



Tesis doctoral por compendio de publicaciones

Los efectos pragmáticos del pensamiento crítico: un modelo explicativo para potenciar el
desarrollo académico y socioemocional

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Dedicatoria

A mi madre, quien fue la primera en intuir en mí lo que yo apenas comenzaba a soñar.

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quebrado de mí mismo.

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Autorización de los directores para la presentación en formato por compendio de publicaciones

El Dr. D. Carlos Saiz Sánchez, Profesor Titular de Universidad, y la Dra. Dña. Silvia Fernández Rivas, Profesora Permanente Laboral, ambos del Departamento de Psicología Básica, Psicobiología y Metodología de las Ciencias del Comportamiento de la Universidad de Salamanca,

CERTIFICAN:

Que el presente trabajo de investigación titulado “*Los efectos pragmáticos del pensamiento crítico: un modelo explicativo para potenciar el desarrollo académico y socioemocional*” constituye el trabajo de investigación que, bajo nuestra dirección, ha realizado D. Miguel Hernando Guamanga Anaconas para optar al grado de Doctor por la Universidad de Salamanca.

La presente tesis doctoral se presenta en la modalidad de *Tesis por Compendio de Artículos*.

Para que así conste, y tenga los efectos oportunos, firmamos este certificado en Salamanca, a siete de abril de 2025.

Dr. D. Carlos Saiz

Dra. D.^a Silvia F. Rivas

Tesis doctoral por compendio de publicaciones

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A continuación, se referencian las publicaciones incluidas en la presente Tesis Doctoral:

1. Guamanga, M. H., González, F. A., Saiz, C., & Rivas, S. F. (2023). Critical Thinking: The ARDESOS-DIAPROVE Program in Dialogue with the Inference to the Best and Only Explanation. *Journal of Intelligence*, 11(12), 226. <https://doi.org/10.3390/jintelligence11120226>

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Todas las publicaciones han sido desarrolladas en el marco del plan de investigación del doctorando y han sido aceptadas en revistas científicas especializadas del área de la Psicología y Educación. El doctorando figura como primer autor en las tres publicaciones, cumpliendo así con los requisitos establecidos para esta modalidad de tesis doctoral.

RENUNCIA EXPRESA A LA UTILIZACIÓN DEL ARTÍCULO COMO PARTE DE
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Fabián Andrés González López

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Resumen

Esta tesis concibe el pensamiento crítico (PC) como una competencia que se compone de habilidades cognitivas avanzadas, disposiciones, conocimientos y acciones con efectos significativos sobre el rendimiento académico, el bienestar psicológico y la empatía. Como concepto operativo, se propone una reconfiguración teórica que sitúa la explicación —y no únicamente la argumentación— como núcleo del razonamiento crítico, en coherencia con el modelo de la inferencia a la mejor y única explicación. A partir de la reconceptualización se fundamenta el modelo ARDESOS-DIAPROVE, concebido como una propuesta pedagógica orientada al desarrollo del PC.

El trabajo académico está conformado por tres artículos. El primero presenta el modelo teórico y lo fundamenta epistemológicamente desde la filosofía de la ciencia. El segundo evalúa, mediante análisis de regresión lineal, el impacto del PC y del bienestar psicológico en el rendimiento académico. El tercero valida un modelo que destaca el papel de la metacognición como variable interviniente entre el PC y las dimensiones socioemocionales. Los resultados empíricos muestran que el PC tiene un efecto positivo sobre la metacognición, y que esta se asocia significativamente con la empatía y con dimensiones eudaimónicas del bienestar como la autoaceptación, el propósito vital y el dominio del entorno.

En conjunto, los hallazgos permiten concluir que el PC, cuando se desarrolla desde un enfoque explicativo y orientado a la acción, es una competencia clave en los procesos de intervención educativa con efectos verificables en el plano académico y personal.

Abstract

This dissertation conceptualizes critical thinking (CT) as a competence composed of advanced cognitive skills, dispositions, knowledge, and actions, with significant effects on academic performance, psychological well-being, and empathy. As an operative concept, it proposes a theoretical reconfiguration that places explanation—rather than argumentation—at the core of critical reasoning, in alignment with the model of inference to the best and only explanation. Based on this reconceptualization, the ARDESOS-DIAPROVE model is established as a pedagogical proposal aimed at fostering CT.

The academic work comprises three articles. The first presents the theoretical model and grounds it epistemologically in the philosophy of science. The second assesses, through linear regression analysis, the impact of CT and psychological well-being on academic performance. The third validates a model that highlights the role of metacognition as an intervening variable between CT and socioemotional dimensions. The empirical results indicate that CT has a positive effect on metacognition, which in turn is significantly associated with empathy and with eudaimonic dimensions of well-being such as self-acceptance, purpose in life, and environmental mastery.

Taken together, the findings support the conclusion that CT, when developed through an explanatory and action-oriented approach, constitutes a key competence in educational intervention processes, with verifiable effects on both academic and personal development.

Introducción

El pensamiento crítico (PC) se ha consolidado como una competencia clave para afrontar los desafíos del siglo XXI, tanto en el ámbito académico como en el social (Atanasiu, 2021; Facione, 1990; Halpern & Dunn, 2023). Su desarrollo exige una comprensión que trascienda las habilidades analíticas e incorpore dimensiones disposicionales, emocionales y pragmáticas (Brookfield, 2007; Dwyer, 2017; Ennis, 2015). La literatura especializada ha planteado tres grandes enfoques para su estudio: el filosófico, centrado en su definición y fundamento epistemológico; el educativo, orientado a su enseñanza y evaluación; y el social, que analiza su papel en la formación de sujetos críticos capaces de intervenir en su contexto (Barnett, 1997; Gallo, 1989; McLaren, 1994; Walters, 1994).

Reducir el PC a un solo enfoque implica limitar su potencial transformador. Por esta razón, esta investigación propone considerar sus componentes de habilidades cognitivas avanzadas, disposicionales, actitudinales, emocionales y pragmáticas como elementos interdependientes de una misma arquitectura conceptual. La integración permite entenderlo no solo como una competencia educativa, sino como una práctica orientada a la acción, con impacto demostrable, por ejemplo, en el bienestar psicológico, la empatía y el rendimiento académico.

A pesar del reconocimiento del PC como una competencia transversal en la educación superior, persisten, por un lado, algunos vacíos teóricos y prácticos sobre cómo promoverlo de forma eficaz y transferible (Abrami et al., 2008; Dwyer, 2017; Halpern & Dunn, 2023; Rivas & Saiz, 2023). Por otro lado, si bien existen avances investigativos relevantes sobre la relación del PC con el rendimiento académico (Butler et al., 2017; Rivas et al., 2023), la inteligencia emocional (Burrus et al., 2012; Guerra-Bustamante et al., 2019) y, más recientemente, con la

empatía y el bienestar (Martingano & Konrath, 2022; Zhao et al., 2024), algunos de estos estudios no siempre abordan la complejidad de las relaciones en modelos que permitan evaluar sus efectos de un modo integrado. Una de las razones principales que explica esta dificultad es la fragmentación que aún persiste en la caracterización del PC.

La tradición discursiva sobre el PC lo caracteriza como un proceso reflexivo, intencional y autorregulado que tiene como protagonistas al análisis, la evaluación y la inferencia junto a una serie extensas de disposiciones (Facione, 1990; Ennis, 2015). En trabajos especializados como los desarrollados por Halpern (1998), Dwyer (2017), Saiz (2020) y Halpern y Dunn (2023), se enfatiza que la práctica del PC no se reduce a lo cognitivo: exige una disposición activa a cuestionar supuestos, considerar diversas perspectivas y persistir en el esfuerzo intelectual, rasgos que si no están presentes pueden bloquear el desarrollo de las habilidades o desvirtuar su alcance. Lo que implica un equilibrio entre habilidades y disposiciones en función de la acción, y esta última como juez imparcial del resultado. Esta conjunción que recopila una larga tradición filosófica, psicológica y educativa posibilita caracterizar también al PC como una teoría de la acción orientada a la solución eficaz de problemas y la toma de decisiones acertadas, tanto en el ámbito académico como en el social.

A partir de la tradición, sus implicaciones explícitas y en especial por su fundamentación epistemológica, se seleccionó el programa ARDESOS-DIAPROVE como eje del modelo teórico y marco curricular para realizar la investigación empírica. El programa asume que el PC debe ser desarrollado mediante estrategias pedagógicas directas e intencionadas que fortalezcan el análisis profundo a partir de la observación, la inferencia causal y la verificación empírica como criterio de una evaluación crítica de la información (Rivas & Saiz, 2023). En este marco, la

metacognición funciona como un andamiaje clave que regula, planifica y ajusta las habilidades del PC para materializar el esfuerzo cognitivo en soluciones eficaces y decisiones acertadas (Rivas et al., 2023; Schraw & Moshman, 1995).

Desde esta perspectiva, la presente investigación parte de la premisa de que el PC cuando se desarrolla a través de una metodología explicativa, focalizada en el aprendizaje basado en problemas (Abrami et al., 2008, 2015; Morales et al., 2015) y orientada a la acción (Lipton, 2003; Saiz, 2020), incide significativamente en el rendimiento académico, el bienestar psicológico y la empatía. Estas dimensiones vinculadas se asumen como fundamentales para la formación integral del sujeto, tanto en el plano individual como en el colectivo. Así concebido, el PC trasciende el plano cognitivo y se aproxima a ser una teoría de la acción con efectos medibles en contextos educativos y sociales (Saiz, 2020).

Objetivos

Objetivo general

Analizar el impacto del pensamiento crítico, entendido como un sistema explicativo orientado a la acción, sobre variables cognitivas y socioemocionales relevantes en el ámbito educativo, y validar empíricamente un modelo de intervención que permita desarrollar esta competencia de forma eficaz y transferible.

Objetivos específicos

Fundamentar epistemológicamente un programa de intervención en pensamiento crítico desde el modelo de la inferencia a la mejor y única explicación, con el propósito de establecer vínculos conceptuales entre la filosofía de la ciencia y la pedagogía.

Evaluar empíricamente la relación entre pensamiento crítico, bienestar psicológico y rendimiento académico, mediante una intervención formativa aplicada a estudiantes universitarios.

Examinar el papel de la metacognición en la relación entre pensamiento crítico y variables socioemocionales, especialmente la empatía y el bienestar psicológico, a través de un modelo de ecuaciones estructurales (SEM).

Hipótesis

El pensamiento crítico, cuando es desarrollado mediante un enfoque explicativo y orientado a la solución de problemas, incide de forma significativa sobre el rendimiento académico, el bienestar psicológico y la empatía, y encuentra en la metacognición un mecanismo mediador esencial para la integración de sus dimensiones cognitivas y socioemocionales.

Hipótesis específicas

El pensamiento crítico desarrollado mediante instrucción estructurada (intencionada y explícita) y orientada a la resolución de problemas tiene un efecto directo, positivo y estadísticamente significativo sobre el rendimiento académico en estudiantes universitarios.

El pensamiento crítico tiene un efecto directo y significativo sobre la metacognición, la cual, a su vez, presenta efectos directos y positivos sobre dimensiones específicas del bienestar psicológico y sobre la empatía, entendida como una competencia multidimensional que integra la toma de perspectiva, la comprensión racional de los estados mentales ajenos y una respuesta adecuada a ellos.

Método

Los materiales y métodos utilizados en este trabajo doctoral se encuentran descritos en los artículos que conforman el compendio. El primer estudio diseña un modelo teórico del pensamiento crítico y ofrece una fundamentación epistemológica a través de la inferencia a la mejor explicación. La propuesta sintetiza los aportes de la filosofía, la psicología y la educación para delimitar una concepción del pensamiento crítico como sistema explicativo orientado a la acción. El segundo estudio analiza la relación entre el pensamiento crítico, el bienestar psicológico y el rendimiento académico en estudiantes universitarios, y utiliza análisis de regresión lineal para estimar la varianza explicada por dichas variables. El tercer estudio examina las relaciones entre pensamiento crítico, metacognición y empatía en población universitaria, a partir de un modelo de ecuaciones estructurales (SEM). Cada uno de los artículos presenta de manera detallada el diseño metodológico, las características de las muestras, los instrumentos aplicados, los procedimientos seguidos y las técnicas de análisis empleadas.

Presentación de los trabajos que componen la tesis

La tesis es la recopilación tres estudios complementarios, cada uno con un enfoque específico que contribuye a la construcción de una visión integrada del pensamiento crítico (PC). El primer artículo ofrece una fundamentación epistemológica para un programa de intervención en PC basado en el modelo de la inferencia a la mejor y única explicación, con el objetivo de diseñar un marco teórico sólido sustentado en la filosofía de la ciencia. El segundo artículo, de carácter empírico, examina la relación entre PC, bienestar psicológico y rendimiento académico, con el propósito de poner a prueba el modelo teórico propuesto. Finalmente, el tercer artículo analiza mediante un modelo de ecuaciones estructurales (SEM) el papel de la metacognición en la relación entre el PC y variables socioemocionales como la empatía y el bienestar psicológico.

En conjunto, estos tres estudios convergen en la idea de que el PC no puede entenderse como una habilidad exclusivamente académica y aislada del contexto, sino como un sistema complejo de razonamiento orientado a la comprensión profunda del entorno, la toma de decisiones acertadas y la resolución eficaz de problemas. Sus efectos, tal como se evidencia en los hallazgos obtenidos, son medibles tanto en el plano cognitivo como en el socioemocional, lo que refuerza su valor formativo integral.

En este sentido, este apartado se organiza en cuatro secciones. En primer lugar, se presenta una síntesis de los tres artículos que componen esta tesis; con esto se destaca el hilo teórico y empírico, así como las contribuciones conceptuales, metodológicas y pedagógicas que emergen de su convergencia. En segundo lugar, se analizan las implicaciones teóricas y prácticas del modelo de PC desarrollado a partir de su potencial para enriquecer la formación académica y socioemocional en distintos contextos. En tercer lugar, se discuten las limitaciones del trabajo,

tanto en su diseño como en su alcance, y se plantean líneas de investigación futuras que podrían fortalecer y ampliar sus aportes. Finalmente, se formulan una serie de recomendaciones dirigidas a los responsables de políticas educativas y a la comunidad académica en general, con el propósito de promover una formación crítica en los estudiantes.

La inferencia a la mejor y única explicación como fundamento del pensamiento crítico

El primer artículo sostiene que pensar críticamente no consiste únicamente en argumentar con solidez, sino en desarrollar una capacidad explicativa rigurosa que permita orientar el pensamiento hacia la acción eficaz. A partir de este planteamiento, se propone que la inferencia a la mejor y única explicación ofrece un andamiaje epistémico potente para diseñar programas de intervención en PC. En particular, se presenta el modelo ARDESOS-DIAPROVE como una propuesta pedagógica que se nutre de este marco teórico y que persigue una transformación en la manera de concebir el PC, desplazándolo de un enfoque argumentativo centrado en la forma a uno explicativo centrado en la resolución de problemas reales.

El enfoque se apoya en una revisión crítica de la literatura sobre programas de intervención en PC y en el análisis de aquellos que han logrado evidencias sólidas en términos de transferencia, permanencia y eficacia (Saiz, 2024). A partir de esta revisión, se argumenta que las habilidades cognitivas avanzadas asociadas al PC—como la inferencia, la explicación, la evaluación, la autorregulación y la argumentación—deben ser trabajadas no como fines en sí mismos, sino como medios para enfrentar con éxito situaciones complejas en contextos reales. El artículo subraya que estas habilidades deben ser comprendidas y desarrolladas desde un enfoque operacional, empírico y orientado a la acción, y no permanecer circunscritas a ejercicios abstractos o exclusivamente académicos.

