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Relationships between motivational factors and critical thinking

Relaciones entre factores motivacionales y pensamiento crítico

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Abstract

The performance of critical thinking skills depends on motivational factors. Based on the expectancy-value motivational theory, this paper analyzes the effect of motivational components (expectancy, utility, attainment, cost, and interest) on the performance of critical thinking skills, and estimates the predictive capacity of these factors on critical thinking skills. In this study, three instruments were applied to a sample of 254 Spanish university students: the Motivation for Critical Thinking Scale (EMPC) and two scales of critical thinking skills: PENCRISAL and CCTST. Multiple regression analysis was used to identify the motivational components that best explain the performance of these skills. The results show that, regardless of the critical thinking test used, the motivational variables explain the variance in the performance of critical thinking skills ranging from 8% to 17%. Finally, the importance of considering these components of motivation to promote performance in these critical thinking skills is discussed.

Keywords: *Motivation, expectancy-value, critical thinking, skills, multivariate analysis*

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Resumen

El rendimiento de las habilidades de pensamiento crítico depende de factores motivacionales. Basándose en la teoría motivacional expectativa-valor, este trabajo analiza el efecto de los componentes motivacionales (expectativa, utilidad, logro, coste e interés) sobre el rendimiento de las habilidades de pensamiento crítico y estima la capacidad predictiva de estos factores sobre las habilidades de pensamiento crítico. En este estudio se aplicaron tres instrumentos a una muestra de 254 estudiantes universitarios españoles: la Escala de Motivación para el Pensamiento Crítico (EMPC) y dos escalas de habilidades de pensamiento crítico: PENCRISAL y CCTST. Se utilizó un análisis de regresión múltiple para identificar los componentes motivacionales que mejor explican el rendimiento de estas habilidades. Los resultados muestran que, independientemente de la prueba de pensamiento crítico utilizada, las variables motivacionales explican la varianza en el rendimiento de las habilidades de pensamiento crítico entre un 8% y un 17%. Finalmente, se discute la importancia de considerar estos componentes de la motivación para promover el rendimiento en estas habilidades de pensamiento crítico.

Palabras clave: Motivación, expectativa-valor, pensamiento crítico, habilidades, análisis multivariante.

Introduction

This relationship between critical thinking skills and motivation is fundamental. As an elaborated and complex skill, critical thinking requires different processes, both cognitive and motivational, to be fully developed (Miele & Wigfield, 2014; Ossa *et al.*, 2018); within the motivational aspects, there are cognitive effort, task valuation (Tee *et al.*, 2018), achievement goals (Bircan & Sungur, 2016; Miele & Wigfield, 2014; Muwonge *et al.*, 2019) and self-efficacy (Dilekli & Tezci, 2016; Shaabani *et al.*, 2011). Without the person's intention to be critical, the reflective and evaluative process becomes a mechanical processing of data (Tee *et al.*, 2018).

There are two main approaches to addressing the issue of "motivational" aspects in the deployment of critical thinking skills: the first of more philosophical roots that accounts for this aspect from the notion of dispositions (Brenes *et al.*, 2018; Gentile *et al.*, 2018; Yorganci, 2016). Although this first approach allows a more intuitive general characterization, it has a critical difficulty with operationalization when this variable is measured. On the other hand, the notion of motivation inherited from a more psychological tradition allows a more rigorous operationalization of the concept. However, the evidence shows a clear predictive advantage of motivation concerning the approach taken from the perspective of dispositions (Valenzuela *et al.*, 2014).

In this paper, we focus primarily on this second dynamic, analyzing how motivation and its components, operationalized from the expectancy-value theory (Wigfield & Gladstone, 2019), would affect the execution of critical thinking skills. Recent research has addressed this issue from goal theory (Kwan & Wong, 2015; Tee *et al.*, 2018) and self-determination theory (León *et al.*, 2015; Rowley *et al.*, 2017). Although we find these perspectives interesting, we believe that conceptualizing motivation from expectancy-value theory allows us to visualize courses of action more clearly from the perspective of investment and, on the other hand, shows a clear predictive advantage over the approach taken by the dispositions perspective (Valenzuela *et al.*, 2014).

