, the time when they should be performed, and the effort and the resources required, and 3)on concluding the process and considering the results, they must assess their own behaviour to determine whether some decision has been inappropriate or inefficacious with a view to correcting it in the future and preserving what has been useful and efficient. That is, cover the main phases of metacognition: planning, monitoring and evaluation (Zimmerman, 2013).

In order that the motivation and interest of students in learning to stay, need to be able to self-regulate their activity during the learning process (Nakamura & Csikszentmihalyi, 2014). In this sense, volition, which intends to regulate the effort, is critical to student performance, especially when the achievement of objectives requires concentration and effort for long periods of time (Kuhl, 2013). From this perspective the role of the will as the driving force behind the person and allows them to run their decisions and protect their psychological states to the other alternatives, unwanted thoughts and emotions is emphasized. Current models of self-regulated learning suggest that volitional strategies in order to maintain motivation and effort towards achieving the objectives and to control negative emotions, are interrelated and jointly participate in the self-regulated learning (Pintrich, 2003b).

Another of the significant changes supported in our new motivation program refers to the structuring of tutorials and their different types (see Olivares et al., 2013). In the earlier study we observed that the starting and final group tutorials of the blocks (groups of 15 students) did not afford the expected effect. In light of this, in the present study we focused the weight of the intervention on the *follow-up tutorials*, working with groups formed by only 4 students, and extended the duration to 30 minutes. However, we maintain and apply the same scheme of action as the starting and final group tutorials in the follow-up tutorials at the moment of starting and finishing the block in question. In this way, each student receives a total of fifteen tutorials in *Meta-Motivation*, equivalent to eight hours of intervention. It should be recalled that

the follow-up tutorials mainly aim to monitor the yield of our students with respect to the applications they perform with *CT* skills in their daily lives, together with the difficulties they encounter on the way. To do so, we follow the same lines of action as in the earlier study: *1.Introduction and establishment of a good atmosphere for the tutorial;* 2.*Exploration of effort vs. motivation;* 3.*A question about utility;* 4.*Utility goals;* 5.*Closure.* A key aspect of the work in these sessions, and one that we have reformulated from the previous study, refers to the notebook for reflections on the practical work ("reflections logbook"), which is now referred to as "*logbook*". This element maintains the same work demands for the students, with two exceptions. The first is that apart from answering the question on utility and reflecting on the personal daily issues commented and debated in the tutorials, we also include a section on metacognition and its development (difficulties, planning, monitoring, strategies, assessment...). The second is that once the block of contents in question has been completed the students must hand in their corresponding logbook in a timely and proper way. It is important to stress that as the content blocks are addressed and the students start handing in their logbooks, apart from working more daily problems that arise with the passing of time, we return to the same or similar situations as those expressed in the students' logbooks with a view to seeking integration of the different blocks.

In the search to equalize the conditions of this educational experience regarding the time invested by the students and the volume of work, the students who to not receive the meta-motivational program do alternative exercises in its place. These essentially consist of the presentation of real problems to be solved in which the skills of instructed *CT* must be brought into play.

Procedure

This teaching initiative was applied along one term in the classroom of the School of Psychology of the University of Salamanca. Once week before the instruction was begun, we gave both the PENCRISAL test, the Modified Achievement Motivation Scale (AMS-M) and the MCAI to all the students. We did the same one week after the completion of the intervention in order to collect the second measurement of the variables. The time elapsed between the pre/post-treatment measurements was four months. The intervention was carried out by two

instructors, one charged exclusively with the instruction in *CT* skills and the other responsible for the meta-motivational aid program in the work tutorials.

Statistical Analyses

To confirm the degree of fit to the normal Gaussian model, we performed an explanatory descriptive study of all the measurement variables using the usual tools, box diagrams and the Kolmogorov-Smirnov goodness of fit test. Once this had been done, we implemented ANOVA to examine the effect of the initiative and check whether there were statistically significant differences between the pre- and post-treatment situations. Data treatment was carried out using Student's t test and ANOVA.