Uno de los aportes clave del artículo es la defensa del papel central de la explicación en la estructura del PC. Se argumenta que poner el énfasis en la explicación, más que en la argumentación, permite conectar el PC con demandas concretas del entorno laboral y social, tales como la adaptabilidad cognitiva, la resolución eficaz de problemas y la toma de decisiones. En este marco, la argumentación no desaparece ni es sustituida, sino que se reubica como una herramienta que sustenta las explicaciones construidas; de este modo, se priorizan las elecciones inferenciales a partir de diagnósticos bien formulados, análisis de causas y evaluación de consecuencias.

El modelo teórico propuesto encuentra afinidades conceptuales con la inferencia holmesiana, formulada por Alexander Bird (2007), así como con la tradición de la explicación científica desarrollada por autores como Salmon (1984) y Lipton (2003). Ambas perspectivas coinciden en destacar la necesidad de construir explicaciones causales, coherentes, parsimoniosas y empíricamente contrastables, cualidades que también deben caracterizar el razonamiento crítico aplicado a problemas personales, profesionales y sociales. La confluencia entre el PC y la epistemología de la ciencia fortalece la coherencia interna del programa, al tiempo que ofrece una base sólida para su aplicación educativa.

Desde el plano teórico, el artículo propone una caracterización renovada del PC como una práctica de razonamiento centrada en la búsqueda de la mejor explicación, en lugar de limitarlo a la producción de argumentos. Esta impronta permite establecer un puente entre el razonamiento práctico, propio de contextos cotidianos, y los estándares epistémicos de la explicación científica, lo cual refuerza la coherencia entre la teoría y la práctica educativa. En

este sentido, se promueve una visión del PC que se aleja de los ejercicios retóricos o normativos, y se orienta hacia la comprensión profunda de los fenómenos y la solución de problemas.

En el plano práctico, se destaca que el programa ARDESOS-DIAPROVE, al integrar procedimientos como el diagnóstico, el pronóstico y la verificación, constituye un modelo de intervención coherente con los estándares epistémicos que sustentan la explicación científica. La estructura le otorga un potencial de transferencia más allá del ámbito académico, especialmente hacia contextos laborales o profesionales donde la toma de decisiones se fundamenta en la interpretación adecuada de datos, la construcción de hipótesis plausibles y la evaluación crítica de alternativas.

No obstante, el estudio presenta ciertas limitaciones que deben ser reconocidas. El énfasis en la explicación podría ser interpretado erróneamente como una desvalorización de la argumentación, lo cual no representa la intención del programa. Por el contrario, se propone una jerarquía entre ambas habilidades: la argumentación se pone al servicio del proceso explicativo. Además, el modelo teórico que se decanta del programa, aunque sólidamente fundamentado, requiere ser validado empíricamente en dominios no académicos para comprobar su aplicabilidad en escenarios reales de toma de decisiones y resolución de problemas.

Con base en estas consideraciones, se plantean varias líneas de investigación que pueden ampliar el alcance del programa. Una primera línea consiste en desarrollar estudios comparativos entre intervenciones que se centren en distintas habilidades cognitivas, como la argumentación o la explicación, y analizar su impacto en contextos laborales o profesionales. Una segunda línea apunta al diseño de investigaciones longitudinales que examinen si la inferencia a la mejor

explicación produce mejoras sostenidas en la toma de decisiones y en la resolución eficaz de problemas.

El bienestar psicológico y el rendimiento académico desde el prisma del pensamiento crítico

El objetivo del segundo artículo era examinar empíricamente el impacto del PC, conceptualizado bajo el modelo teórico desarrollado en el primer estudio, sobre dos variables clave para el desarrollo estudiantil: el bienestar psicológico y el rendimiento académico. Hemos partido del supuesto de que las habilidades cognitivas avanzadas —como el análisis profundo, la inferencia explicativa y la evaluación crítica —contribuyen al desempeño académico y pueden potenciar dimensiones fundamentales del bienestar psicológico. En concordancia con este lineamiento, se diseñó una intervención basada en el programa ARDESOS-DIAPROVE. La intervención fue implementada bajo un diseño pre y posttest con estudiantes universitarios, con el fin de operacionalizar el PC como un proceso intencional, sistemático y orientado a la resolución eficaz de problemas reales.

Los resultados del análisis estadístico permitieron confirmar parcialmente la hipótesis formulada. En términos específicos, se encontró que el PC tiene un efecto significativamente mayor sobre el rendimiento académico ($\beta = .47$) que el bienestar psicológico ($\beta = .27$). La diferencia sugiere que el desarrollo del PC incide positivamente en el rendimiento de los estudiantes, lo que valida el valor instrumental de estas habilidades en el contexto educativo. Sin embargo, no se observó una correlación directa entre PC y bienestar psicológico, lo que abre la posibilidad de que dicha relación esté mediada por otros factores que no fueron considerados en este estudio, como la metacognición, la autorregulación emocional o las competencias interpersonales.

Desde una perspectiva teórica, estos hallazgos refuerzan la idea de que el PC puede contribuir al bienestar personal en la medida en que permite al sujeto evaluar sus experiencias, generar soluciones realistas a los problemas vitales y tomar decisiones coherentes con sus propósitos. No obstante, esta influencia no parece ser directa ni inmediata, sino dependiente de procesos intermedios que requieren mayor desarrollo empírico y conceptual. En consecuencia, se plantea que una arquitectura explicativa más robusta debe integrar dimensiones cognitivas, metacognitivas y afectivas para comprender plenamente el alcance del PC en la esfera personal.

En el plano práctico, se concluye que los programas de intervención en PC deben diseñarse con una orientación más explícita hacia contextos de vida relevantes para el estudiante. Superar el enfoque puramente académico exige incorporar metodologías activas como el aprendizaje basado en problemas (ABP), que sitúan el razonamiento en escenarios auténticos y promueven la integración entre el componente cognitivo y el afectivo. Este tipo de abordaje permite que las habilidades desarrolladas se traduzcan en mejoras académicas y en formas más eficaces de afrontamiento y autorregulación.

A pesar de los aportes, este estudio presenta limitaciones que deben ser reconocidas. La medición del bienestar psicológico se basó exclusivamente en autoinformes, lo cual introduce el riesgo de sesgos asociados a la deseabilidad social y a la variabilidad emocional del momento en que se aplica la prueba. Asimismo, el diseño transversal adoptado no permite analizar los efectos a largo plazo ni la posible transferencia sostenida de las habilidades trabajadas hacia otros contextos vitales.

Las limitaciones abren diversas líneas de investigación futura. Una de las más relevante es la realización de estudios longitudinales que permitan observar la evolución del bienestar

psicológico en relación con el desarrollo progresivo del PC. También se hace necesaria la inclusión de variables mediadoras, como la metacognición o la motivación intrínseca, que podrían contribuir a una explicación más precisa de la relación entre PC y bienestar. Finalmente, se propone estudiar con mayor profundidad el papel de la cultura estudiantil como variable contextual que condiciona la forma en que los estudiantes perciben y valoran las habilidades cognitivas, en función de su etapa formativa y de las demandas que enfrentan en su trayectoria académica.

En síntesis, este segundo estudio reafirma el PC como un predictor sólido del rendimiento académico, pero al mismo tiempo pone de manifiesto la complejidad de su relación con el bienestar psicológico. La intervención demostró ser eficaz para mejorar el desempeño académico, pero su impacto sobre el desarrollo personal requiere una base teórica y metodológica más robusta, capaz de incorporar factores socioemocionales y contextuales en el diseño curricular y en las estrategias pedagógicas orientadas a la formación integral del estudiante.

La metacognición como puente clave entre el pensamiento crítico, la empatía y el bienestar psicológico

El tercer artículo surge como respuesta directa a una de las limitaciones detectadas en el segundo estudio: la ausencia de una relación estadísticamente significativa entre PC y bienestar psicológico. Para abordar esta brecha, se formuló un modelo teórico y empírico en el que la metacognición cumple un rol mediador entre el PC y dos dimensiones fundamentales del desarrollo socioemocional: el bienestar psicológico y la empatía. La hipótesis central consistió en demostrar que la metacognición no solo está asociada al PC como una habilidad complementaria,

sino que constituye un puente estructural entre los procesos cognitivos superiores y las competencias socioemocionales.

Desde el punto de vista teórico, el estudio se sustentó en la distinción clásica planteada por Flavell entre conocimiento metacognitivo y regulación metacognitiva. El primero hace referencia a lo que el individuo sabe sobre su propio pensamiento, mientras que el segundo alude a la capacidad para planificar, supervisar, regular y evaluar dicho pensamiento en función de una tarea o problema específico. Desde esta base conceptual, se diseñó un modelo de ecuaciones estructurales que establecía una relación directa entre PC y metacognición, así como relaciones entre la metacognición y las variables afectivas de interés: empatía y bienestar psicológico.

Para evaluar empíricamente este modelo, se trabajó con una muestra de estudiantes universitarios ($n = 156$), quienes participaron en una intervención basada en el programa ARDESOS-DIAPROVE. La medición se realizó a través de tres instrumentos validados y de amplio reconocimiento académico que evalúan estos constructos. El análisis mediante ecuaciones estructurales (SEM) confirmó la validez del modelo teórico propuesto y arrojó resultados empíricamente significativos. Específicamente, se encontró un efecto directo positivo del PC sobre la metacognición ($\beta = .35, p = .003$), lo que indica que el desarrollo de habilidades cognitivas avanzadas fortalece los procesos de planificación, monitoreo y evaluación del pensamiento. A su vez, la metacognición mostró un efecto robusto sobre el bienestar psicológico ($\beta = .71, p < .001$) y sobre la empatía ($\beta = .64, p < .001$), lo que permite sostener que las habilidades de autorregulación del pensamiento inciden de manera significativa en dimensiones socioemocionales clave para el desarrollo personal. Los hallazgos empíricos fortalecen la hipótesis central del estudio, en la que se plantea que la metacognición constituye un puente

fundamental entre las capacidades cognitivas superiores y las competencias afectivas de orden interpersonal e intrapersonal.

Los resultados permiten sostener que el PC, cuando se trabaja a través de procesos sistemáticos e instrucción deliberada, tiene un impacto directo en la metacognición, y que esta, a su vez, influye significativamente en el desarrollo de dimensiones socioemocionales clave. Tal como se planteó en el modelo, la metacognición cumple un papel central que explica cómo el razonamiento crítico incide en la forma en que los sujetos se comprenden a sí mismos y se relacionan con los demás. El hallazgo adquiere mayor relevancia si se tiene en cuenta que la empatía fue abordada desde un enfoque amplio, incluyendo sus dimensiones cognitivas, afectivas y conductuales, y que el bienestar psicológico se evaluó a partir de componentes fundamentales como la autoaceptación, el propósito de vida y el dominio del entorno, en concordancia con el modelo propuesto por Ryff.

Desde una perspectiva pedagógica, los datos aportan evidencia sólida para afirmar que la instrucción estructurada en PC, cuando incorpora procesos metacognitivos y metodologías activas (ABP), puede generar efectos formativos más allá del ámbito cognitivo. La mejora en habilidades como la planificación, el monitoreo, la evaluación del propio pensamiento y la autorregulación emocional se traduce en una mayor capacidad para tomar decisiones conscientes, resolver conflictos interpersonales y afrontar con flexibilidad situaciones complejas. La metacognición, en este sentido, actúa como un mecanismo de integración que conecta los productos del razonamiento crítico con los comportamientos prosociales y las disposiciones personales hacia el bienestar.

Desde la perspectiva práctica, los hallazgos invitan a replantear el diseño de programas de formación en PC. Más allá de centrarse en habilidades como el análisis o la argumentación, se propone incorporar explícitamente objetivos de desarrollo metacognitivo, trabajando secuencias didácticas que promuevan la planificación, el monitoreo, la depuración y la evaluación del pensamiento. Asimismo, se sugiere que los contextos de aplicación incluyan dilemas morales, problemas interpersonales y situaciones que exijan toma de perspectiva, de modo que el PC pueda operar en escenarios que requieran la practicidad del empatía.

Como toda investigación empírica, este estudio presenta algunas limitaciones. Aunque el tamaño de la muestra fue suficiente para realizar el análisis SEM, no permite generalizar con seguridad los resultados a poblaciones más amplias o diversos contextos socioculturales. Además, el uso de autoinformes para medir la empatía y el bienestar psicológico introduce sesgos inevitables, a pesar del uso de instrumentos validados. Finalmente, el diseño transversal del estudio impide conocer la sostenibilidad de los efectos observados a largo plazo, por lo que sería deseable realizar estudios longitudinales que complementen y profundicen estos hallazgos.

En consecuencia, se abren varias líneas futuras de investigación. La primera consiste en replicar este modelo con muestras más amplias y heterogéneas, como los contextos laborales o profesionales, para comprobar su estabilidad y aplicabilidad fuera del ámbito educativo. La segunda apunta a estudios longitudinales que permitan observar la evolución de las habilidades metacognitivas y su impacto sostenido sobre la regulación emocional, la empatía y el bienestar. Finalmente, se propone comparar los efectos de diferentes tipos de programas formativos centrados en PC y su impacto combinado sobre el desarrollo integral del estudiante. Las

proyecciones permitirían avanzar hacia una comprensión más profunda, empíricamente fundamentada y pedagógicamente útil del PC como competencia multidimensional.

3. Integración de los tres artículos: un modelo renovado del pensamiento crítico

La articulación de los tres artículos que componen esta tesis permite construir una comprensión renovada del PC, que trasciende la noción de habilidad aislada o estrictamente académica, para consolidarse como una brújula cognitiva y socioemocional. El enfoque proyecta al PC como un sistema que orienta el desarrollo personal hacia la toma de decisiones acertadas y la resolución eficaz de problemas.

El hilo conductor que atraviesa los tres estudios parte de un fundamento epistemológico que reorganiza el eje tradicional del PC. En el primer artículo se plantea una reconfiguración conceptual que desplaza el foco predominante en la argumentación hacia la explicación, entendida como el producto superior del razonamiento crítico. En este modelo, la argumentación no es eliminada ni desplazada por completo, sino reubicada como una herramienta que sustenta, acompaña y fortalece el proceso explicativo, pero que no representa el fin último del PC. La propuesta se apoya en los desarrollos contemporáneos de la inferencia a la mejor y única explicación, con raíces en la epistemología científica y la lógica abductiva.

Sobre la base de este modelo teórico, el segundo artículo puso a prueba su eficacia en una intervención empírica centrada en dos variables clave del contexto educativo: el rendimiento académico y el bienestar psicológico. Los resultados mostraron que el PC, cuando es cultivado mediante un enfoque estructurado y orientado a la solución de problemas, tiene un efecto significativamente positivo sobre el rendimiento académico. No obstante, su relación con el bienestar psicológico resultó más ambigua, lo cual planteó la necesidad de explorar mecanismos

intermedios que pudieran explicar dicha conexión. Este interrogante dio paso al tercer artículo, en el que se introdujo la metacognición como variable mediadora entre el PC y las competencias socioemocionales. El análisis estadístico confirmó esta hipótesis, se evidenció que la metacognición actúa como puente regulador entre las dimensiones cognitivas del pensamiento y variables afectivas como la empatía y el bienestar psicológico.