Critical Thinking

Critical thinking is reasoned, and reflective thinking is focused on the person's decision about what he/she does or believes he/she should do. In this process, together with deductive and inductive reasoning, processes such as problem-solving, calculating probabilities, and decision-making are involved (Halpern, 2006). Two main components converge in the realization of these processes. On the one hand, the skills and, on the other hand, a motivational component that activates them and makes them persist over time.

The way to classify these skills is partially coincident. The rise of various models and categorizations implies a methodological challenge to have adequate instruments to measure this construct (Ossa *et al.*, 2017).

Critical Thinking: Facione's Theoretical Proposal

One of the most widespread operationalizations of critical thinking is that of Peter Facione, who led an investigation that sought to elucidate the skills involved in critical thinking. To this end, Facione resorted to the Delphi method to agree on which skills would be involved (Facione, 1990a). Through this iterative mechanism of consulting a panel of experts, this author arrived at the proposal of six fundamental skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Although this proposal has the advantage of consensual support from a large group of experts, it has the disadvantage of a weak instrumental operationalization of each of these skills. The operationalization of these dimensions carried out by Facione himself through the California Critical Thinking Skill Test - CCTST (Facione, 1990b; Facione & Facione, 1992), only accounts for analysis, evaluation, and inference, to which he adds two scales to measure deductive and inductive reasoning. However, although his research shows that interpretation, explanation, and self-regulation are central critical thinking skills, this author does not consider them when measuring critical thinking. Despite the above, Facione's perspective and the CCTST continue to be used by researchers.

Critical Thinking: Saiz's Theoretical Proposal

For Carlos Saiz, a Professor at the University of Salamanca, critical thinking is seeking knowledge through reasoning, decision-making, and problem-solving skills, which allow us to achieve the desired results effectively (Saiz, 2017). Along these lines, critical thinking skills can be grouped under three major sections: Reasoning, problem-solving, and decision-making (Saiz & Rivas, 2009). From this author's perspective (Saiz, 2002, 2017), reasoning, has specific reasoning skills as components (see Table 1). In this framework, we find deductive reasoning, which integrates both categorical and propositional reasoning; inductive reasoning, a category that regroups inductive generalizations, causal reasoning, analogical reasoning, and hypothetical reasoning; and practical reasoning, which despite drawing on inductive and deductive reasoning, has particular characteristics since the specific skills it brings together are centered around the soundness of argumentation and specific skills to evaluate its soundness. Therefore, it is helpful to distinguish this type of reasoning from the previous two and consider it separately.

The second capacity of critical thinking is problem-solving (Morales *et al.*, 2015; Saiz, 2002), i.e., the ability to define the problem and articulate strategies to obtain the desired end. Different reasoning processes are involved in decision-making; however, the distinctive and critical element in this process is the staging of strategies, whether these are known or not or whose elaboration is necessary. From this perspective, specific skills involve strategies used or developed to face a new situation or adequately solve a problem.

Table 1

Capacities, components, subcomponents, and specific skills of critical thinking (Saiz, 2002).

Capacities	Components	Specific skills
Reasoning	*Deductive Reasoning*	Categorical Reasoning Propositional Reasoning
	Inductive Reasoning	Inductive generalizations Causal Reasoning Analogical Reasoning Hypothetical Reasoning
	Practical Reasoning	Method of analysis and argumentation (formalization skills, evaluation)
Problem solving	*Problem solving*	Strategies
Decision-making	*Decision-making*	Use of Heuristics Probabilities

Finally, a particular case of problem-solving is decision-making, and given its importance, it is considered a separate figure case. Evidently, in both cases, the management of uncertainty (Nieto, 2002b) and the good use of heuristics (Nieto, 2002a) are determinants. However, although decision-making is a particular case of problem-solving, it is argued that its particularity "is so essential and possesses such autonomy that it deserves a separate treatment" (Saiz & Rivas, 2008, p. 132).