Results

We first performed a descriptive analysis of the properties of the sample according to the pre- and post-measurement times, both at global level (the whole sample) and by intervention groups. Following this, Student's t test and ANOVA were implemented.

Regarding the descriptive statistics of all the variables in the different conditions of the study, we observed that these were distributed according to the normal Gaussian curve, exhibiting distributions with suitable asymmetry indices and kurtosis. Likewise, as may be seen in the table below, at the time of the pre-treatment measurements there were no significant differences in any of the variables, such that we knew we had similar groups as regards the intervention.

Table 1

Comparison of Pre-Measures Taking into Account the Intervention Group

Variables		n	Mean	Standard Deviation	Difference between means	Student's t test		
						T Value	df	p-sig. (bilateral)
Total Critical Thinking	e.g.	67	29.69	7.03	.95	.81	131	.415 NS
	c.g.	67	28.74	6.24				
Practical Reasoning	e.g.	67	7.34	2.81	.11	.24	131	.807 NS
	c.g.	67	7.23	2.65				
Deductive Reasoning	e.g.	67	3.49	1.57	.29	1.05	131	.291 NS
	c.g.	67	3.20	1.64				
Inductive Reasoning	e.g.	67	4.69	1.47	.14	.59	131	.553 NS
	c.g.	67	4.55	1.24				
Decision-Making	e.g.	67	7.39	2.65	.28	.70	131	.480 NS
	c.g.	67	7.11	1.85				
Problem Solving	e.g.	67	6.78	2.31	.40	.28	131	.775 NS
	c.g.	67	6.67	2.08				
Total Motivation	e.g.	67	137.45	13.51	2.21	-.07	131	.942 NS
	c.g.	67	137.61	11.30				
Interest / Effort	e.g.	67	40.76	4.29	-.24	-.33	131	.739 NS
	c.g.	67	41.00	3.94				
Interaction with Professor	e.g.	67	23.27	3.60	.03	.04	131	.966 NS
	c.g.	67	23.24	3.50				
Task / Capacity	e.g.	67	25.16	3.65	.69	-1.89	131	.060 NS
	c.g.	67	26.26	2.96				
Peer Influence for Learning	e.g.	67	12.81	3.49	.17	1.13	131	.260 NS
	c.g.	67	12.14	3.32				
Exam	e.g.	67	15.51	3.05	-.35	-.64	131	.522 NS
	c.g.	67	15.86	3.33				
Collaborative Interaction Peers	e.g.	67	19.94	2.90	.83	1.62	131	.107 NS
	c.g.	67	19.11	3.01				
Total Meta-cognition	e.g.	67	94.46	6.95	.32	1.07	131	.285 NS
	c.g.	67	93.20	6.63				

Following this, we implemented ANOVA, in which we compared the pre/post-measurements and the groups with one another on all the measurements analyzed. We also calculated the effects of the change in each case. First, we analyzed the assumptions of the normality and homogeneity of variance of the sample. The Kolmogorov-Smirnov test revealed that the sample in the pre-treatment measure maintained a normal distribution with $p>.05$ for most of the study variables except seven, where a slight deviation from the normality curve was observed. However, this was not given importance because even though p was <.05, it was ≥.01

in nearly all of them and, moreover, once the analysis had been made with non-parametric tests these did not reflect important differences as regards the parametric procedure performed. The same was the case in the post- condition, in which 10 variables deviated slightly from the normal curve. Regarding the principle of homogeneity, the Levene test revealed that this condition was met in all the study variables.

The results of the ANOVA show that with respect to the total *CT* variable, at the time of pre-post measurements there were significant differences with $p<.05$ ($F_{CT}(1, 132)=80.44$, $p=.00$), where the post-condition revealed a considerably higher performance ($M_{pre}=29.20$; $M_{post}=36.42$). This was also the case at intergroup level, with $p<.05$ ($F_{CT}(1, 132)=5.55$, $p=.02$), where the experimental group had a significantly higher mean ($M_{eg}=33.85$) with respect to the control group ($M_{cg}=31.76$). However, regarding the intersection between the group and the time of application, no significant differences were observed $p>.05$ ($F_{CT}(1, 132)=1.91$, $p=.16$) (See table 2).