A partir de esta trayectoria analítica y empírica, la tesis propone tres contribuciones centrales al campo del PC. En primer lugar, ofrece una aportación teórica significativa al formular un modelo conceptual del PC como práctica inferencial-explicativa orientada a la acción eficaz. El modelo se basa en estándares epistemológicos propios de la explicación científica y se enmarca en la tradición del razonamiento abductivo, que destaca el papel de la comprensión objetiva, la identificación de causas relevantes y la justificación razonada de decisiones. En segundo lugar, presenta una contribución empírica robusta al demostrar que las intervenciones estructuradas en PC generan efectos medibles y estadísticamente significativos en variables centrales del proceso educativo, tales como el rendimiento académico, la autorregulación cognitiva, la empatía y el bienestar psicológico. La utilización de modelos de ecuaciones estructurales permitió mapear con precisión estas relaciones, lo que aportó solidez metodológica a las conclusiones. Finalmente, se ofrece una contribución didáctico-aplicada mediante la validación del programa ARDESOS-DIAPROVE, una propuesta pedagógica que sincroniza habilidades cognitivas avanzadas con procesos metacognitivos, bajo un diseño sustentado en el aprendizaje basado en problemas (ABP) y en tareas que promueven el diagnóstico, el pronóstico y la verificación como herramientas cognitivas de alto nivel.

En conjunto, estos estudios configuran una perspectiva renovada del PC como sistema de razonamiento complejo y transferible. El modelo está centrado en la explicación como producto cognitivo que orienta la acción, integra habilidades cognitivas y metacognitivas en circuitos de análisis, inferencia, evaluación y regulación, y establece conexiones significativas con competencias socioemocionales, tales como la empatía y el bienestar psicológico. Además, sus efectos pragmáticos pueden ser evaluados en contextos educativos reales, especialmente en lo relativo al rendimiento académico y la toma de decisiones. En este sentido, se supera la fragmentación conceptual que ha caracterizado parte de la literatura sobre el tema, y se proyecta el PC como un eje transversal del desarrollo formativo frente a los desafíos que plantea la educación, el trabajo y la vida en sociedad en el siglo XXI.

Implicaciones teóricas y prácticas

Los hallazgos de esta tesis tienen implicaciones relevantes en dos planos complementarios: el teórico y el práctico. Desde una perspectiva teórica, se propone una ampliación conceptual del PC, en la que su núcleo no reside exclusivamente en la argumentación, como se ha sostenido tradicionalmente, sino en la capacidad explicativa orientada a la acción. El desplazamiento de foco hacia la explicación como producto superior del razonamiento crítico se sustenta en el modelo de la inferencia a la mejor y única explicación, ampliamente discutido en la filosofía de la ciencia.

Otra implicación teórica significativa es la incorporación estructural de la metacognición en el modelo propuesto. En esta tesis se argumenta que la metacognición es un catalizador esencial entre las dimensiones cognitivas del PC y sus efectos sobre el desarrollo socioemocional. La metacognición, entendida como la capacidad de planificar, supervisar y

evaluar los propios procesos de pensamiento, cumple un papel de enlace entre lo que el sujeto conoce y lo que puede llegar a hacer con ese conocimiento. Así, el PC se retroalimenta permanentemente a través de procesos metacognitivos que le confieren dirección, control y capacidad de transferencia.

Desde una perspectiva práctica, la tesis ofrece evidencia empírica que permite orientar el diseño e implementación de programas educativos centrados en el desarrollo integral del sujeto. El programa ARDESOS-DIAPROVE, que articula la inferencia, la explicación, la autorregulación y la toma de decisiones, se configura como un dispositivo didáctico riguroso, capaz de intervenir en múltiples niveles del aprendizaje. Su estructura basada en el aprendizaje por problemas (ABP), y su énfasis en tareas de diagnóstico, pronóstico y verificación, permite vincular directamente las habilidades cognitivas con la resolución de situaciones reales, dentro y fuera del aula. En consecuencia, los procesos de enseñanza-aprendizaje dejan de ser ejercicios abstractos o descontextualizados y se transforman en escenarios formativos con impacto en la vida académica, personal y profesional de los estudiantes.

Por último, cabe destacar que el desarrollo de PC no puede abordarse mediante enfoques intuitivos, espontáneos o exclusivamente declarativos. Se requiere una planificación didáctica estructurada, esto es, intencionada y explícita, acompañada de metodologías activas y sistemas de evaluación sensibles al cambio. Esta tesis contribuye, por tanto, a la consolidación de una cultura pedagógica basada en la evidencia, en la que el PC no es una aspiración general, sino un objetivo medible, cultivable y replicable en diversos contextos educativos.

Recomendaciones finales: pensamiento crítico y política educativa

Aunque esta investigación no se llevó a cabo exclusivamente en el contexto colombiano, sus hallazgos y propuestas ofrecen fundamentos sólidos para ser replicados, adaptados y potenciados en el sistema educativo de esta nación. En efecto, el PC ha sido reconocido por el Ministerio de Educación Nacional como una competencia esencial para el desarrollo de las capacidades del siglo XXI. El documento *Visión STEM+* (Ministerio de Educación Nacional, 2022) enfatiza que el PC es clave para formar ciudadanos capaces de resolver problemas complejos, tomar decisiones informadas y participar activamente en una sociedad marcada por la transformación tecnológica, la incertidumbre y el conflicto social. No obstante, este mismo documento advierte que “la enseñanza del pensamiento crítico sigue siendo débil en la mayoría de los niveles educativos en Colombia, tanto por la baja formación de los docentes como por la escasa incorporación sistemática de esta competencia en los programas escolares” (Ibid., 2022, p. 29). La declaración permite afirmar que el país enfrenta una debilidad estructural significativa en la enseñanza y evaluación del PC, lo que exige el diseño de estrategias formativas sostenidas, rigurosas y adaptadas al contexto nacional.

En este escenario, los resultados de esta tesis ofrecen una respuesta concreta y replicable al reto colombiano. El modelo teórico propuesto, basado en la inferencia explicativa, la metacognición y la integración con habilidades socioemocionales, brinda una arquitectura sólida para construir programas de intervención de alto impacto. Además, el programa ARDESOS-DIAPROVE se presenta como una alternativa pedagógica coherente, científicamente fundamentada y viable, con potencial para ser incorporada en distintas instituciones del país, desde la educación media hasta la superior.

Es necesario, por tanto, fortalecer en Colombia una cultura de evaluación y seguimiento del PC, mediante instrumentos que permitan no solo diagnosticar habilidades, sino también orientar procesos de mejora continua. Igualmente, se requiere una inversión sostenida en formación docente, en la que se promueva el dominio teórico y práctico del PC como un eje transversal del currículo. Este enfoque exige una transformación profunda en la forma en que se diseñan las experiencias de aprendizaje, incorporando situaciones auténticas, deliberación y resolución de problemas interdisciplinarios.

Finalmente, el PC debe asumirse también como una competencia ciudadana de carácter ético y político. En un contexto social marcado por la desinformación, la polarización y la pérdida de confianza en las instituciones, pensar críticamente es tanto una capacidad intelectual como un acto de responsabilidad cívica. Formar estudiantes que puedan distinguir entre hechos y opiniones, que sepan deliberar con evidencia y que puedan actuar con juicio informado, constituye una de las tareas más urgentes del sistema educativo colombiano. La presente tesis respalda teóricamente dicha tarea y aporta herramientas concretas para comenzar a materializarla.

Presentación de los artículos

A continuación, se presentan en su totalidad los artículos publicados que conforman la tesis doctoral, acompañados de sus respectivos anexos y, cuando aplica, del material complementario disponible en la versión digital de las revistas. Se incluye también un resumen en castellano de cada publicación, organizado en los siguientes apartados: introducción, objetivos, método, resultados y conclusiones. El formato de cada artículo —incluidas las referencias, los anexos y el material adicional— se mantiene en la medida de lo posible conforme a las normas editoriales de la revista correspondiente.

Artículo 1

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Título

El pensamiento crítico: El programa ARDESOS-DIAPROVE en diálogo con la inferencia a la mejor y única explicación

Resumen

Introducción. El pensamiento crítico (PC) debe ser concebido no solo como una herramienta argumentativa, sino como una teoría de la acción orientada a la resolución efectiva de problemas reales. El artículo plantea que la enseñanza del PC ha privilegiado componentes formales o lingüísticos y ha descuidado su aplicación práctica. Frente a este desafío, se propone una reconfiguración de la noción de PC a partir de la inferencia a la mejor y única explicación como eje metodológico y epistemológico.

Objetivos. Explorar los fundamentos epistemológicos del programa ARDESOS-DIAPROVE. Mostrar su propuesta pedagógica centrada en la explicación como herramienta para resolver problemas del mundo real. Exponer cómo el programa incorpora las nociones de inferencia explicativa para fortalecer el pensamiento crítico, la toma de decisiones y la autoconciencia metacognitiva.

Método. El artículo tiene un enfoque teórico y conceptual. Presenta y analiza tres modelos epistemológicos de explicación científica: (1) el modelo mecanicista de Salmon, (2) la

inferencia a la mejor explicación de Harman y Lipton, y (3) la inferencia a la única explicación formulada por Bird. Estos modelos se contrastan con los fundamentos metodológicos y pedagógicos del programa ARDESOS-DIAPROVE.

Resultados. La inferencia explicativa, en especial el enfoque de la inferencia a la única explicación, constituye una base sólida para estructurar un PC eficaz y aplicable a la toma de decisiones en contextos complejos. El programa ARDESOS-DIAPROVE incorpora esta perspectiva en su diseño didáctico mediante el uso de problemas reales (ABP), el análisis de sesgos y deficiencias cognitivas, y el planteamiento de explicaciones únicas. Su estructura integra habilidades cognitivas, disposiciones actitudinales y procesos metacognitivos.

Conclusiones. El programa ARDESOS-DIAPROVE propone una reorientación del pensamiento crítico desde la argumentación hacia la explicación. Establece un vínculo directo entre pensamiento, acción y realidad. El análisis de su fundamento teórico a la luz de las principales teorías epistemológicas confirma la solidez de su enfoque. El artículo plantea la necesidad de ampliar esta línea investigativa para reducir sesgos cognitivos y mejorar la calidad de las decisiones en contextos educativos y profesionales.

Palabras clave: pensamiento crítico; programa ARDESOS-DIAPROVE; epistemología; explicación; inferencia a la mejor explicación.

Texto original

Critical Thinking: The ARDESOS-DIAPROVE Program in Dialogue with the Inference
to the Best and Only Explanation

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Abstract

In our daily lives, we are often faced with the need to explain various phenomena, but we do not always select the most accurate explanation. For example, let us consider a “toxic” relationship with physical and psychological abuse, where one of the partners is reluctant to end it. Explanations for this situation can range from emotional or economic dependency to irrational hypotheses such as witchcraft. Surprisingly, some people may turn to the latter explanation and consequently seek ineffective solutions, such as visiting a witch doctor instead of a psychologist. This choice of an inappropriate explanation can lead to actions that are not only ineffective but potentially harmful. This example underscores the importance of inference to the best explanation (IBE) in everyday decision making. IBE involves selecting the hypothesis that would best explain the available body of data or evidence, a process that is crucial to making sound decisions but is also vulnerable to bias and errors of judgment. Within this context, the purpose of our article is to explore how the IBE process and the selection of appropriate explanations impact decision making and problem solving in real life. To this end, we systematically analyze the role of IBE in the ARDESOS-DIAPROVE program, evaluating how this approach can enhance the teaching and practice of critical thinking.

Keywords: critical thinking; ARDESOS-DIAPROVE program; epistemology; explanation; inference to the best explanation

1. Introduction

The purpose of an educational intervention is intrinsically causal (Ennis 1973). Its goal is to induce changes in the student through a series of conceptual, methodological, pedagogical, and didactic proposals that translate into expected results in academic performance and student behavior (Anderson and Krathwohl 2001). The teaching and learning of critical thinking (CT) cannot be separated from this causal notion. The key questions of any CT program are as follows: what learning objectives should guide the intervention? What content should be taught? Which strategies should be implemented? And self-critically, why do it, and what changes are expected?

Through the literature on CT, essential skills, dispositions, and knowledge can be identified that define it and are reflected in the curricular designs of direct instruction (Fasko 2003; Saiz 2017). The timeline that Thomas and Lok (2015) trace from Dewey to the present day with theoretical works and practical manuals on CT shows that despite the lack of consensus on a defined concept of CT, the associated skills are a common meeting point. The classic references of CT have highlighted interpretation, explanation, analysis, inference, evaluation, and self-regulation (Ennis 2015; Facione 1990; Halpern and Dunn 2023) with varying degrees of intensity. The same has happened with dispositions such as being analytical, systematic, inquisitive, having an open mind, being willing to seek the truth and the precision that the situation requires (Ennis 2015). Necessary knowledge has also been identified, such as general knowledge, professional expertise, and knowledge in formal processes of logic, mathematics, and statistics (Glaser 1942).

Understanding this conceptual framework invites, first of all, to think that the task of training in critical thinking is infinite, especially considering that the real world has not yet appeared as the protagonist of the conceptual conglomerate. Secondly, it invites us to value the valuable accumulated knowledge that we have today about CT from philosophy, cognitive psychology, and critical pedagogy (Jahn and Kenner 2018).

In this timeline, it can be traced how some skills have been prioritized, which often undermines other skills or leaves them forgotten in instructional designs. It can be observed that the discourse of CT seems to be more holistic than linear. This explains why, even if a specific skill or knowledge is prioritized or worked on deeply, there will always be a CT expert from whom good reasons could be argued to indicate that a wrong path has been chosen.

CT, as a holistic discourse, seems to have great potential in the field of education. For this reason, severe criticisms arise, demanding that CT apply to itself the criteria it strongly defends (Mulnix 2012). These criticisms seek to commit CT not only to cognitive changes in the student but also demand that it be operational, that is, that it can offer useful tools to effectively solve real-world problems (Atanasiu 2021; Halpern and Dunn 2021; McLaren 1994).

How can we design an intervention program that allows students to develop CT skills? How can we ensure that these skills are not only applied in the academic field but also generalized to the real world? How can we make CT a useful tool for solving everyday problems, both personal and professional? Despite the importance given to CT in pedagogical discourse, these questions highlight existing gaps. The lack of effective answers is the reason why CT is sometimes perceived as a grandiloquent discourse that is disconnected from real-world problems. Perhaps this has not been intentional but simply the result of prioritizing some attributes over

others. The truth is that this approach, characterized by argumentation theory, has been criticized by experts who consider that CT fails to connect thought with action (Barnett 1997; McLaren 1994; Walters 1992). It seems that the term ‘critical’ remains in the abstract separation of assumptions and facts, but the latter loses prominence. Alternatively, it is as if the programs focused only on cognitive objectives, making the student aware of something important and necessary to know and handle but not necessarily to apply.

For this reason, authors like Barnett (1997) chose to refer not to CT but to critique. According to Barnett, critique is structured in three dimensions. The first is linked to the analytical stage of evaluating phrases or arguments. The second is associated with an act of a metacognitive nature: self-regulation and self-examination. Finally, critique action is the realization of the will to analyze and evaluate the real world. This is aligned with an ideal of transformation that can be individual or collective, such as an ideal of social justice that can make this a better place. Therefore, critique, understood as the conjunction of the self and action, allows us to speak of a fully critical person. This makes a lot of sense to develop a CT that transforms reality and provides tools to solve problems in the real world. Paul (2018) has also questioned this traditional approach and has proposed distinguishing between weak or narrow CT and strong or broad CT. The weak CT defends, analyzes, and evaluates a set of propositions or arguments within a limited framework. Arguments that belong to that framework are considered solid or valid, and dissenting opinions are presented as fallacies. On the contrary, strong CT conceives the thinker as someone capable of transcending their framework, accepting that there can be more than one valid argument, even if they do not agree with it. This implies that CT is not only associated with the quality of judgment on the argumentative or exclusive reflection with the linguistic components but also with the referent, the real world.