One of the advantages of this conceptual proposal of critical thinking is that it allows organizing in a coherent and integrated manner the instruction of these skills and, on the other hand, provides a basal structure from which it is possible to rigorously assess each of the skills and the components in which they are regrouped (Saiz, 2017)

Based on this conceptual matrix, the PENCRISAL test has been developed (Fernández-Rivas *et al.*, 2014; Morales *et al.*, 2015; Rivas & Saiz, 2012; Saiz, 2007), which assesses each of these five skills through a series of everyday life situations. In this sense, one of the particularities and advantages of this test is that its situations are not formal but correspond to everyday life situations. On the other, the evaluation is not limited to identifying the correct answer among many others, as is the case of multiple-choice questions. Instead, this test is designed based on task analysis (Kirwan & Ainsworth, 1992) in such a way that the design of each situation anticipates the operations necessary to solve the problem correctly and, therefore, the production of the answer or the specific analysis that is demanded, evidences the use of the skills that are to be evaluated. It allows a more precise evaluation of the skill, avoiding the bias of the random response.

Motivation and critical thinking

Indeed, it is not enough to acquire and achieve a certain mastery in specific critical thinking skills; it is necessary to consider the motivational component that activates these skills and keeps them in execution (Tee *et al.*, 2018).

Although this component of critical thinking has traditionally been analyzed from the perspective of *dispositions*, this theoretical perspective has the significant disadvantage of not providing clues on how to intervene in its components since it does not provide a theoretical framework that accounts for how they are constituted, evolves or how they are susceptible to be modified (Valenzuela *et al.*, 2014). Therefore, we have chosen to analyze this critical thinking component from the theoretical framework of the psychology of motivation.

Motivation

Varied are the theoretical perspectives that attempt to account for what prompts people to choose a task, persist in it, or engage in a given activity (Cook & Artino, 2016). Some

stand out for their predictive capacity within this wide range of perspectives. In this line, the conceptualization that distinguishes intrinsic and extrinsic motivation (Cerasoli *et al.*, 2014; Ryan & Deci, 2017) is a theoretical approach that allows predicting academic performance to a good extent. However, such an approach has, on the contrary, the weakness that the scope for intervention, for example, at the school level, is very limited. This weakness also applies to other theoretical options, which, although they have several noteworthy aspects, do not provide more evident clues for intervention.

In this context, our view of motivation adheres to the expectancy-value theory proposed by Eccles and Wigfield (Eccles & Wigfield, 2020; Wigfield *et al.*, 2020), which holds that motivation is the resultant product of the two terms that give the model its name (Zhan *et al.*, 2021). The first of these components is the expectancy of a person to perform a task adequately. This notion of expectancy would be conceptually equivalent to the self-efficacy beliefs proposed by Bandura (Maddux, 2016; Vancouver *et al.*, 2018; Zhan *et al.*, 2021). The second component corresponds to the value assigned to the task, composed of four sub-components: interest, attainment, utility, and cost (Eccles & Wigfield, 2020; Wigfield & Eccles, 2020). Intrinsic interest accounts for the enjoyment of doing the task. This dimension takes up the contributions of Ryan and Deci (Ryan & Deci, 2017, 2020), who highlight the impact on the performance of intrinsic interest or valuation of the task (Ainley, 2017; Akkerman & Bakker, 2019; Silvia, 2006).

Similarly, the importance that the person assigns to the task (attainment) contributes to configuring its value based on the relationship established between it and the person's personal or identity project. For its part, the dimension related to task utility focuses on evaluating the extent to which a task is perceived to fit in with the subject's future plans. Finally, this model incorporates the cost dimension as the effort that one is willing to assume to perform the task (Neuville *et al.*, 2004), assuming that these always exist, whether linked to the task itself, to the loss of opportunities or the emotional cost (Barron & Hulleman, 2015; Flake *et al.*, 2015).

Although for Eccles and collaborators, the model was initially conceived to be applied to choice and achievement in a concrete domain (Wigfield & Eccles, 2020), applying this model to critical thinking implies going beyond the level of the concrete task. It implies placing it on a more specific level that allows it to account for a way of performing the task: operationally, through rigorous reasoning.

When faced with a problematic situation, the subject can choose to confront it using rigorous reasoning (more costly) or to utilize daily basis thinking (less costly) (Valenzuela *et al.*, 2011). In this sense, the subject who must make the decision can let the automatism of daily use act or choose to face the problem or situation more or less reflexively and rigorously.