Table 2

Summary of the Significance of the Effects of Both Factors on the Total Critical Thinking Variable

Variable	Measures & S.D.		FACTOR	DF	MC	F	p	Power	Partial Eta2
Total Critical Thinking	Applic. pre. 29.20 (s.d. 6.62)	Applic. post. 36.42 (s.d.7.34)	Applic. Pre/Post	1,132	3489.138	80.44	.000**	-	.379
	E.G. 33.85 (s.d. 5.11)	C.G. 31.76 (s.d. 5.11)	Group Exp/Cont	1,132	290.451	5.55	.020*	-	.040
	E.G. pre. 29.69 (s.d.7.03)	E.G. post. 38.01 (s.d. 7.35)	Group/Applic.	1,132	82.84	1.91	.169^{NS}	.648	.014
	C.G. pre.28.72 (s.d. 6.19)	C.G. post. 34.82 (s.d. 7.03)							

Note: NS= correlation not significant (p> .50) *Signiticant at .05 ** Highly significant .01

Regarding the results obtained for the 5 factors of *CT* as a function of the moment of pre-post measurement, differences can be seen in all the factors ($F_{PR}(1, 132)=96.41$, $p=.00$; $F_{DR}(1, 132)=23.53$, $p=.00$; $F_{IR}(1, 132)=23.00$, $p=.00$; $F_{DM}(1, 132)=37.89$, $p=.00$) except in problem-solving ($F_{PS}(1, 132)=2.98$, $p=.08$). As expected, the scores obtained at pre- were lower than those obtained after the intervention. In the comparison between groups, we noted significant

differences in consonance with the intervention only in the decision-making factor (F_{DM}(1, 132)=8.22, p=.00) with respect to the other factors. Regarding the interaction of the two levels, significant differences were seen only in the decision-making factor (F_{DM}(1, 132)=3.82, p=.05), where the experimental group showed a better performance on the post- measurement than the control group. Nevertheless, in the other factors, although the measurements increased as a result of the intervention, the difference between groups was not significant since both improved their performance to almost the same extent (See table 3).

Table 3

Summary of the Significance of the Effects of Both Factors on the Dimensions of Critical Thinking