In this line of argument, a CT approach that places the real world as the protagonist faces a complex task. First, it must be based on a CT concept that recognizes and connects the logical–epistemological, cognitive psychological, and critical pedagogical traditions. It is important to recognize that the conceptual heritage has had representatives from each of these branches, and the CT cannot be simplified to a single constitutive definition. The goal is to find an operational concept that can measure the skills subordinate to the student’s operational change, allowing him to solve real-world problems through generalization.

Secondly, the program that is built on this concept must also recognize and methodologically resolve its limits. In this way, the CT can move to dimensions that are different from the logical–epistemological, where argumentation has prevailed as a keyword (Jahn 2019; Jahn and Kenner 2018; Saiz 2017, 2020). Without detracting from other programs that have focused all their efforts on theories of argumentation (Morrow and Weston 2016; van Gelder 2015; Walton 2000) with exceptional achievements, making it one of the skills with the most consensus in evaluative criteria, the concept of CT we are looking for must have a different gravitational axis. As can be seen, the change in focus is not minor, and the proposal is not limited to simple descriptions. It is about highlighting the interests, personal and professional problems, as well as the social needs inherent to the individual under the conception of the CT as a theory of action. The idea would be to place social life (the facts, the behaviors, etc.) as a unit of analysis and questioning at the center of a CT instructional program to discover tensions and inconsistencies between perspectives that make the CT more original or closer to an individual with economic, cultural, political, but also everyday and professional interests.

How can we advance in a challenge that we know cannot be met with an intervention program due to the inherent complexity of (CT)? Despite the obvious limits, how can we implement an instructional program that focuses on the demands of the real world without losing methodological rigor and the historical richness of CT? Finally, how can we determine if our conceptual, methodological, and generally instructional efforts are effective in addressing the realities of the world?

This article presents the ARDESOS-DIAPROVE program, which seeks to respond to the demand for a change in focus in (CT). The program does not intend to be a definitive solution but a pedagogical effort to develop, strengthen, and promote CT in relation to the real world. Our thesis argues that CT should focus on the best explanation and not necessarily the best argumentation. Given its trajectory, background, and consolidated quantitative results, it can be considered that ARDESOS-DIAPROVE is a mature program that has been evaluated in different scenarios and is constantly improving (Rivas and Saiz 2023; Saiz 2017, 2020; Saiz and Rivas 2011).

We will focus on one of the key foundations of the program: explanation. From an epistemological perspective, we seek to place explanation at the center of the program as a possible response to a shift in focus in CT. Given that explanation has an inherent causal nature that interrelates with the real world, it is a key concept in the objectives of science. In the program, the importance of explanation strategically displaces argumentation. The methodology of CT focuses on finding the best explanation for professional and everyday problems to make accurate decisions. Logical support and the causal explanatory model are used to privilege uniqueness. These are based on the inference to the best explanation (IBE) (Galavotti and

Pagnini 2010; Harman 1965; Hitchcock 1995; Lipton 2003; Salmon 1984a, 1984b) and on the inference to the only explanation (IOE) (Bird 2007, 2010).

Identifying and studying each of the foundations of the program, including those of the epistemological spiral, is part of the program's continuous improvement strategy. This includes increasing clarity, providing didactic examples, updating concepts, and debating the main challenges proposed by epistemology. In addition, the program incorporates epistemology, a central branch of philosophy that can significantly contribute to scientific literacy, a trait that should also be part of the critical thinker. After all, the epistemological debate focuses, among other things, on the true and justified beliefs we have about the real world (Bunge 2000).

2. ARDESOS-DIAPROVE Program

CT is one of the higher thought processes (Paul and Elder 2006). Its complexity lies in the fact that it relates cognitive, attitudinal, and metacognitive components (Lau 2015; Rivas et al. 2022). Conceptual comprehensiveness and its implementation lead us not only to focus thematically on the development, strengthening, and promotion of some skills, but we must also deal with those other logically necessary components that function as the engine that mobilizes skills towards results. Thus, for example, if, as in our case, we privilege specific skills intrinsic to reasoning, decision making, and problem solving, we must also privilege non-cognitive components, such as the will to do it, really desire to put into practice the necessary and useful problem-oriented reasoning. This conceptual network is more evident in operational conceptions of CT, such as those that focus their efforts on establishing an identity between the critical and the effective, since willingness to be effective is determined by intrinsic and exogenous motivations so dissimilar and multiple that they are complex to systematize in the conceptual

network of a definition. Thus, metacognition, self-regulation of skills, and motivation, the active driving force behind them, form an essential part of the program (Saiz 2020).

We think to solve problems, we make our inventive and problem-solving efforts available in the face of epistemic, ontological, ethical, and political obstacles or concerns (in general, in the face of a problem). This means that we plan, strategize, and act to achieve that solution. Decision making is key in linking the start and end of any process. It is not just about finding the best theoretical solution but also about ensuring it can be applied in reality. This creates a complex network of concepts that seem separate only in theory.

As a corollary to this conceptual framework, we have chosen to characterize critical thinking, rather than as an academic discourse, as a tool for effectively solving a problem or achieving desired goals; moreover, as a generator of change, understood as the passage from one welfare state to another. This establishes serious commitments, as it means that no effort must be spared in achieving the effectiveness of the means (the best result, the best explanation, or problem solving) to accomplish the desired change. It also implies that it is not enough to find alternative answers or solutions but to find the best among the range of options. If thinking critically is thinking effectively to achieve the desired change or goal, and this is not only desirable in the academic and professional sphere but extends to the everyday and personal sphere, CT is desirable higher order thinking. Therefore, by virtue of the conceptual network described and the relevance of critical thinking, we have proposed that “to think critically is to reach the best explanation for a fact, phenomenon or problem in order to know how to solve it effectively” (Saiz 2017, p. 19).

2.1. Methodological Foundations

The program has been modified and is the product of several years of research from its origin to the present, giving positive results and continuous improvement, as can be seen in different works (Rivas and Saiz 2023; Saiz 2020; Saiz and Rivas 2011). ARDESOS can be understood as the program's mesocurriculum, as it includes everyday situations to accommodate the activities of problem-based learning (PBL) or ecological learning (Morales et al. 2015), the argumentative tradition, decision making, and problem solving. At the methodological and didactic level, the foundations are the development of DIAPROVE. Firstly, it consists of identifying the limits of a good thinker, i.e., identifying the deficiencies and biases that prevent progress in the development of critical thinking. This is key, as we are faced with errors that can be systematic and prevent us from thinking correctly, as well as ontological and epistemic compromises that can block the search for the best explanation, such as irrelevant or isolated but striking data that can make us lose sight of the objective and create a blanket of contradictory data or details that need to be observed and analyzed (Saiz 2020). This part is therefore crucial, as it can prevent correct diagnoses from being made. After this, the search for the best explanation that can explain the facts and forecast is ensured by the suitable application of logical principles, causal simulations, and other necessary contrastive steps.

In short, the general route of the program is to identify the cognitive biases and deficiencies that sometimes prevent us from solving some problems, looking for the best explanation of the problem, and making sure it is the best. The following are some of the most relevant foundations of the program:

(a) We think in order to survive. Biological nature determines what we are on a physical and mental level, the latter feature emphasizing that the essential mental actions (perceive–learn–retain) are a function of the telos as a species: to survive (Saiz 2020).

(b) Thinking, willing, and acting are inherent actions. If (a) is accepted, then the concept of “thinking” does not refer to just any word but to critical and effective thinking: it is not about finding the solution but the best solution. However, the links between thinking and acting are the non-cognitive components of CT (dispositions, motivations); therefore, neither skills nor dispositions alone are sufficient for a CT program (Saiz 2017).

(c) Thinking is inferential. The best solution can only be arrived at by a correct inferential process, which, within its own complexity, contains instances of contrast (verification/falsification) with the facts.

(d) The deductive machinery is necessary, though not sufficient. It is necessary because it warns us and helps us to correct our biases and cognitive limitations. Understanding the complexity of the inferential process (c) requires knowing the basic rules of logic and adopting a more semantic than syntactic stance so as not to confuse the sufficient condition with the necessary condition and vice versa. However, it is neither necessary nor sufficient, as the formal scaffolding must be complemented by causal scenarios to be resolute (Saiz 2020).

(e) The connection between CT and metacognition is reciprocal. Critical thinking does not arise randomly; it only manifests when we are aware of our actions, whether they are correct, to repeat and improve them, or incorrect, to amend them (Rivas et al. 2022).

(f) It follows that metacognition is what enables us to be aware of our cognitive process and, in turn, to transfer it to other areas of life, to reflect on how we learn, and to select, monitor, and evaluate our own strategies.

(g) From (e) and (f), it follows that the program incorporates the non-cognitive component (b) through the treatment of metacognition and motivation, which are sequentially linked to each other since skills can only be organized, planned, and goal-directed once they have started to function, i.e., motivation must activate skills for metacognition to function.

(h) For this last reason, and to bridge the gap between theory and practice, sometimes criticized in intervention programs, or what in practical terms is the gap between training and what the professional environment demands of students (Casner-Lotto 2006), the program uses relevant situations so that students have the possibility of applying what they have learned (Saiz and Rivas 2008). Under the premise that we can only know what we apply and that there is no point in perfecting critical skills if they are not used, the activities characterized as relevant in the program are based on PBL (problem-based learning). This is mainly because it is problem-based learning in which the student must apply processes of research, reflection, and analysis that are evident in the delimitation and understanding of the problem, interpretation, decision, and, obviously, solution.

2.2. Epistemological Foundation

The first distinctive feature of the program is that it distances itself from the logical–epistemological tradition if the latter is reduced solely to the theory of argumentation. What we have argued in this respect is that CT is at the service of the best explanation and not of the best

argumentation as an end in itself. This break is better understood if we consider the dilemma of understanding CT as a theory of argumentation or as a theory of action (Saiz 2017, 2020).

As a theory of argumentation (Hitchcock 2017; Morrow and Weston 2016; Toulmin 2003; van Gelder 2015), the identity between knowing or training in CT and achieving goals inherent in human life itself (such as happiness or well-being) is questionable. As a theory of action, the identity between knowing and solving effectively in practice must be a principle. This nexus is unquestionable in a theory of action; it is not enough to make the argument the best product of reasoning, but at most, a feasible means to ends that require problem solving.

The aim of the program is to achieve effectiveness through the best explanation. In the face of a fact, explanation takes precedence over argumentation. Through the description of the process and the incorporation of strategies of order and clarity, the latter appears to justify what is found in the explanatory process; it proceeds to discursively substantiate why it is that cause and not another. Thus, argumentation is subordinated to explanation. The conceptual and operational linkage of the critical concept is with the indicator of effectiveness; one is effective to the extent that one is talking about a better way of doing things, which means that it is not possible to be critical and not effective.

The focus of the program is on explanation, which means that it is a core concept around which the other concepts of the method orbit with multiple relationships to achieve change as an objective of critical thinking. Explanation is the heart of the program due to its direct link with reality. Imagine a situation where there is compelling evidence but no response to a phenomenon that is not explained by our current beliefs. To understand and solve this, we need to identify the cause.

Argumentation requires activating this response. But even so, outside the problem, argumentation could appear in a simulated situation or to sustain a conviction or belief that does not arise from a problem of reality. Explanation as a concept proper to inquiry is conceived as a mechanism that engages with the deductive machinery to establish the combinations of deductions with the facts and to unconfirm alternative explanations so that the objective of CT is fulfilled, namely, to find the best explanation and with it, once the decision making takes place, to bring the explanation as a solution into the practical realm (Saiz 2017, 2020).

A program like ARDESOS-DIAPROVE can only be nourished by science, its data, and methodologies. Science is distinguished by the constant search to understand and explain the phenomena we observe in the world. Studies of scientific practice show that it is not limited to pure observation but often involves the search for testable hypotheses. This activity is carried out with the precision of data obtained through experimentation (Bunge 2000). For this reason, science describes events and links seemingly unconnected propositions into a coherent system of explanations. This ability to link and abstractly formulate structural properties is what differentiates science from common sense and elevates it to a deeper and more systematic level of understanding (Nagel 1987). With the conviction that it is not simply a matter of observing and recording but of understanding, of looking for patterns, of formulating hypotheses, and testing them, science advances by providing explanations that are both rigorous and capable of refinement (González and Guamanga 2022). This commitment to explanation defines and distinguishes science and is the reason it determines the program.

Scientific explanation is a crucial tool in the development of critical thinking. By understanding how foundations in science are constructed and validated, it is possible to

strengthen essential skills for logical reasoning and the evaluation of claims. In this section, we will focus on three epistemological approaches to scientific explanation: the theories proposed by Wesley Salmon, the concept of IBE, and IOE. Through this analysis, we intend to provide some of the epistemological foundations of the ARDESOS-DIAPROVE program, especially those dealing with the scope and limits of explanation. This is to deepen the challenges to be considered when looking for ways to develop the ability to explain to promote critical thinking. For this, it is significant to distinguish between the conceptualization of explanation and how it is achieved and, of course, to establish that a request for an explanation of an everyday or professional situation is not necessarily a scientific explanation but an explanation that emerges from the epistemological standards of science.

2.2.1. The Spiral of Explanation

Wesley Salmon has been a leading figure in the debate on scientific explanation (Galavotti and Pagnini 2010). His approach focuses on the causal nature of explanation, a perspective that seeks to go beyond classical analyses, as those proposed by David Hume (1739). In the *Treatise on Human Nature*, Hume puts forward an empiricist view of knowledge, arguing that many fundamental ideas, such as causality, have no direct impression to derive from and are therefore mere chimeras. With the example of billiard balls, Hume questions the traditional notion of causality, arguing that we cannot perceive a necessary connection between events but only certain circumstances: contiguity, priority, and constant conjunction.

Contiguity refers to the specific order in which we perceive events in space and time. Priority indicates that cause always precedes effect, although this does not imply a direct causal relationship. Constant conjunction suggests that, given certain conditions, the same effects will

follow the same causes. However, Hume argues that, beyond these circumstances, we cannot discover a necessary connection between cause and effect. In his view, our idea of causality arises from habit and the expectation that the future will resemble the past rather than from necessary connections.

Whereas Hume regards causality as an epistemological and psychological construct based on habit, Salmon (1984a) tries to establish the existence of objective causal relations in the real world. Salmon's aim is to show that these causal relations can satisfy the explanatory demands of science. For Salmon, scientific explanation goes beyond the simple connection of relationships, so he proposes that a true explanation must identify complete causal processes and structures. This perspective differs from other approaches by stressing the importance of objective causality rather than simply observed regularities.

Salmon stresses that not all causal relations are compatible. For a causal relation to serve as an explanation, it must be part of a complete causal structure. This structure must be able to show how particular events or conditions give rise to the phenomena being explained. Salmon proposes an alternative notion of causality that aims to satisfy the demands of explanation in science. Unlike Hume (1739) and Mackie (1965), Salmon suggests that it is not adequate to speak of "the cause" of an event since an effect can have multiple causes. Instead of presenting individual causes, Salmon introduces the concept of "causal process", which refers to the transmission of an effective entity, such as energy, information, or electric charge (Salmon 1984a; Gómez and Guerrero 2020).