The way of approaching these problematic situations would be determined by the person's motivation to think critically in a given situation. This motivation is determined by the person's perception of his or her ability to deal effectively with a given task (expectancy) and, on the other hand, the value attributed to thinking in a rigorous manner (utility, importance, interest, and cost). Thus, the motivation to think critically involves activating cognitive resources (such as attention, retrieval, or metacognitive processing). However, motivation goes beyond the decision: it also affects persistence in the task.

Hypothesis

Considering the above, we hypothesize that motivation for critical thinking should have a positive and significant association with critical thinking, regardless of the options for classifying skills and the method for assessing them. Specifically, we expect that against overall critical thinking scores, motivation evidences a statistically significant effect size (Dominguez Lara, 2017). On the other hand, when comparing this relationship with deductive and inductive reasoning, measured through two different evaluation systems, we expect the results to be similar *in both cases.*

Method

Participants

Two samples of students participated in the present study, with a total of 254 Spanish university students from two fourth-year Psychology cohorts, who were invited to participate voluntarily by being offered an academic reward consisting of additional points in their Psychology of Thought course at a Spanish state university. The sample was mainly female (93%), and its mean age was 21.2 years (sd= 0.89).

Instruments

Motivation toward critical thinking was assessed using the Motivational Scale for Critical Thinking - EMPC (Berger et al., 2020; Valenzuela et al., 2011). The EMPC, validated in Spanish and Latin American university students, is composed of 20 Likert-type items with a scale of 1 to 6. Five subscales are evaluated, which correspond to the dimensions proposed in the expectancy-value theory (Eccles & Wigfield, 2002; Wigfield & Gladstone, 2019). The scale shows high levels of reliability: expectancy (α=.774), utility (α=.790), attainment (α=.770), cost (α=.775), and interest (α=.724).

To assess critical thinking, we used two instruments: the traditional test with multiple-choice items, the CCTST, and another that incorporates production tasks, the PENCRISAL. The CCTST (Facione, 1990b) consists of 34 multiple-choice items and five subscales, measuring analysis, evaluation, inference, deduction, and induction scales. The test has been validated in its Spanish version, and its manual reports a reliability level in the range of α=.68 -.71 (Facione, 1995). The second test used to evaluate critical thinking was the PENCRISAL (Rodríguez, 2008; Saiz, 2007), which, unlike the CCTST, evaluates critical thinking through a series of everyday life situations (35), where the person must produce (write) an evaluation of the correctness, soundness or relevance of reasoning, make a decision or solve a problem, and always justifying his or her answer. The psychometric characteristics are reported in detail in Rodríguez (2008), and in the case of this study, this test had an average reliability of α=.68.

Procedures

The CCTST was administered in a pen-and-paper mode in a single group session under the supervision of two researchers with an average duration of 30 minutes. On the other hand, the EMPC and the PENCRISAL were taken individually and digitally through online survey software. The students could enter the server via identification as often as they considered necessary, allowing them to gain access from where they had left off in the previous session. This strategy prevented them from correcting the answers they had already given. This modality was used in the case of the PENCRISAL, a test that, due to its length, if taken in one sitting, could affect performance in the final items. On the contrary, given its brevity, in the case of the EMPC, almost all the participants answered it in a single session of 10 to 15 minutes.

Results

a multiple regression analysis was performed to test the effect of motivation on critical thinking performance. The global critical thinking score was measured as dependent variables through the PENCRISAL and the CCTST. Independents variables considered motivation through the four components of value (Attainment, Utility, Cost, and Interest) and expectancy. In all cases, we used the adjusted regression coefficient (R^2_{adj}) as an indicator of the variance explained.

The results (see Table 2) show that in both cases, motivation explains, in a statistically significant way, the variance in critical thinking both in the case of the PENCRISAL (R^2_{adj}=.173; p<.001) and the CCTST (R^2_{adj}=.080; p=.013). Also, the component of

motivation that contributes most significantly to explaining this variability in critical thinking performance is expectancy.