Variables	Means & S.D		FACTOR	df	MC	F	p	Power	partial Eta2
Practical Reasoning	Applic. pre. 7.30 (s.d. 2.72)	Applic. post. 9.94 (s.d. 1.98)	Applic. Pre/Post	1,132	467.597	96.41	.000**	-	.422
	E.G. 8.73 (s.d. 1.80)	C.G. 8.52 (s.d. 1.80)	Group Exp/Cont	1,132	2.925	.44	.506	-	.003
	E.G. pre. 7.34 (s.d. 2.81) C.G. pre. 7.26 (s.d. 2.65)	E.G. post. 10.11 (s.d. 1.71) C.G. post. 9.77 (s.d. 2.22)	Group/Applic	1,132	1.209	.24	.618^{NS}	.249	.002
Deductive Reasoning	Applic pre. 3.34 (s.d. 1.60)	Applic post. 4.60 (s.d. 2.72)	Applic. Pre/Post	1,132	105.313	23.53	.000**	-	.151
	E.G. 4.22 (s.d. 1.65)	C.G. 3.71 (s.d. 1.65)	Group Exp/Cont	1,132	17.254	3.16	.078^{NS}	.423	.023
	E.G. pre. 3.49 (s.d. 1.57) C.G. pre. 3.19 (s.d. 1.63)	E.G. post. 4.96 (s.d. 2.82) C.G. post. 4.24 (s.d. 2.60)	Group/Applic.	1,132	2.925	.65	.420^{NS}	.126	.005
Inductive Reasoning	Applic pre. 4.63 (s.d. 1.36)	Applic post. 5.96 (s.d. 2.80)	Applic. Pre/Post	1,132	118.224	23.00	.000**	-	.148
	E.G. 5.49 (s.d. 1.51)	C.G. 5.09 (s.d. 1.51)	Group Exp/Cont	1,132	10.881	2.40	.123^{NS}	.338	.018
	E.G. pre. 4.69 (s.d. 1.47) C.G. pre. 4.57 (s.d. 1.24)	E.G. post. 6.30 (s.d. 3.42) C.G. post. 5.61 (s.d. 1.96)	Group /Applic.	1,132	5.388	1.04	.308^{NS}	.174	.008
Decision-making	Applic pre. 7.22 (s.d. 2.30)	Applic post. 8.80 (s.d. 2.25)	Applic. Pre/Post	1,132	166.123	37.89	.000**	-	.223
	E.G. 8.42 (s.d. 1.66)	C.G. 7.59 (s.d. 1.66)	Group Exp/Cont	1,132	45.974	8.22	.005**	-	.059
	E.G. pre. 7.39 (s.d. 2.65) C.G. pre. 7.06 (s.d. 1.88)	E.G. post. 9.46 (s.d. 1.86) C.G. post. 8.13 (s.d. 2.41)	Group /Applic.	1,132	16.750	3.82	.053*	.152	.010
Problem Solving	Applic pre. 6.70 (s.d. 2.20)	Applic post. 7.09 (s.d. 2.20)	Applic. Pre/Post	1,132	10.090	2.98	.086^{NS}	.404	.022
	E.G. 6.97 (s.d. 1.78)	C.G. 6.81 (s.d. 1.78)	Group Exp/Cont	1,132	1.806	.28	.595^{NS}	.083	.002
	E.G. pre. 6.78 (s.d. 2.31) C.G. pre. 6.63 (s.d. 2.09)	E.G. post. 7.18 (s.d. 2.06) C.G. post. 7.00 (s.d. 2.34)	Group /Applic.	1,132	.015	.00	.947^{NS}	.050	.000

Regarding the total *Motivation* variable, the data show that in the intergroup factor there were significant differences, in agreement with the hypothesis posited $p<.05$ ($F_{MO}(1, 132)=7.11$, $p=.00$), where the scores increased in the post-measurement ($M_{Opre}=137.36$;$M_{Opost}=141.53$). However, at intergroup level no significant differences were observed ($F_{MO}(1, 132)=.392$, $p=.53$) but the result is consistent with our hypothesis. With respect to the relationship between the intervention groups and the time of applying the pre-post tests, no significant differences were observed either ($F_{MO}(1, 132)=.576$, $p=.44$), although the scores of the experimental group did increase in the post-intervention test to a greater extent than those of the control group, again in agreement with our hypothesis ($M_{EGpre}=137.44$; $M_{EGpost}=142.80$; $M_{CGpre}=137.28$; $M_{CGpost}=140.26$) (See table 4).

Table 4

Summary of the Significance of the Effects of Both Factors on the Total Motivation Variable

Variable	Means & S.D.		FACTOR	df	MC	F	p	Power	partial Eta2
Total Motivation	Applic. pre. 137.36 (s.d. 12.51)	Applic. post. 141.54 (s.d. 17.81)	Applic. Pre/Post	1,132	1165.97	7.11	.009**	-	.051
	E.G. 140.12 (s.d. 12.49)	C.G. 138.77 (s.d. 12.49)	Group Exp/Cont	1,132	122.243	.39	.532^{NS}	.095	.003
	E.G. pre. 137.44 (s.d. 13.51)	E.G. post. 142.80 (s.d. 21.52)							
	C.G. pre. 137.28 (s.d. 11.52)	C.G. post. 140.26 (s.d. 13.14)	Group/Applic.	1,132	94.332	.57	.449^{NS}	.117	.004