Salmon uses Newton's theories to reconstruct Hume's illustration of billiard balls, contending that physical laws offer an objective method to evaluate the relationships between

objects. He presents the idea of causal interaction, a term used to describe scenarios where processes of cause and effect intertwine, leading to enduring transformations. He further underscores the phenomenon of mutual modification, which transpires when two such processes intersect, resulting in reciprocal changes. An illustrative example is the collision of two billiard balls: each trajectory is a causal process, and the collision is a causal interaction. If a ball bears a mark, such as a scratch, and continues its trajectory after the collision, it demonstrates the continued transmission of the mark, reaffirming the causal nature of the process (Salmon 1984a).

Finally, Salmon's causal mechanistic model of explanation is based on several key points. These include the distinction between causal processes and pseudo-processes, the counterfactual notion of transmission of a mark, and causal interaction. Explanation within this model traces the causal processes and interactions that lead to a specific event, allowing for a deeper and more nuanced understanding of causality in various phenomena. In this model, a causal process is a physical phenomenon that can transmit a "mark" on a continuous basis. These processes are distinguished from pseudo-processes, which cannot transmit marks. In addition, Salmon introduces the idea of causal interaction to account for two causal processes that intersect and modify each other. In the model, explaining an event involves tracing the causal processes and interactions that lead to it (Gómez and Guerrero 2020). Although the model of explanation proposed by Salmon succeeds in accounting for many phenomena and, in some respects, overcomes the problem of causality proposed by Hume, it is not without its critics. In this regard, Christopher Hitchcock (1995) argues that Salmon's model does not fully capture the essence of what we consider relevant in an explanation. For example, in the case of billiards, although the model may identify the movement of the balls as a causal process, it does not distinguish which

aspects of that process are, in fact, relevant to the explanation, such as the mass and speed of the balls, as opposed to other less relevant factors.

Christopher Hitchcock (1995) also points out that the model faces similar challenges in other contexts, such as the example of birth control pills. Although taking a pill can be considered a causal process, the model does not adequately distinguish between the relevance of taking a pill for a man (which is irrelevant to preventing pregnancy) and for a woman (obvious relevance). Thus, Salmon's model, while useful for identifying causal processes, does not provide an adequate tool for discerning which features of a process are actually relevant to an explanation.

Another significant criticism focuses on the inclusion of pragmatic and contextual elements in his model. Although Salmon attempts to establish a notion of objective causality, his proposal seems to compromise this objectivity by relying on the interests or views of users. To illustrate this point, consider the example of the 40-year-old man who faces a series of unfortunate circumstances on a stormy morning. His old car, the storm, the bad road, the faulty brakes, his work-related stress, and the lightning striking a tree all contribute to a tragic accident. Hours later, three experts arrive on the scene: a medical examiner, an insurance mechanic, and a road engineer. Each, from their professional perspective, could identify a different cause of the accident. The doctor might point to a heart attack, the mechanic might focus on faulty brakes, and the engineer might criticize the road design. In this case, the objectivity of causation is challenged by the different perspectives and areas of expertise.

The ARDESOS-DIAPOVE program tries to take the best of existing theories of explanation and adapt them to meet the specific needs of its pedagogical approach. In this case,

the program emphasizes, from Salmon's approach, the importance of identifying objective causal relationships in the real world. The distinction between causal processes and pseudo-processes provides a valuable tool for the program, as it allows for a deeper understanding of facts beyond appearances. However, the program cannot follow Salmon's model point by point, especially as it opens the door to different perspectives, leading to different explanations. Moreover, although the mechanistic causal model of explanation is useful for identifying causal processes, it does not always provide an adequate tool for discerning which features of a process are relevant to an explanation.

Salmon's model focuses on causes and stipulates necessary features of the explanation, such as showing which factors are relevant for the occurrence of the event and excluding irrelevant factors; however, the central difference with the program is that in Salmon's model, the event is placed in a network of statistical relationships of factors that are relevant for its occurrence without this implying finding the best explanation. While Salmon's model does not conceive the explanation under the structure of an argument and the fact remains in a geometric network of relevant interactions, from the ARDESOS-DIAPROVE program, it can be questioned, in Galavotti's words (Galavotti 2018), that it is still not indicated which properties should be taken as explanatory, it is like a telephone network that does not account for the specificity of the messages, while in the program it is crucial to get to the message, to the best explanation.

2.2.2. The Inference to the Best Explanation: Better?

IBE, first proposed by Gilbert Harman in 1965 and later extended by Lipton (2003), emerges as an essential epistemological methodology in hypothesis selection in science. Harman

argued that not all inductions are based on guarantees of non-deductive inference. Instead, it is necessary in many cases for scientists to infer a hypothesis not because it is possible but because it provides the best explanation for the available evidence (Harman 1965). Unlike traditional approaches that rely exclusively on direct observations or deductive logic, IBE foregrounds the explanatory power of a hypothesis.

This intrinsic process of IBE begins with the identification of hypotheses that might make sense of certain evidence. Given the plurality of hypotheses that can often explain the same evidence, it becomes imperative to evaluate and test these hypotheses against each other. Harman emphasized that the choice of the “best” hypothesis is not an arbitrary act but is governed by specific criteria. These criteria include aspects such as the simplicity of the hypothesis, its ability to address and explain a variety of phenomena, and its consistency with the established body of knowledge.

To further illustrate how this process works in practice, consider the following example: in a small village, the eucalyptus trees, symbols of the locality, started to become diseased, with dark spots on their leaves and discoloration of their bark. The scientists proposed several hypotheses: H1, a new pesticide affected the trees; H2, an unknown fungus infected the eucalyptus trees; H3, climatic changes stressed the trees; and H4, invasive insects damaged the eucalyptus trees. After evaluation, only hypothesis H2 was retained, supported by the presence of a fungus in diseased trees that was absent in healthy trees.

To validate hypothesis H2, the fungus was introduced into a healthy tree in a controlled experiment, and the tree began to show symptoms similar to those of the diseased eucalyptus, confirming the cause of the disease. This process demonstrates the effectiveness of IBE in

scientific research, highlighting the importance of rigorously proposing, evaluating, and validating hypotheses in order to reach accurate conclusions (Laudan 2007).

The IBE has established itself as a valuable tool in the scientific landscape by enabling researchers to deduce the most likely cause behind an observed phenomenon. This methodology is characterized by a series of criteria that determine what is considered a “best” explanation. These criteria, which include simplicity, consistency with established theories, explanatory scope, and plausibility, allow scientists to select hypotheses not only on the basis of observations or pure logic but also on their intrinsic ability to provide a coherent and plausible explanation in the face of the evidence presented. IBE is an essential methodology in science that guides researchers in selecting hypotheses based on the available evidence.

However, this tool is not without its critics. One of the most prominent objections is the “bad lot” argument, which postulates that all available hypotheses may be inadequate in certain circumstances (Fraassen 1989). An illustrative example, following the eucalyptus case, where a hypothesis not initially considered turned out to be the true cause of a disease (H5: a specific type of water contamination affecting eucalyptus trees), shows that the original hypotheses were insufficient.

IBE faces epistemological challenges, especially when it comes to inferring truth from criteria such as simplicity and coherence. While these virtues are useful for assessing the quality of an explanation, they do not guarantee its truthfulness. Therefore, while IBE remains central to scientific reasoning, it is crucial to recognize and address its limitations and potential with a critical approach.

The ARDESOS-DIAPROVE program, like IBE, values the importance of explanation as a central tool for understanding and solving problems. Both seek to identify and validate the best possible explanation for a given phenomenon or problem. However, while the IBE focuses on virtues such as simplicity and coherence to judge the quality of an explanation, the ARDESOS-DIAPROVE program emphasizes the practical and applied relevance of explanations and, above all, the process of eliminating possible explanations to obtain not only the best but the only one that can explain the event.

2.2.3. Inference to the Only Explanation: The Only One?

The difficulties that conceptually arise have tried to be studied by advocates of this inferential process characteristic, according to them, of science. Among them is the philosopher of science, Alexander Bird (Bird 2007, 2010). Bird's proposal moves from IBE to IOE. For our purpose, understanding this approach is key, as the correlation with the ARDESOS-DIAPROVE program would be in the central thesis, unlike the relationship with Salmon and the IBE, with which relationships are established between some premises.

Bird's thesis is that if the IBE allows the selection of a single potential explanation, then that is the only explanation (Bird 2010). He is, therefore, committed to the uniqueness of explanations. Bird (2007) calls this inference "Holmesian inference".

By inference to the only explanation (IOE), I intend something quite specific: at the end of the inquiry, we can be in the position to infer the truth of some hypothesis since it is the only possible hypothesis left unrefuted by the evidence. It is the form of inference advocated by Sherlock Holmes in his famous dictum, "Eliminate the impossible, and whatever remains,

however improbable, must be the truth”. Of course, one requires the auxiliary hypothesis that there is an explanation of the phenomenon in question (p. 425).

It is an IOE because all but one explanation can be eliminated from the evidence. In structural terms, we would have an argument that goes from determinism, through hypothesis selection and eliminative inference, and ends in a single conclusion. In this way, it seems a more categorical bet than the Hartman–Lipton IBE by not resorting to other explanatory goodness, and therefore, Bird will argue this initiative through scientific practice in medicine, for which he reconstructs the classic case of Semmelweis.

Bird’s interpretation does not supplant Lipton’s explanation (Lipton 2003) but shows the complement of the IBE in Semmelweis’ case. For Bird, this case obeys more a Holmesian inference than a Liptonian IBE, and as proof of this, the “explanatory charm” of the inferential study can be omitted. Holmesian inference structurally starts from a fact that has an explanation; there is a collection of hypotheses that can explain it, and the hypotheses have been falsified by the evidence, except for one. It follows that the hypothesis that survived the eliminative process is the hypothesis that explains the fact. As can be seen in the scheme, there is no other criterion or explanatory goodness beyond having passed the process of testing against the evidence.

In following Lipton’s approach, Bird also accepts the basic IBE principle of discarding the null or zero hypothesis, i.e., the deterministic idea that for every intriguing piece of evidence, there is an explanation. Bird emphasizes the process of progressive refutation, i.e., eliminating rival hypotheses until the true explanation remains, hence the name Holmesian inference: “Eliminate the impossible and what remains, however improbable, must be true”.

Bird's case study is Semmelweis. Between 1844 and 1848, Semmelweis worked at the Vienna General Hospital. The scientific concern that made him famous and a reference in epistemological studies was why a large number of women contracted a terrible and sometimes fatal disease called puerperal or postpartum fever with a higher preponderance in one division than in the other. The investigation led Semmelweis to consider various hypotheses, from the most scientific to the least plausible, each of which was tested by experience.

The difference with other analyses is traced by Bird in determining what is selected in this case as intriguing evidence (explanandum) to understand the correspondence of this with the explanans. Either E1, "The existence of puerperal fever in division 1", or E2, "The preponderance of puerperal fever in division 1". The former is much more general, as it can be understood as speaking of the existence of the disease elsewhere. The following hypotheses emerge from the first phase of the IBE: H1, the cause of the high mortality is the overcrowding of division 1; H2, the cause is an epidemic or climatic influence; H3, the culprit is the careless examination of medical students in division 1; H4, the cause is the terrifying effect of the priest passing through division 1 before anointing dying patients; and H5, the cause of the disease in the division is that women gave birth on their backs. Once the possible explanandum and explanans have been determined, it is essential, Bird points out, to determine the explanandum to correctly understand the phases of the IBE. If, for example, it is E2, H1 and H2 can be ruled out since divisions 1 and 2 share much of the same healthcare practice conditions and, division 1 being infamous, then division 2 was more overcrowded. In the contrastive explanation, there is no particularity that is unique to division 1. According to Bird, H3 is an implausible hypothesis that even Semmelweis could dismiss based on initial knowledge, namely that there was no significant difference between the care of students and midwives in division 2 versus natural

childbirth injuries. In the case of H4, Semmelweis convinced the priest not to go through division 1, and this was not significant with the results: the large preponderance of postpartum fever, i.e., the evidence was inconsistent, and H4 can be falsified. The same was true for H5, given that women gave birth sideways without this constituting a decrease in mortality. This means that no H can explain E2. The case that accidentally made another hypothesis possible was the death of a colleague of Semmelweis, Dr Kolletschka, who died of a wound sustained during an autopsy. Semmelweis observed that Kolletschka's symptoms were similar to those of women dying of postpartum fever. This allowed him to posit H6: the women were infected with "cadaveric matter" by medical students performing autopsies before examining the women in division 1.

In this regard, Bird states that, from this hypothesis, there are two divergent hypotheses, only one of which is supported by the evidence and the Kolletschka case: the first (H6a), the women were infected during the examination by the medical students; and the second (H6b), the infectious agent was the "cadaveric matter" imported by the students. Bird's claim is that only H6a is verified by the evidence, while H6b is plausible, but with the data, it cannot be verified; otherwise (bearing in mind that Semmelweis suggested that the students wash with a chlorinated lime solution and this measure caused the deaths to decrease), the cause lies in some property of the students' hands that is removed by washing them. With this, Bird asserts that the evidence leads not only to the best explanation but sometimes to the only explanation and that it is arrived at by eliminating all potential alternatives. From this statement, it is relevant to note, "sometimes", to limit the claim of universality or extension to all phenomena in science.

The ARDESOS-DIAPROVE program focuses on finding the best explanation for professional and everyday problems involving decision making. Moreover, it has a logical underpinning and a causal explanatory model. Thus, the inference referred to is not in an epistemological gap but is an inference that seeks uniqueness in the same way that Bird has proposed. Now that we have an identified foundation with which there are conceptual and methodological relationships, what does the program gain by identifying an epistemological foundation? From the perspective that this is a program underpinned by scientific data and validated pedagogical practices, the gains can be debated. What is unquestionable is that it provides greater conceptual clarity and foundations to a program whose didactic route is to achieve better results through Holmesian inference, as we have pointed out on other occasions, at that point without the need to descend theoretically down the explanatory spiral. On the other hand, the search for the causes in the science of phenomena or problems in which life is at stake is a component that enriches the program didactically. Within the didactics, a unit on these achievements in science and how they have been a successful illustration case shows the strength of how we are in line with the most accurate description of science and how a professional also solves problems effectively.

The points of agreement with Bird that can be noted are as follows: first, the premise that every phenomenon requires an explanation, and this explanation is causal, material, and objective, is not disputed. Bird's analysis of the classic Semmelweis case illustrates this: faced with a multiplicity of hypotheses, some of them dominated by a set of unfounded beliefs, they are dismissed by the inscrutable strength of the facts. Secondly, both in Bird and in the program, there is this need to arrive at the best explanation through the procedurally correct elimination of logical principles in combination with the contrast with experience. In Bird, we can also observe

the need, as in our program, to attend to relevant, contradictory, and extraneous data in order to propose an alternative solution, a reason that resembles the ongoing process of knowing how to handle data with the deductive machinery. Thirdly, although Bird accepts that his case of arriving at a single explanation is an exceptional case of the IBE, this is not a limit to the program; as Bird detailed above, the issue is not understanding the problem but determining which explanandum is the one to be solved. It may be the case that curricular activities do not have this causal relationship or that they are, in principle, posed as multi-causal when, in fact, the question or problem has not been adequately defined.