In the case of the PENCRISAL, motivation explains 7.2% of the variance (p<.002), while in the case of the CCTST, it reaches 6.8% (*p*=.002). However, it should be noted that in the case of PENCRISAL, together with expectation, the perceived importance of the task appears as a significant factor, an element which, together with expectation, explains 16.9% of the variance.

Table 2
Regression coefficients between motivation and critical thinking

	R	**R^2**	**R^2_{adj}**	**SE**	**Sig.**
Critical Thinking (PENCRISAL)					
Motivation	.46	.21	.17	0.17	.000
Expectancy	.28	.08	.07	0.19	.002
Expectancy/Attainment	.43	.18	.17	0.18	.000
Critical Thinking(CCTST)					
Motivation	.35	.12	.08	3.60	.013
Expectancy	.28	.08	.07	3.58	.002

Note. Motivation= Expectancy x Task Value

Analogous to the previous analysis, we wanted to analyze to what extent motivation and its components explain the variance of each thinking skill. Given that there is only a partial coincidence between both tests, we will first account for those two common subscales (deduction and induction) and then for the rest of the subscales of the PENCRISAL and the CCTST.

Concerning the explanatory capacity of motivation in the deduction tasks, we observed that the components of motivation as a whole explain 12.9% (p<.001) of the variance, while in the case of the CCTST, although the contribution is slightly lower (8.6%; p=.013), it is also significant. In the case of deductive reasoning, we observed that expectation is the component that in both tests contributes most significantly to the explanation of variance: PENCRISAL, R^2_{adj} =.082; p<.001 y CCTST, R^2_{adj} =.099; p<.001.

In the case of induction, the explanatory capacity of motivation varies significantly depending on the critical thinking test used. In the case of the PENCRISAL (see Table 3), motivation explains non-significantly, barely 0.2% (p=.383). In contrast, in the CCTST (see Table 4), even though the motivation components as a whole also fail to explain the

variance of inductive reasoning significantly, R^2_{adj}=.035; p=.108, the interest component does contribute a significant degree of determination, R^2_{adj}=.052; p=.007.

Table 3

Regression coefficients between motivation and specific critical thinking skills (PENCRISAL)

	R	**R^2**	**R^2_{Adj}**	**S. E**	**Sig.**
PENCRISAL - *Deduction*					
Motivation	.40	.16	.13	0.38	.001
Expectancy	.30	.09	.08	0.39	.001
Expectancy +Utility	.38	.15	.13	0.38	.001
PENCRISAL - *Induction*					
Motivation	.19	.04	.00	0.19	.383
PENCRISAL - *Practical Reasoning*					
Motivation	.20	.04	.00	0.37	.354
PENCRISAL – *Decision-making*					
Motivation	.28	.08	.05	0.25	.036
PENCRISAL – *Problem solving*					
Motivation	.26	.07	.03	0.28	.079
Utility	.20	.04	.04	0.28	.039

Note. Motivation= Expectancy x Task Value

The other subscales of the PENCRISAL (see Table 3) show no significant effects of motivation as a whole are observed on practical reasoning, R^2_{adj}=.04; p=.354 nor on the problem-solving subscale, R^2_{adj}=.034; p<.079. However, in this last subscale, the utility component appears with a significant contribution, R^2_{adj}=.035; p<.039. Finally, the decision-making subscale of the PENCRISAL appears significantly explained by motivation as a whole, R^2_{adj}=.046; p=.036.

In the case of the subscales proposed by the CCTST, it is observed that the set of motivation components does not significantly explain the variance of the subscales *evaluation*, R^2_{adj}=.091; p=.053, and *inference*, R^2_{adj}=.026; p=.156. Nevertheless, similar to what happens with some subscales of the PENCRISAL, some components of motivation significantly predict the CCTST subscales. In the case of *the evaluation* subscale, the predictors are Interest and Cost, R^2_{adj}=.064; p=.008; and *the inference* subscale is predicted by Expectancy R^2_{adj}=.036; p=.022.

Table 4

Regression coefficients between motivation and specific critical thinking skills (CCTST).