Note: NS= correlation not significant (p> .50) *Significant at .05 ** Highly significant .01

Regarding the results obtained for the six motivation factors, based on the pre-post-measurement moment, significant differences were only found for two of the six factors ($F_{TC}(1, 132)=21.35$, $p=.00$; $F_{CIP}(1, 132)=16.35$, $p=.00$). In the Peer Influence on Learning factor the differences were almost significant ($F_{PIL}(1, 132)=3.61$, $p=.05$). The means of the scores show that a significant increase occurred in the Task/Capacity and Collaborative Interaction with Peers factors, as expected for the intervention, where the experimental group showed better performance owing to the motivational intervention received ($M_{TCEG}=10.46$; $M_{TCCG}=9.67$; $M_{CIPEG}=10.46$; $M_{CIPCG}=9.67$). Regarding the relationship between the pre-post variable and the intervention groups, we only found significant differences in the Task/Capacity factor ($F_{TC}(1,132)=4.30$, $p=.04$) ($M_{TCEGpre}=25.16$; $M_{TCEGpost}=27.60$) (See table 5).

Table 5

Summary of the Significance of the Effects of Both Factors on the Dimensions of Motivation

Variables	Means & S.D.		FACTOR	df	MC	F	p	Power	partial Eta2
Interest/Effort	Applic. pre. 40.84 (s.d. 4.11)	Applic post. 40.81 (s.d. 5.32)	Pre/Post Applic.	1,132	.060	.00	.944^{NS}	.755	.051
	E.G. 30.01 (s.d. 4.08)	C.G. 30.60 (s.d. 4.08)	Exp/Cont Group	1,132	.731	.02	.883^{NS}	.052	.000
	E.G. pre. 40.76 (s.d. 4.29)	E.G. post. 41.00 (s.d. 6.56)	Group/Applic.	1,132	4.836	.39	.530^{NS}	.096	.003
	C.G. pre. 40.92 (s.d. 3.74)	C.G. post. 40.62 (s.d. 4.98)							
Interaction with Professor	Applic. pre. 23.19 (s.d. 3.60)	Applic. post. 23.50 (s.d. 5.10)	Pre/Post Applic.	1,132	6.272	.55	.458^{NS}	.114	.004
	E.G. 25.46 (s.d. 3.72)	C.G. 24.91 (s.d. 3.72)	Exp/Cont Group	1,132	22.123	.79	.373^{NS}	.144	.006
	E.G. pre. 23.27 (s.d. 3.60)	E.G. post. 24.00 (s.d. 5.21)	Group/Applic.	1,132	12.123	1.06	.303^{NS}	.177	.008
	C.G. pre. 23.00 (s.d. 4.98)	C.G. post. 23.50 (s.d. 5.10)							
Task/Capacity	Applic. pre. 25.67 (s.d. 3.37)	Applic. post. 27.35 (s.d. 4.20)	Pre/Post Applic.	1,132	188.899	21.35	.000**	-	.139
	E.G. 10.46 (s.d. 3.16)	C.G. 9.67 (s.d. 3.16)	Exp/Cont Group	1,132	4.571	.22	.634^{NS}	.076	.002
	E.G. pre. 25.16 (s.d. 3.65)	E.G. post. 27.60 (s.d. 4.64)	Group/Applic.	1,132	38.063	4.30	.040*	-	.032
	C.G. pre. 26.18 (s.d. 3.01)	C.G. post. 27.10 (s.d. 3.72)							
Peer Influence on Learning	Applic. pre. 12.48 (s.d. 3.40)	Applic. post. 13.15 (s.d. 3.65)	Pre/Post Applic.	1,132	30.224	3.61	.059^{NS}	.471	.027
	E.G. 10.46 (s.d. 2.88)	C.G. 9.67 (s.d. 2.88)	Exp/Cont Group	1,132	20.433	1.23	.269^{NS}	.197	.009
	E.G. pre. 12.81 (s.d. 3.49)	E.G. post. 13.37 (s.d. 3.80)	Group/Applic.	1,132	.731	.08	.768^{NS}	.060	.001
	C.G. pre. 12.15 (s.d. 3.30)	C.G. post. 12.93 (s.d. 3.50)							
Exam	Applic. pre. 15.66 (s.d. 3.19)	Applic. post. 15.96 (s.d. 3.37)	Pre/Post Applic.	1,132	6.272	1.35	.246^{NS}	.212	.010
	E.G. 10.46 (s.d. 2.92)	C.G. 9.67 (s.d. 2.92)	Exp/Cont Group	1,132	5.108	.29	.585^{NS}	.084	.002
	E.G. pre. 15.51 (s.d. 3.05)	E.G. post. 15.64 (s.d. 3.34)	Group/Applic.	1,132	.034	.00	.932^{NS}	.051	.000
	C.G. pre. 15.81 (s.d. 3.34)	C.G. post. 16.09 (s.d. 3.41)							
Collaborative Interaction with Peers	Applic. pre. 19.52 (s.d. 2.96)	Applic. post. 20.76 (s.d. 3.45)	Pre/Post Applic.	1,132	102.821	16.35	.000**	-	.110
	E.G. 10.46 (s.d. 2.67)	C.G. 9.67 (s.d. 2.67)	Exp/Cont Group	1,132	28.896	2.01	.159^{NS}	.291	.015
	E.G. pre. 19.94 (s.d. 2.90)	E.G. post. 21.00 (s.d. 3.51)	Group/Applic.	1,132	2.149	.34	.560^{NS}	.089	.003
	C.G. pre. 19.10 (s.d. 2.99)	C.G. post. 20.52 (s.d. 3.40)							