Finally, it can be seen in Bird's proposal that his cases are set in reality and not in the imaginary; he shows cases that happened and were transformative for some sciences. In the same way, the program proposes real activities of ecological situations that, if not resolved, have implications in the real world. It can therefore be concluded that we are faced with an epistemological reference that also supports the program's proposal. This is certainly not costless, as it requires a deepening of the reserves as the bad lot to avoid in the hypothesis construction phase to ensure that you really understand the problem to be solved. There is, therefore, more common ground between Bird and the ARDESOS-DIAPROVE program than with other proposals. The limits pointed out are precisely pedagogical warnings so that the didactic material and instructions, the PBL, and other pedagogical foundations are well-aligned curricularly with the purpose of the program.

2.2.4. Conceptual Circuit

In the ARDESOS-DIAPROVE program, the conceptual circuit that complements the IOE is based on heuristics and decision making. An epistemological pillar may have little value if it

fails to apply to real-world problems, becoming a mere static ornament. It must establish cooperation networks with other concepts to achieve an effective connection with reality where decision making stands out as the key concept.

The definition of CT that we use as a starting point for this program has a clear intention: to find effective solutions to problems. However, it is evident that finding solutions and executing them are two different things. The IOE, along with its entire process, provides us with a guide on how to reach these alternatives and the criteria to choose one of them. This is a crucial step, as it ensures rigor and transversality in the search for an explanation. Ideally, the process should go beyond the abstract solution of the problem, and transversality should be evident in a well-made decision. However, the principle of reality about how we make decisions, especially when we collect data about our mistakes when deciding, confronts this ideality. The issue of the limits of our cognitive machinery arises in the program with the same naturalness with which we accept our fallibility. For this reason, we have decided to integrate real cases into the conceptual configuration. These cases are designed to challenge the student to face future professional problems, some of which will require transcendental decision making in practical terms. These decisions will not only test the professional quality of the student but will also influence the decisions that others will make based on the professional's criteria. To illustrate this, we will use the Lilly case (Saiz 2020).

Decision making is a skill that is perfected after having made the decision. There is a path, whether intuitive or rational, that has been followed to select and carry out a solution. It is possible that a specific alternative has been chosen as a result of the extensive path described in the IBE process or that this path has been shortened. In any case, the decision arises as a result of

the application of one or several pre-decisional skills. To a large extent, the dilemma determines the quality of the decision: the greater the identification and monitoring of pre-decisional skills, the greater the self-regulation in case it is necessary to intervene to correct any error in decision making.

The high recurrence of failures in decision making could contradict the essentialist definition of man as a being given with logos: language and reason (Gadamer 2004). However, this definition is quite far from the results proposed by Kahneman and Tversky, who, through extensive experimental work, demonstrated that there is no such rational purity or essentialist category of rationality (Kahneman 2013; Kahneman et al. 2022; Kahneman and Tversky 1984; Tversky and Kahneman 1974).

According to the data, the opposite occurs: in different professional scenarios, where agreements and correct decisions should predominate, such as medicine and law, decisions are easily classified into random scatter plots (noise) or systematic deviation (biases) (Kahneman et al. 2022).

What is the role of CT in the face of obstacles that lead to wrong decisions? The answer seems clear: it must incorporate them into an instructional design to expose students to these deficiencies of cognitive machinery, both at a descriptive and normative level. This exposure should facilitate the identification of these deficiencies and the generation of strategies to reduce them in the decision-making process. The program takes on this challenge and, through specific cases, exposes the student to situations in which, if they do not overcome these deficiencies, they will not be able to solve the problem and, as a result, will probably make a wrong decision. In this thematic content, the explanation again takes precedence over the argument. Although the

latter could arise even after reaching a wrong alternative, the explanation directly precedes decision making. The action of arguing can be activated even in defense of a wrong decision. Given a point of view that wants to be defended and an intention, it is possible to develop an argument with a logical emphasis, oriented to the quality of the relationship of the propositions, dialectical, focused on the correct dialogic processes, or rhetorical, focused on the universes of beliefs accepted between the speaker and the audience (Tindale 2004). However, these approaches do not correct the possible error but can amplify it. Therefore, there must be other paths that lead us to decision making or on which the hygiene of decisions falls (Kahneman et al. 2022).

Hygienic decision making is based on disciplining intuition. It is not about prohibiting it but resisting premature intuitions and balancing them according to the context that requires explanation, factual data, causal scenarios, and forecasts. These are necessary steps, among others, to arrive at the only explanation (Saiz 2020). It is important to distinguish between the generation of explanation alternatives and the choice between them. Although the distinction is simple, clarification is necessary to avoid confusing problem solving with decision making (Halpern and Dunn 2023). The central point is to have and master clear and solid criteria for choosing an alternative and, in a strict sense, excluding the others, thus advancing towards decision making with an explanation alternative as the protagonist. These criteria and procedures have been provided to us by the epistemological debate in this article illustratively by IOE.

From an analytical point of view, it could be argued that without the best and only explanation, we are unlikely to be making a good decision. This statement supports the inclusion of heuristics and biases in the program, in particular, the representativeness heuristic. According

to Kahneman (2013), “The technical definition of heuristic is a simple procedure that helps find adequate, though often imperfect, answers to difficult questions” (p. 271).

This suggests that heuristics can lead us to make incorrect judgments and establish a hierarchy of events that is not necessarily based on solid foundations. An example of this is the representativeness heuristic, which uses a personality trait as a basis to estimate the probability of expected behavior, giving priority to this trait as if it were representative of the entire personality structure (Saiz 2020).

With the aim of completing the conceptual cycle of the ARDESOS-DIAPROVE program in relation to IBE, real-world decision making, and the representativeness heuristic, we propose the Lilly case for integrated analysis. In this case, the tragic death of a company manager occurs under suspicious circumstances. The manager’s sister, also a co-owner of the company, plays a crucial role. With a history of mental health problems (depression, suicide attempts, emotional independence) and the consumption of sedatives on a tragic night, she shoots her brother, mistakenly believing he was an intruder in the house they shared. Despite her acquittal due to the accidental nature of the incident, questions arise about her ability to lead the company and her possible involvement in the fact. As the new manager, she has made significant business decisions without consulting the board of directors. The same happens in her personal life; she has set the date of her wedding without consulting her fiancé. The company’s executive board commissions a psychology professional to prepare a report to determine whether or not the new manager is qualified to run the company. The professional is asked to decide with an exclusive response, yes or no.

The professional is at a crossroads to make a decision. Let us analyze the first path, which originates from the representativeness heuristic. By focusing on personality traits such as emotional dependence and low self-esteem during the patient's study, it is natural to conclude that she is a person with a tendency to self-harm. Evidence of a suicide attempt could reinforce this assessment, even leading to rule out that she is prone to harm others. By establishing a personality profile based on the observed traits and behaviors, the professional could overlook relevant information, such as the patient's involvement in the accidental or intentional death of her brother. As a result of this diagnosis, the professional would consider it unlikely that she is an aggressive and violent person, as the observed traits are representative of certain behaviors. The professional's categorization can cause other relevant data to go unnoticed, focusing only on one aspect of the case. This demonstrates how labeling can limit our perception and understanding of a situation.

There is an alternative path that the professional could choose. Although less intuitive, it is more complex and encapsulates the methodological component of the ARDESOS-DIAPROVE program. This sequential process requires the professional to recognize the general limitations that hinder correct or resolute thinking, which could obscure the required decision making. However, it is not enough to just recognize these limitations; it is also crucial to identify them. In the program, this step is known as DEFISESGO, which refers to the identification of deficiencies and biases. By correctly applying this step, the professional would not focus solely on diagnoses and personality categorizations. Instead, she would analyze additional information, such as the sister's behavior and business decisions after the incident. In this way, the representativeness bias is recognized and overcome, avoiding basing the analysis solely on the psychological profile, the police report, or the court decision.

In a later stage, the professional should explore alternative explanations that transcend the simple collection of third-party data. This process is called BUSEXPLICA (search for a unique explanation). This process is conceptually aligned with IME, at least in its first phase. In this process, the professional should explore alternative hypotheses that consider family and business dynamics to provide a better explanation of the observed facts and contribute to decision making. To accomplish this, she could meticulously examine all available data and evidence, including forensic reports, testimonies, and business records, and combine them with the data she has collected herself. However, one thing is to seek the explanation, and another very different thing is to obtain a single explanation verified by the judge, which is the facts. This last step is called MEXPLICA (to have the best explanation and seek to unequivocally explain a fact or problem). It is at this moment that the powerful but sometimes complex machinery of deduction (Govier 2010) and causality is set in motion. This last stage is associated with IBE by the categorization of unequivocal explanation, but above all, because there can be no doubt that it is this explanation and not another that should be the protagonist in decision making. With the data logically integrated, the professional has all the elements of judgment to make a decision based on the two hypotheses at stake. Hypothesis 1: the emotional instability of the new manager makes her incompetent to lead the company, backed by her mental health history, reasonable doubts about her responsibility in the death of her brother, and her behavior after the incident. Hypothesis 2: the new manager is able to lead the company, demonstrated by her ability to handle crisis situations, the forensic experts who exonerated her of any intentionality in the death of her brother, and her adaptability shown after the incident.

The ARDESOS-DIAPROVE program highlights in its analysis of the Lilly case, presented here in a summarized form, the relevance of basing explanations on evidence and

observable facts. This approach underscores the need to overcome cognitive biases to facilitate decision making based on rigorous explanations derived from various sciences. The cases studied in the program are characterized by their ability to simulate reality, representing challenges that professionals must face. For this reason, the methodology focuses on the objective reality of the case, seeking to improve accuracy in the decision-making process. The application of the inference method to the best and only explanation, in this context, is especially effective. It facilitates the identification and support of the hypothesis that best aligns with the available evidence, leading to a more structured and logical analysis. This allows for a deeper and more precise understanding of the situation.

3. Conclusions

The aim of this article was to comprehensively expose one of the fundamental pillars of the ARDESOS-DIAPROVE program: inference to the best explanation. This aspect is crucial as it directly connects with the real world and refers to intriguing evidence that requires a cause to satisfy its explanatory character. The program focuses on the development of problem-solving skills through explanation. However, it is not about any explanation, but the best one. In this sense, it is essential to consider the reflections and challenges that the concept has faced in the epistemological approach.

An explanation is a powerful tool for understanding and solving problems, but only if it is accurate, relevant, and evidence-based. Unlike argumentation, explanation directly links to decision-making and real-world issues. Therefore, in teaching and practicing CT, it is essential not only to teach students to question and evaluate explanations but also to generate them effectively. For this, we take scientific activity as a reference. This involves understanding the

criteria, methods, and scientific standards that allow obtaining the best explanation and, at the same time, being aware of the complexity and limitations of the explanation process itself. The ARDESOS-DIAPROVE program has solid foundations drawn from psychology and the most outstanding developments of the rich tradition of critical thinking and, above all, has incorporated successful pedagogical practices and strict compliance with scientific standards. Therefore, it is not surprising that, as a result of the dialogue between the epistemological approach and the program, there is a high degree of coincidence. To the extent that an educational intervention program incorporates scientific results and applies scientific methods in search of explaining and predicting reality in a rigorous, replicable, and objective way, the dialogue with any epistemological approach will be constructive.

With the Lilly case, we have tried to emphasize the importance of seeking reasonable explanations and grounded in concrete evidence to guide decision making. We certainly recognize that the nature of a good explanation varies according to context and discipline, indicating the need for a more detailed and contextualized analysis. In addition, CT, as manifested in this analysis, goes beyond simple first-order reasoning. It involves a deep and methodical reflection on one's own thought process, including both the generation of conclusions through direct reasoning and the continuous evaluation of our cognitive abilities to overcome possible cognitive biases. The Lilly case demonstrates that an evidence-based and cognitive-bias-free approach, which prioritizes reasonable and contextualized explanations, is essential in knowledge processes and problem solving, but above all, it should guide decision making.

The ARDESOS-DIAPROVE program is an integrated system that relies on precise explanations to solve problems and substantiate informed decisions. The process begins with the

identification and understanding of the problem. A misunderstanding at this stage can result in inadequate solutions or incorrect decisions. The program also promotes the creation of various explanations or hypotheses to discover viable solutions. This step requires creative exploration and logical reasoning. The proposed solutions undergo a critical analysis, considering factors such as coherence, applicability, and consistency with prior knowledge. Finally, the program highlights the need for rigorous evaluation to ensure that decisions are based on solid explanations. In summary, the program links decision making and explanation in a continuous cycle. Effective explanations arise from problem solving and guide future decisions. This process highlights the importance of critical thinking and the inference of the best and only explanation in the generation, evaluation, and selection of solutions, resulting in effective decisions and well-founded explanations.

Finally, epistemology, understood as a study of scientifically justified true beliefs, establishes conceptual spirals that reinforce scientific practice, especially highlighting methodological rigor. We have established dialogues within this explanatory spiral with selected authors. However, we could have extended these dialogues to other contemporary authors and established necessary contrasts, for example, with topics such as causality and probability or directly with abduction. These dialogues not only validate and conceptually strengthen the program but also allow us to participate in debates about these conceptual achievements. In recent years, we have not had the opportunity to participate in epistemological dialogues, mainly because the objectives of the program have been practical. We seek changes in students, their persistence over time, and their generality in reality. This sometimes leads us to assume practical commitments with applied research in CT without this being interpreted as a critical stance against the purely conceptual.

As has been demonstrated in this text, there are still many issues to debate, not only with this program but also with others. In addition, the door remains open to continue investigating the epistemological foundations of the proposals on CT and how they relate to the real world. An important direction for future research is how the role of CT, linked to epistemological debates, can mitigate cognitive biases in problem solving and decision making beyond the factual field of psychology. Perhaps the most relevant thing is how and under what conditions to measure the effectiveness of the program beyond a test that, although it can be predictive of behaviors in the world, is not the real world. These areas of research not only expand the scope of the current article but also open new avenues for understanding the practical application of critical thinking and epistemology in real life.

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Artículo 2

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Título

Análisis de la contribución del pensamiento crítico y el bienestar psicológico al rendimiento académico

Resumen

Introducción. El ingreso a la universidad representa un reto significativo para los estudiantes, los procesos de adaptación personal a contextos nuevos y las exigencias académicas que experimentan son factores determinantes del éxito académico y de la permanencia en la institución educativa. El artículo se enmarca en la necesidad de comprender cómo las competencias cognitivas y los factores socioemocionales influyen en el rendimiento académico, particularmente en estudiantes universitarios de primer año.

Objetivos. Se analizó el papel del pensamiento crítico (PC) y del bienestar psicológico en el rendimiento académico, para lograr esto se evaluó cómo y en qué medida ambos factores contribuyen al desempeño.

Método. Participaron 128 estudiantes de primer año del grado en Psicología de una universidad pública española. Se aplicó la escala de bienestar psicológico de Ryff y la prueba PENCRISAL de pensamiento crítico. El rendimiento académico se midió mediante las

calificaciones obtenidas en el curso. Se realizaron análisis de correlación y regresión lineal múltiple con el software IBM/SPSS versión 29.0.

Resultados. El PC mostró una correlación positiva y significativa con el rendimiento académico ($r = .514$), superior a la obtenida entre bienestar psicológico y rendimiento ($r = .336$). El modelo de regresión indicó que ambas variables predicen significativamente el rendimiento académico, sin embargo el PC se destacó como el predictor más potente ($\beta = .473$). No se observaron correlaciones significativas entre PC y bienestar psicológico. El PC también se relacionó significativamente con otras medidas académicas, como el promedio de expediente y la nota de ingreso.