	R	R^2	R^2_{Adj}	S. E	Sig.
CCTST- *Deduction*					
Motivation	.35	.13	.09	2.44	.009
Expectancy	.33	.11	.10	2.42	.000
CCTST- Induction					
Motivation	.28	.08	.04	1.65	.108
Interest	.25	.06	.05	1.64	.007
CCTST- *Analysis*					
Motivation	.32	.10	.06	1.49	.036
Expectancy	.29	.09	.08	1,47	.001
CCTST- *Evaluation*					
Motivation	.30	.09	.05	2.026	.053
Interest	.22	.05	.04	2.037	.016
Interest + Cost	.28	.08	.06	2.012	.008
CCTST- *Inference*					
Motivation	.26	.07	,03	1,507	.156
Expectancy	.21	.04	,04	1,499	.022

Note. Motivation= Expectancy x Task Value

Discussion

Although there are different ways of conceptualizing and classifying the skills that would be part of critical thinking, there is consensus that performance in these tasks would depend on the mastery of these skills and also on a motivational component that would act as an activator of these skills (Ennis, 1962; Perkins & Tishman, 2001; Valenzuela *et al.*, 2014). The results show that motivation would significantly explain critical thinking performance, ranging from 8% to 17%, depending on how critical thinking is measured. In this framework, one of the most important motivational components to explain critical thinking performance is expectancy.

It is striking that, together with expectancy, the second-best motivational predictor in the case of PENCRISAL is the utility component (i.e., the benefit that people perceive from thinking critically), while in the CCTST, it is the interest component (i.e., the liking for performing certain tasks). The explanation for this difference could be due to how the different skills (and subsequent subscales) are conceptualized in each theoretical perspective. A possible explanation is that the CCTST focuses its assessment on reasoning skills (analysis, evaluation, inference, deduction, and induction). At the same time, PENCRISAL incorporates more practical dimensions such as decision-making and problem-solving (Morales *et al.*, 2015).

Another explanation for the differences observed in the components of motivation that predict critical thinking is the methodological options of both tests. While in the CCTST, a response of interpretative-logical recognition of the situation is requested from closed alternatives (of the type: conclusion X: a) could not be false; b) is probably true, but may be false; c) is probably false, but may be true; d) could not be true), in the PENCRISAL the statement corresponds to a situation of daily life and where a response is requested that implies the elaboration of an argued idea, but which has been designed taking into account the methodology of task analysis. According to this approach, as stated by Kirwan and Ainsworth (1992), problems are posed in such a way as to anticipate the operations that the person performing them needs to apply to solve them correctly (Rodríguez, 2008). From this perspective, it would seem that the tasks demanded by PENCRISAL would have a more contextualized and operative character, so it would be reasonable to expect a higher incidence of utility. On the contrary, the tasks proposed by the CCTST, given their characteristics more distant from a concrete situation and closer to logical analysis, would reduce the usefulness incidence and allow the interest component to have a more significant impact.

At the methodological level, it should be noted that our option of measuring motivation for critical thinking as the set of the four components of the value plus the expectation and not as expectation plus the aggregate score of the value has the disadvantage that as the number of variables increases, the adjusted R2 decreases due to the loss of degrees of freedom, sometimes causing two variables to explain more than the set. Nevertheless, it seemed better to maintain homogeneity in the measure and, through disaggregated analysis, to be able to examine, with more precision, what are the most influential elements.

The lack of agreement on an operative concept of critical thinking and the different methodological options for measuring these skills make it challenging to make a more precise estimate of the extent to which motivation would influence critical thinking performance since the results would depend on what is understood by critical thinking and the methodological options chosen. Nevertheless, regardless of the instrument used, that is, of the theoretical and methodological differences involved, motivation clearly contributes

significantly to the explanation of performance in critical thinking tasks. This implies that motivation should be considered an intervening variable if we want a more accurate approach to explaining critical thinking performance, as suggested by recent research (Nahdiyah *et al.*, 2020). Similarly, any intervention device that promotes the development of critical thinking cannot be restricted to teaching such skills but must incorporate the motivational variable as a determining factor for the success of the intervention. Thus, it is suggested that interventions that promote this complex skill consider motivation at the beginning and during the intervention program as a triggering factor of the skill and as a mechanism to maintain the level of achievement to develop critical thinking skills effectively.

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