Concerning the total *Metacognition* variable, our findings show that in the intragroup factor there were significant differences, $p<.05$ ($F_{ME}(1, 132)=15.90$, $p=.00$). This difference is reflected favorably in the means since the scores increased in the post-measurement ($M_{Epre}=93.96$; $M_{Epost}=96.33$). However, no significant differences were seen either at intergroup level ($F_{ME}(1, 132)=.001$, $p=.96$) nor with respect to the relationship between the intervention groups and the time of pre-post-measurement ($F_{ME}(1, 132)=2.63$, $p=.10$), where we observed that the scores of both groups increased in the second measurement, the mean of the control group being higher, although not significantly so ($M_{EGpre}=94.46$; $M_{EGpost}=95.87$; $M_{CGpre}=93.46$; $M_{CGpost}=96.79$) (See table 6).

Table 6

Summary of the Significance of the Effects of Both Factors on the Total Meta-Cognition Variable

Variable	Means & S.D.		FACTOR	df	MC	F	p	Power	parcial Eta2
Total Meta-cognition	Applic. pre. 93.96 (s.d. 6.93)	Applic. post. 96.33 (s.d. 6.22)	Pre/Post Applic.	1,132	374.959	15.90	.000**	-	.108
	E.G. 95.16 (s.d. 5.63)	C.G. 95.12 (s.d. 5.63)	Exp/Cont Group	1,132	.093	.00	.969^{NS}	.050	.001
	E.G. pre. 94.46 (s.d. 6.95)	E.G. post. 95.87 (s.d. 6.07)	Group/Aplicac.	1,132	62.093	2.63	.107^{NS}	.364	.020
	C.G. pre. 93.46 (s.d. 6.93)	C.G. post. 95.79 (s.d. 6.18)							

Note: NS= correlation not significant (p> .50) *Significant at .05 ** Highly significant, .01

Discussion

The results reported here show that the efficacy of the initiative used has improved in some aspects of the intervention more than in others. Regarding instruction in *CT* skills by means of ARDESOSv.2 it should be noted that the results obtained were highly satisfactory. Both regarding total scores and in the different dimensions (except in *Problem Solving* factor), the results were improved considerably after the intervention in both groups, although with a better performance in the experimental group, as suggested by one of our hypotheses. This indicates we are working in the right direction facing the adjustment of the training program of the fundamental skills of *CT*. The specificity and learning from the limitations show us that they are

two strategies that can operate successfully in the instruction of *CT* (Saiz et al., 2015). Ultimately, the goal-motivational intervention reinforces ARDESOS program variables, which have already been tested in other studies (see Saiz and Rivas, 2011, 2012, 2016; Saiz et. al. 2015).