Conclusiones. El PC constituye un factor determinante en el rendimiento académico y representa una competencia susceptible de ser entrenada de manera intencional y explícita. El bienestar psicológico, aunque menos influyente, también contribuye al desempeño académico, lo que respalda la necesidad de modelos educativos de intervención que se enfoquen a la vez tanto en dimensiones cognitivas como afectivas. La relación entre bienestar y PC no quedó demostrada en este estudio, lo que plantea interrogantes teóricos y metodológicos para futuras investigaciones.

Palabras clave: pensamiento crítico, bienestar psicológico, rendimiento académico, educación superior, evaluación

Texto original

Analysis of the contribution of critical thinking and psychological well-being to academic
performance

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Abstract

This study examines the influence of critical thinking and psychological well-being on the academic performance of first-year college students. It emphasizes the importance of a model of psychological well-being focused on self-acceptance, environmental mastery and purpose in life, along with a critical thinking approach oriented to problem solving and decision making. A total of 128 first-year psychology students from a Spanish public university participated, assessed by means of Ryff's psychological well-being scale (PWBS) and the PENCRISAL critical thinking test, complemented with grades obtained in a critical thinking course. The results show positive correlations between psychological well-being, critical thinking and academic performance, with a stronger relationship between critical thinking and academic performance. However, psychological well-being also plays a significant role in academic performance. The findings highlight the need for holistic pedagogical approaches that combine cognitive skills and personal development to enhance first-year students' learning.

1 Introduction

In the context of the increasing demands of contemporary societies, in this study we address how critical thinking (CT) and psychological well-being (PWB) influence academic performance within the university setting. Upon entering university, first-year students are faced with the challenge of adapting to new academic dynamics and demands, which they must balance with the pursuit of personal satisfaction (Acee et al., 2012; Casanova et al., 2018). The adaptation process, which involves the achievement of academic goals and the projection of long-term life objectives, is fundamental to academic performance, considered a key indicator of successful adaptation and a reflection of the competencies required in the professional environment (Alonso-Borrego and Romero-Medina, 2016; Frick and Maihaus, 2016).

The goal of this research is to show the link between CT, which is characterized by analyzing and evaluating information, making evidence-based inferences, and reflecting on one's own thought process for decision making and problem solving (Bailin et al., 1999; Ennis, 2015; Jahn and Kenner, 2018; Saiz, 2020; Halpern and Dunn, 2023), and the PWB, which focuses on personal development (Ryff, 1989, 2013; Ryff and Keyes, 1995); and analyze how both contribute to academic performance. Despite the complexity of the factors that can influence academic performance, in this study we want to combine cognitive and socio-affective variables to better understand these dynamics. Based on The Ryff Psychological Well-Being Scale (PWBS), we examine how well-being, especially through self-acceptance, environmental mastery, and purpose in life impacts academic performance. As a starting point we recognize that CT may have an even greater effect on academic performance. This holistic approach seeks to contribute to the debate on the competencies needed for the 21st century through the relevance of

CT and PWB in university education and their role in the formation of individuals capable of coping with contemporary demands.

1.1 Contextualization and characterization of academic performance

In the university context, academic performance is influenced by a series of factors ranging from pedagogical practices and student satisfaction with them to more personal and intrinsic elements. These include the student's motivation and emotional state, academic background, IQ, personality traits and level of psychological maturity. This multi-layered approach focuses the complexity underlying academic performance and emphasizes the interaction between the educational environment and the individual qualities of each student.

A study by Oliván Blázquez et al. (2019) highlights the flipped classroom (FC) method in comparison to traditional lecture-based learning (LB) and shows that FC not only improves students' grades, but also maintains their satisfaction with learning without increasing their perceived workload. Although FC was initially perceived as more difficult, this did not have a negative impact on satisfaction or long-term learning, underscoring the importance of student perceptions and involvement in the learning process. These results support the introduction of FC in higher education and point to the need for continuous adjustments based on student feedback to maximize academic performance and develop critical and practical skills.

Beyond educational practices, Gilar-Corbi et al. (2020) investigated how motivational and emotional factors and prior academic performance influence college students' success. The study used the Motivated Strategies Learning Questionnaire (MSLQ) and the Trait Meta-Mood Scale (TMMS) to measure motivational learning strategies and emotional intelligence. The findings show that scores obtained in the diagnostic tests have a strong influence on academic

performance, while emotional attention has a minor influence. The study points out that prior performance, together with self-efficacy and appropriate emotional regulation, plays a crucial role in predicting academic success. Thus, the authors suggest that interventions focused on improving self-efficacy and emotional intelligence may be key to optimizing students' academic outcomes.

In the same context, this time with more variables, Morales-Vives et al. (2020) investigate the influence of intelligence, psychological maturity and personality traits on the academic performance of adolescents, and find that these factors combined explain about 30% of their variability. Intelligence, especially in reasoning and numerical aptitude, emerges as the most significant predictor, while psychological maturity, reflected in work orientation, and traits such as conscientiousness and openness to experience, have an indirect influence. These findings show that, although intelligence plays a decisive role, maturity and personality are in a lesser proportion.

These conclusions and the recommendations derived from them resemble recent advances in academic research. One example is the work of Mammadov (2022), which draws attention to cognitive ability as the main predictor of academic performance, but also points to the relevance of conscientiousness, a personality trait associated with self-discipline and organization, which explains a significant part of the variability in academic performance. Mammadov also suggests that the influence of personality on performance varies by educational level, showing the dynamics between a student's personality and his or her educational context. These findings demonstrate the need for educational strategies that promote both cognitive development and the reinforcement of positive personality traits.

Recent research on academic performance shows two consensuses. First, there is a growing understanding of the influence of the interaction between intrinsic and extrinsic factors, including pedagogical methods and motivational, emotional and cognitive elements, in improving the performance and satisfaction of students in higher education. The studies reviewed highlight the relevance of cognitive ability and personality traits such as consciousness, and promote a holistic educational approach that integrates the development of cognitive and personality dimensions. Second, academic achievement is recognized as a multidimensional construct, objectively assessed through quantitative indicators such as grade point average (GPA) and standardized assessment scores. These reflect the attainment of educational objectives and the accumulation of knowledge and skills over time.

1.2 Contextualization and characterization of critical thinking

Halpern (1998) argues that intrinsic effort and a willingness to analyze and solve complex problems are key competencies for learning and adapting to a constantly changing environment. According to Halpern (1998) CT transcends the mere acquisition of analytical skills and requires the development of an active predisposition to question assumptions, consider diverse perspectives, and persist in cognitive effort. This disposition is by no means innate, but can be cultivated through a pedagogy that explicitly integrates the teaching of critical skills such as logical analysis, argument evaluation, and information synthesis, and that emphasizes problem structuring to facilitate skill transfer and metacognitive self-regulation. Halpern proposes an educational framework that promotes the acquisition of these skills and encourages reflection on the thinking process so that students are able to apply CT effectively in diverse contexts and continuously improve. This methodical and structured approach characterizes CT as a set of

advanced cognitive skills and an exercise of conscious judgment that is essential for informed, evidence-based decision making, which integrates non-cognitive elements (Halpern and Dunn, 2023).

Throughout the development of the discourse on CT, various theories and their empirical foundations have evolved into meaningful educational practices, recognized in diverse academic settings. Meta-analyses, particularly those by Abrami et al. (2008, 2015) have contributed significantly to the understanding of effective teaching of CT and have emphasized the need for specific and tailored teaching strategies that incorporate clear CT objectives into educational programs. These studies demonstrate that CT, defined as a process of intentional, self-regulated judgment that includes interpretation, analysis, evaluation, and inference, is increasingly recognized as essential in the knowledge era. Abrami et al. (2008) note that critical skills and dispositions are developed through explicit pedagogical interventions, as opposed to spontaneous acquisition, which challenges traditional pedagogical paradigms and fosters a shift towards intentional educational practices, placing students at the center of learning.

In addition, a more detailed analysis by Abrami et al. (2015) identifies that strategies that encourage interactive dialogue, confrontation with real problems, and individual tutorials are particularly effective. This suggests that active and meaningful learning outperforms traditional methods in the development of critical skills. This approach not only enhances students' analytical and synthesis skills, but also facilitates the transfer of knowledge to new contexts, a key skill for the 21st century. The research reinforces the view that CT is a cross-cutting competency, crucial for navigating the complexity of contemporary challenges, and argues for an education that integrates these skills into all areas of learning.

Despite in-depth analyses of the need for CT, the growing discrepancy between rapid progress, the availability of information and the ability to critically analyze it poses a major challenge. Dwyer et al. (2014) point out that the exponential increase in global information has outpaced the ability of traditional education systems to teach effective CT skills, creating a gap that may inadequately prepare students for the challenges of today's world. The authors argue that the ability to critically evaluate, synthesize, and apply knowledge is crucial for academic success and survival in the 21st century. This approach highlights how CT, by fostering analytical and reflective skills, transcends academia to positively impact individual and collective well-being, and argues for educational strategies that bridge the gap between information acquisition and critical analytical skills.

Recent research on this topic points to the indisputable relevance of CT as an essential component of academic performance and points to its role as a key predictor of success in educational processes. Rivas et al. (2023) show that CT transcends conventional cognitive skills. This is because CT is characterized as a rigorous practice that fosters in-depth analysis, critical evaluation and synthesis of information oriented to decision making and problem solving, fundamental skills to understand and apply knowledge in complex contexts. Research shows that CT skills not only maintain a positive correlation with academic performance, but can be significantly improved through targeted educational programs. For this reason, the authors advocate their integration into curricula and educational assessment systems to prepare students for the challenges of the 21st century, especially when phenomena such as artificial intelligence acquire greater prominence in social and professional dynamics (Saiz and Rivas, 2023).

The literature on CT identifies two fundamental consensuses: first, it defines it as an intentional and deep process, oriented to problem solving and decision making, based on meticulous analysis that goes beyond logical reasoning to include a critical evaluation of the basis for judgments. In addition, it involves detailed scrutiny and integration of new information in changing contexts, as well as metacognition, i.e., conscious self-regulation of thinking that facilitates adaptation and continuous improvement of cognitive strategies in accordance with the major demands and obstacles of our first half century (Dwyer, 2023). In its practical application, CT enables daily challenges to be met through informed judgments and a willingness to question and adjust perspectives in response to new information. Characterized by curiosity and adaptability, CT is essential for making responsible decisions and achieving successful outcomes, underscoring its practical value in both personal and professional settings.

Second, CT, beyond its theoretical value, can be conceived as a key theory of action for academic performance and PWB (Saiz, 2020; Saiz and Rivas, 2023), by enhancing in individuals the ability to face and solve problems in an effective and grounded manner. CT involves crucial skills such as analysis, evaluation and synthesis, indispensable for acquiring and retaining knowledge, and also for applying it in new contexts, which improves academic performance and has, in principle, positive effects on quality of life. Thus, CT emerges as an academic competence and an essential tool for everyday life (Dumitru and Halpern, 2023; Guamanga et al., 2023). Therefore, to synthesize theoretical paths with a practical function, we understand that “to think critically is to arrive at the best explanation of a fact, phenomenon or problem in order to know how to solve it effectively” (Saiz, 2024, p. 19).

1.3 Contextualization and characterization of psychological well-being

The task of relating concepts that are difficult to operationalize, such as well-being, is a major challenge; but it is necessary to approach it, more within a framework of CT understood as a means to achieve broad objectives than as an end in itself. Thinking critically transcends the mere application of skills or the accumulation of goal-oriented knowledge. In fact, it requires a detailed examination of the effect that such management has on the environment and how the satisfaction derived from reaching certain achievements is related to subjective aspects.

CT by its very deliberative and goal-oriented nature goes beyond the search for how to reach effective solutions and addresses a wider range of human and social consequences resulting from these actions (Facione, 1990; Elder, 1997; Jahn, 2019). The idea is to involve non-cognitive aspects that occupy a central place in academia, and that are crucial in the interaction between specific knowledge and skills, elements widely explored in the discourse of CT. In this sense, PWB has been selected as the focus of study, recognizing it as a desirable attribute in educational processes. The challenges this poses are not lost sight of, especially when it comes to quantifying transient, subjective and normatively mediated judgments about what states or conditions are considered good, healthy or desirable in the complexity of human experience, as detailed by Flanagan et al. (2023).

Ryff (1989, 2013), Ryff and Keyes (1995) contribution to the conceptual understanding and dissemination of PWB is notorious and highly valued in different fields of knowledge (Van Dierendonck and Lam, 2023). The imprint of his research has been marked by criticism of a reductionist conception of PWB that simplifies well-being to the presence of positive affective states (Ryff, 1989). Consequently, Ryff defends a much more complex multidimensional concept that seeks to attune the attainment of goals with the development of potentialities. Ryff's thesis is

that PWB is a multidimensional construct that transcends happiness or mere life satisfaction (Ryff and Keyes, 1995).

Carol Ryff's theory of PWB, based on humanistic, clinical and developmental psychology, as well as Aristotelian eudaimonia, focuses on self-actualization, the search for meaning and purpose in life as the core of well-being. As detailed in the text *Happiness is everything, or is it? Explorations on the meaning of psychological well-being* (Ryff, 1989) the model consists of six dimensions that converge in personal development: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance.

The first dimension, self-acceptance, implies a positive attitude towards oneself and an acceptance of all aspects of one's identity, including both positive and negative qualities. As for positive relationships with others, Ryff states that these are interpersonal relationships characterized by warmth, trust and genuine concern for the well-being of others; this dimension is dominated by the value of empathy in human well-being. Autonomy is defined by an individual's capacity to maintain independence and resist social pressures in order to regulate their behavior according to internal personal norms. This dimension emphasizes self-determination as a compass for the pursuit of well-being. On the other hand, environmental mastery emphasizes the ability to effectively manage and control the external environment, which implies a feeling of competence and control over personal and professional life. Finally, purpose in life and personal growth refer to the possession of goals, direction and a sense of development and fulfillment of one's potential. These dimensions reflect the search for meaning and continuous personal evolution as fundamental components of PWB.

Ryff's PWBS has established itself as a key instrument in positive psychology. Research after 1989 (Ryff and Keyes, 1995; Ryff, 2013) has explored the variability of these dimensions with age and across genders. These studies showed the influence of sociodemographic factors on well-being, so the model has been extended to consider the development of PWB across the lifespan and determined by more contextual factors such as health. The approach enriches the understanding of PWB and denotes the practical relevance of the construct in fields such as mental health and social policy. Ryff's work has inspired other researchers to discuss and extend its principles (Van Dierendonck and Lam, 2023). For example, Huppert (2009) complements Ryff's dimensions by emphasizing the management of negative emotions and resilience as key components of sustainable well-being; Huppert aligns this view with the World Health Organization (WHO) definition of health and adds a dynamic dimension on overcoming adversity. This theoretical and practical deepening demonstrates the robustness and adaptability of Ryff's model. The synthesis of these contributions confirms the value and applicability of Ryff's PWBS; they reveal how the eudaemonic model not only reinforces an academic discourse, but also guides practices that promote well-being in different contexts and consolidates itself as a vital field in human development.