Another revealing finding is with the *Decision-Making* factor, because we have not managed to obtain significant differences in this factor both intergroup level as at the intersection of the two levels. With the changes in the instruction, mainly referring to the solving of real problems and the large number of daily problems used where students have felt identified, we have managed to improve our students' skills in *decision-making* both in the actual process of making a good as in the fact of knowing which the best solution is. The current knowledge society presents many challenges where an active and committed attitude seems to be a sine qua non condition for success in the academic, professional and personal world (Franco & Almeida, 2015), specially knowing that there is a direct relationship between socio-economic performance of a country and the quality of learning of the population (PISA, 2009). Then, it would try to ensure that individuals develop creative skills, *CT* and cooperation, and also they cultivate the dispositions related to the practice consciously and deliberately (OECD, 2015).

Conversely, we did fail to obtain significant results in several of the levels of the *CT* variables, and also the *Problem-solving* factor. It would be necessary to further refine some aspects both regarding their conceptualization (*DM* and *PS* as a single dimension) and the instruction and criteria of test correction in this skill, because some contents overlap theorically (solving a problem involves making a decision). Nevertheless, we are closer to achieving our aims, data confirm that we are working in the right direction and this is encouraging for teaching and assessment duties.

With respect to the scores obtained on the *Motivation* variable, there were significant differences in agreement with the hypothesis posited only in the *Total Motivation, Task/Capacity, Collaborative Interaction with Peers* and*,* almost reaching significance, *Peers Influence for Learning* scores with respect to the moment of the pre-post measurements, obtaining better performances in the post. Regarding the interaction between the moment of measurement and the intervention groups, only the *Task/Capacity* dimension revealed significant results in favor of the experimental group. Although we do not have obtained the results expected for this variable, these findings offer interesting data. First, the use of rubrics has given us meticulous specificity in the performance of each task and good results, and also we have worked it in the program of meta-motivational aids, where we were also trying to

nurture the perception of self-efficacy and capacity of our students since this revealed the good results and achievements made. These results in *Task/Capacity* dimension are consistent with other studies (Diseth, 2011; Schukajlow et al., 2012). Maintaining a sense of self-efficacy and competence with obtaining good results improves significantly motivation and learning goals. Self-efficacy, self-concept and outcome expectations are key elements for the intervention in *Motivation*, especially in procedural skills. Our meta-motivational program helps our students to establish greater confidence in aptitude and their probability of success, which tells us that we are on the right path.

Second, another cardinal aspect of the intervention refers to the work carried out in groups of four people. We confirm the transcendental role of peers in this situation because of their work, effort and dedication depend on the results and the quality of their learnings. The importance and necessity of social goals in learning and academic achievement is evident, they are related to the value of the task and the achievement motivation that the student has (Midgley, 2014). The experimental group showed better performance in *Collaborative Interaction with Peers* dimension, which covers aspects such as satisfaction with shared goals, level of interaction, performance of tasks, perseverance, etc. We were worked it insistently in the tutorials in order to create, as far as possible, a good working atmosphere and to remove its possible negative effects on the group.

With the exception of the *Exam* variable, in the other factors we found that the means of the experimental group increased to a greater extent than the control group in favor of our hypothesis, although no significant differences. It is curious that the *Interest/Effort* dimension has no significant differences, factor tightly linked to motivation. However, on reviewing meticulously the items making up that dimension we see that mostly of them focus on the academic result. The motivation test considers the *Interest-Effort* tandem in quantitative terms, so the assessment of a purely intrinsic interest would not be covered completely. With our intervention we seek to promote the motivation to learn, not the motivation for results. We think this fact is related to what was obtained for the *Exam* variable, where the control group showed an increase in their mean scores with respect to the experimental group. Evaluation is an essential part of this methodology and seeks an improvement in learning. Nevertheless, the exam situation can generate negative reactions (stress, difficulty solving problems, low self-esteem, low expectations of self-efficacy,…) (Wigfield y Eccles, 2000). These repercussions were addressed as far as possible in the meta-motivational tutorials, where we insisted that in this

methodology what is being pursued is effort and persistence in the tasks at hand, not quantitative, along with work on motivational regulation strategies (management of academic goals, pursuit of value for the task, seeking help...).

According with other studies (Facione, 2000) we check that *Motivation* is a construct that modulates *CT,* alone it is unable to increase performance in the skills involved in it. Only with dispositions would we obtain a smaller increase in the performance of these skills and vice versa. In conclusion, both factors -dispositions and skills- are necessary for the proper use and practice of such skills and their transfer to daily life situations (Ennis, 2013; Nieto & Valenzuela, 2012).

Finally regarding the *Metacognition* variable, we only observed significant differences at the pre-post measurement; this is surprising but also disappointing. As we expected, the working methodology through *learning from limitations* clearly contributed to the development of *Metacognition*, we have proof through feedback offered by the experiences with the students along the instruction. Self-regulated students use their metacognitive skills (planning, supervision and regulation) to regulate their learning effectively and, in turn, the regulation their own learning can lead them to new knowledge related to the task, the strategies must manage their own resources and learning (Pozo, 2006; Pintrich, 2003b). In our case, both groups obtained similar performances. So, we conclude our current intervention in metacognition might not be effective enough to produce significant differences between groups; we should make modifications on it. But we also think that the test cannot be seen a suitable tool for measuring metacognition in this special type of instruction because some items even though we were working metacognition in general, contextualizes it within the academic-schooling field particularly (i.e. "*I get questions about the lesson before you start studying";"when I study I try to divide the lesson in subsections"*). We worked in the tutorials placing greater stress on its applicability to the solution of real-life problems and on ensuring that the students would be aware of the difficulties facing them and how to overcome. We are re-revising other measuring instruments for the construct with a view to locating one that better fits the design of our intervention.

Final Comments

In conclusion, our hypotheses would be partially confirmed. We were seeking to improve the performance scores in both *CT* as *Motivation* and *Metacognition* variables, looking for the experimental group performed better compared to the control group. With regard to variable *CT*, both groups improved their performances but the experimental group obtained a better performance in all the dimensions of *CT* studied, giving significant trends (except in *Decision Making* factor where there were significant differences). The same happens with the scores in *Motivation* variable, where performance increased in nearly all the dimensions being significant only in some factors between both groups. However, in *Metacognition* variable we only managed significant differences in the measurement moment. So we can conclude that the intervention in meta-motivation has been efficient since it does contribute to improving performance in *CT*, but not sufficiently so to produce significant differences in all the study variables, especially as regards the results obtained in the intersection of the levels.

We are considering these limitations and modifying the instruction to improve the meta-motivational program, above all with respect to *Metacognition*, since this is the first direct intervention that we have performed. The implementation of programs like the one presented here, which promote skills development and learning processes in University, could be included in the form of seminars, within sessions start course for students entering to the University or as elective subjects with ECTS (as some universities, i.e.Texas, Michigan) in order to create more opportunities for students to be more competent and gain greater success in their academic lives and in their professional future. More studies are needed to assess the impact of the program's effectiveness over time using other process variables (e.g. log-books, see Schmitz & Wiese, 2006), also obtaining data transferability long term (Nestel, Groom, Eikeland-Husebo & O´Donnell). In short we hope that this study encourages other researchers to work in promoting motivation and self-regulation in university to improve thus our understanding of the learning process and increase their eficacy.

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