However, due to the same complexity and extension of the PWB construct, Ryff's PWBS has different observations that question its theoretical and statistical foundations. On the first aspect, the work of Disabato et al. (2016), by examining the distinction between hedonic and eudaimonic well-being, problematizes the theoretical basis of this dichotomy. Through an analysis incorporating data from 7,617 individuals from 109 countries, the authors find that there is no clear distinction between hedonic well-being experiences, focused on pleasure, and eudaimonic ones, related to personal fulfillment. The results indicate a high correlation between

the two types of well-being ($r = 0.96$). This suggests that people do not significantly differentiate between pleasure seeking and self-fulfillment in their perception of well-being. This implies that the hedonic-eudaimonic dichotomy may not hold empirically and, therefore, a unified model of well-being that reflects the current behavioral dynamics should be sought.

From a statistical perspective, Ryff and Keyes (1995) analyses show that the PWBS, composed of 18 items, meets psychometric criteria and shows strong internal and moderate correlations among different scales. Correlations between dimensions range from low to modest (0.13 to 0.46), suggesting that each dimension addresses unique aspects of well-being. From the theoretical model, this diversity underscores that, although interrelated, the dimensions represent unique aspects of psychological well-being. In terms of specific results, studies indicate that with age the dimensions of environmental mastery and autonomy increase, while purpose in life and personal growth tend to decrease, with no significant changes in self-acceptance and positive relationships with others. Women outperform men on positive relationships with others and personal growth, suggesting that changes in these dimensions reflect evolving priorities and perceptions of personal development across the life span (Ryff and Keyes, 1995).

On the number of dimensions of PWBS, Blasco-Belled and Alsinet (2022) note that the six-dimensional theoretical model has generated debate even among experts in the field. Some suggest that a four-dimensional model-environmental mastery, personal growth, purpose in life, and self-acceptance-might represent a second-order PWB factor, indicating a possible conceptual overlap between Ryff's original dimensions; others exclude positive relationships with others and autonomy from the model. The study of Ryff's PWBS by network analysis conducted by Blasco-Belled and Alsinet (2022) shows four different dimensions, in one of these, the most

important node of the network, self-acceptance, purpose in life and environmental mastery are grouped, with special emphasis on self-acceptance because of its centrality in the network at the item level.

In the Spanish-speaking context, Nogueira et al. (2023) identified three main factors: autonomy, positive relationships with others, and competence. This suggests that PWBS may vary according to cultural and contextual factors. Furthermore, although it is not a study analyzing the dimensions of Ryff's PWBS, the study by Páez-Gallego et al. (2020) applied the PWBS to Spanish adolescent students and found a strong positive correlation with the use of adaptive decision-making strategies. Specifically, the findings show that the adaptive approach is significantly associated with improvements in self-acceptance, environmental mastery, and purpose in life. In contrast, maladaptive strategies characterized by impulsivity and avoidance are associated with lower PWB. From this we infer that fostering effective decision-making skills is important for well-being and, in particular, we identify from empirical studies the dimensions of PWBS that correlate with post decisional skills.

Taken together, these findings suggest that Ryff's PWBS, although pioneering and widely used, could benefit from revision to more accurately reflect the structure of PWB and its application in diverse cultural and educational contexts. The convergence of evidence from factorial and network analysis perspectives points to the need for a more integrated and adaptive model capable of capturing the complexity and dynamics of the underlying constructs. This underscores the continuing interest in PWB in research and practice. It is also an indication of the ongoing scholarly debate about its conceptualization and measurement. The recurrence of dimensions such as self-acceptance, environmental mastery, and purpose in life across analyses

suggests a common core of PWB. This raises the question of whether these dimensions can be conceptually aligned with academic achievement and CT. In addition, questioning the boundaries between hedonic and eudaimonic raises the issue of whether a broader construct is needed to analyze well-being in educational settings. In this context, we start from the premise that self-acceptance, environmental mastery, and purpose in life are sufficient to explore college students' PWB. These dimensions reflect students' ability to recognize their strengths and weaknesses, set goals, and navigate effectively in their educational environment, aspects that could be considered part of the dispositional component necessary for the development of higher-level competencies such as those of the CT.

The research brings to empirical analysis the complex interplay between CT, PWB, and academic performance in the university context. We seek to answer how CT skills and PWB influence college students' academic performance; and, how CT practices can be aligned with PWB to improve academic performance. We propose that the study variables converge in both a theoretical and an empirical model. The argumentative strategy consists of analyzing the direct impact of CT on academic performance, assessing whether PWB correlates with better academic outcomes, examining in detail the predictive factor of the relationship between CT and PWB on academic performance, and finally, according to the data obtained, proposing some dialogic bridges between cognitive and non-cognitive aspects of CT.

2 Methodology

2.1 Participants

The study involved 128 first-year psychology students from a Spanish public university. The vast majority were women (83.1%), with only 16.9% men, which is usual in social sciences

and humanities degrees. Age ranged from 18 to 33 years, with a mean of 19.28 ($SD = 1.73$). The sample was essentially composed of students who had completed secondary education (75.3% of the students were 19 years old). Between the ages of the students according to sex — females ($M = 19.09$, $SD = 0.814$) and males ($M = 20.20$, $SD = 3.78$) — there were no statistical differences, but the age of the males was not only higher, but also more dispersed.

2.2 Instruments

The instruments applied were Ryff's PWBS in its Spanish adaptation (Díaz et al., 2006) and the PENCRIAL critical thinking test (Saiz and Rivas, 2008; Rivas and Saiz, 2012). For academic performance, the academic records of the students participating in the critical thinking course in the first year of the psychology graduation were collected. The grades have an ascending interval from 1 to 10.

Ryff's PWBS as mentioned in the previous discussion has different models. This instrument aims to measure psychological well-being, focusing on students' own evaluations of their situations and perceived success in various aspects of life and personal development. It explores well-being through six main dimensions, self-acceptance ($\alpha: 0.83$), positive relationships with others ($\alpha: 0.81$), environmental mastery ($\alpha: 0.71$), autonomy ($\alpha: 0.73$), purpose in life ($\alpha: 0.83$) and personal growth ($\alpha: 0.68$). The questionnaire consists of 39 items, presented in a Likert scale format ranging from 1, strongly disagree, to 6, strongly agree (Díaz et al., 2006).

Consistent with the complexity of the scale and some data in common with other studies, we have chosen to consider only self-acceptance, environmental mastery and purpose in life. In support of this methodological decision, we have performed with our sample an exploratory factor analysis (principal components method) to see if these three dimensions converge in the same factor. The data confirm this convergence and show that this single factor has an eigenvalue of 2.43 and explains a very high value of the variance of its results (81.1%).

In the case of the PENCRISAL, the full version was applied, and the score was taken for each of the five dimensions and the total score. The PENCRISAL was applied to measure CT skills. This test consists of 35 problem situations that participants answer in an open-response format. The test is organized into five key areas: deductive reasoning, inductive reasoning, practical reasoning, decision making and problem solving.

The deductive and inductive component tests different forms of reasoning, such as propositional, categorical, causal, analogical and hypothetical. Decision-making measures the ability to make probabilistic judgments and to effectively use heuristics to identify potential biases. The problem-solving section poses participants with general and specific problems that require appropriate solution strategies. These sections are intended to encourage the application of strategies necessary for effective problem planning. The open-ended question format encourages participants to justify their answers, which are evaluated using a scoring system that rates the quality of their responses on a scale of 0 to 2. Responses are converted into numerical scores using item-specific criteria. These are used to describe and identify the thinking mechanisms underlying each response. A score of 0 indicates that the answer is incorrect, 1 indicates that the answer is correct but no or inadequate justification is provided, and 2 indicates

that the answer is correct and adequate justification is provided. The PENCRISAL yields an overall score of the CT ranging between 0 and 70 and between 0 and 14 for each dimension. Reliability assessments show satisfactory accuracy, with a minimum Cronbach's Alpha of 0.632 and a test–retest reliability of 0.786 (Rivas and Saiz, 2012). The test is administered online through the SelectSurvey.NET V5 platform.

2.3 Procedures

Students gave their free and informed consent to participate in the study. The PWBS was carried out at the beginning of the semester of the CT course. The PENCRISAL test was taken at the beginning and at the end of the academic period. Only the results of students who completed both instruments are considered. Academic performance is represented by the grade obtained by students at the end of the course. Statistical analyses were performed with IBM/SPSS version 29.0. After performing the descriptive statistics, we proceeded to a correlation analysis and, finally, we evaluated the impact of the PWBS and the CT on the variance of academic performance by performing a regression analysis.

3 Results

Table 1 presents the descriptive data of the students' scores on the two instruments applied, and the measure of academic performance. In addition to the minimum and maximum values, the mean, standard deviation and indicators of skewness and kurtosis of the distribution of the results are presented.

Table 1. Descriptive statistics for the measures used ($n = 128$).

Variables	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
PWBS	39	103	79.80	13.41	-0.437	0.076
DR	1	14	5.56	2.59	0.395	0.173
IR	2	16	6.36	2.10	0.858	2.248
PR	2	14	10.20	2.41	-1.002	1.338
DM	4	13	8.52	1.83	0.080	0.031
PS	2	16	6.87	2.32	0.409	0.797
TCT	19	56	37.21	7.17	-0.012	-0.293
AP	3.66	9.01	6.10	1.05	0.204	-0.155

Psychological well-being scale (PWBS), deductive reasoning (DR), inductive reasoning (IR), practical reasoning (PR), decision making (DM), problem solving (PS), critical thinking total (TCT), academic performance (AP).

Observing the results, we can see a distribution with a slight tendency towards values above the mean ($m = 79.80$) for the PWBS, which is reflected in a negative skewness (-0.437). With respect to the five dimensions of CT, it can be stated globally that the mean value of DR, IR and PS is moving away from the maximum value observed and towards the minimum value, which represents a positive symmetry. The opposite situation occurs with the RP dimension. Regarding the TCT, the data show a tendency to scores around the mean ($m = 37.21$), as can be deduced from the residual values of skewness and kurtosis. Regarding the AP, the data suggest a balanced distribution of academic scores around an intermediate value between 3.66 and 9.01 as scores at the lower and upper extremes ($m = 6.10$), with very low skewness and kurtosis.

In general, the results show good variability or dispersion, since the mean of each variable is located in the center of the data interval, which is desirable in research to adequately represent the population studied. Skewness and kurtosis indices close to zero for academic achievement are especially indicative of a normal or Gaussian distribution of values. The slightly higher kurtosis in the IR dimension of CT (2.248) is still acceptable.

Table 2 shows the correlations between the variables in this study. Since these were interval metric variables, Pearson's product x moment method was used to calculate the correlations. For statistical significance, the two-tailed test was used and $p < 0.05$ was set as the limit of significance.

Table 2. Correlations between study variables.

Variables	PWBS	DR	IR	PR	DM	PS	TCT	AP
PWBS	–	–0.082	–0.167	–0.041	–0.132	0.040	0.039	0.336**
DR	–0.082	–	0.450***	0.271	0.227**	0.118	0.589***	0.211*
IR	–0.167	0.450***	–	0.362***	0.218*	0.129	0.622***	0.205*
PR	–0.041	0.669***	0.362***	–	0.381***	0.132	0.668***	0.337***
DM	–0.132	0.593***	0.218*	0.381***	–	0.295**	0.593***	0.217*
PS	0.040	0.502***	0.129	0.132	0.295**	–	0.502***	0.183*
TCT	0.039	0.589***	0.622***	0.668***	0.593***	0.502***	–	0.514***
AP	0.336**	0.211*	0.205*	0.337***	0.217*	0.183*	0.514***	–

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed).

According to the data, the highest correlation is found between TCT and AP, with the lowest correlation being between CT and PWBS measurement (no correlation). At an intermediate level is the correlation between PWBS and AP. Likewise, all the dimensions of the CT correlate with the AP with values between 0.183 (PS) and 0.337 (PR). As can be seen, there are variations in the correlations among the five dimensions of the CT, but all have high correlations with the total score (between 0.502 and 0.668). In this sense, only the TCT score is used for the regression statistical analysis.

In summary, the data suggest that there is a significant and positive relationship between PWBS and AP, as well as an even stronger and more significant relationship between TCT and AP. There is no evidence of a significant relationship between PWBS and TCT. To further explore the relationships between cognitive and noncognitive variables in AP, we turned to a

regression analysis. We opted for a linear regression with PWBS and TCT as predictors and AP as the criterion or dependent variable. Table 3 presents the regression values obtained.

Table 3. Impact of psychological well-being and critical thinking on academic performance.

		B	Error	Beta	<i>t</i>	Prob.
1	(Constant)	1.653	0.793		2.085	0.041
	PWBS	0.022	0.007	0.271	3.004	<0.01
	TCT	0.074	0.014	0.473	5.252	<0.001

The regression model was found to be statistically significant, with an *F*-value (2, 88) = 18.571, $p < 0.001$. This indicates that, collectively, PWBS and TCT provide significant prediction of AP. The coefficient of determination (R^2 adj.) is 0.285, which means that approximately 30% of the variability in AP can be explained by the independent variables in the model. As can be seen from the *t*-values and significance, both variables have a significant impact on AP, although TCT has a greater impact.

In a complementary manner, with the objective of enriching the analysis of the influence of the CT on the PA, we have included additional measures to the grade obtained by the students in the course (NCT), such as the selectivity grade with which they entered the university (NEBAU), the average grade of the transcript (NMEXP), that is, the grades of the other courses that the students must take, and the pretest results obtained with the PENCRIAL (PCT). The data obtained are recorded in Table 4.

Table 4. Correlations between study variables and complementary measures.

Variables	PCT	TCT	NCT	NMEXP	NEBAU	PWBS
PCT	–	0.477***	0.196*	0.271***	0.089	–0.142
TCT	0.477***	–	0.512***	0.464***	0.177*	–0.128
NCT	0.196*	0.512***	–	0.642***	0.288**	0.194*
NMEXP	0.271**	0.464***	0.642***	–	0.455***	0.075
NEBAU	0.089	0.177*	0.288***	0.455***	–	0.008
PWBS	–0.142	–0.128	0.194*	0.075	0.008	–

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed). PCT, PENCRIAL total PRE; TCT, total of PENCRIAL POST; NCT, critical thinking course note; NMEXP, grade point average; NEBAU, selectivity score; PWBS, Psychological Well-Being Scale.

Table 4 shows that the relationship between PWBS and NMEXP has a Pearson correlation of 0.075, with a p -value of 0.372. This low correlation indicates that the connection is minimal. In contrast, the relationship between TCT and NMEXP shows a stronger correlation of 0.464**, suggesting a moderate positive association. The significance of this correlation, less than 0.001, indicates a statistically significant relationship, which implies that this result is not likely to be a coincidence. A similar case occurs with the relationship between NEBAU and NMEXP.

Given this context, if we perform a multiple linear regression analysis with NMEXP as the dependent variable and PWBS and TCT as independent variables, we would expect TCT to have a more significant impact on NMEXP. This projection is based on the statistically significant correlation of these variables. On the other hand, NEBAU has a slightly lower correlation with NMEXP compared to TCT (0.455 vs. 0.464), but the difference is very small, indicating that both have similar impact capacity for NMEXP in terms of linear correlation.

Confirmation of these hypotheses by appropriate regression analysis will provide a more detailed and accurate understanding of how PWBS and TCT individually contribute to the prediction of NMEXP, considering the influence of interrelated variables. However, in performing this procedure, a reduction in sample size to only 64 cases were observed. This

increases the risk of failing to detect significant differences or could lead to unstable effect estimates.

4 Discussion and conclusions

The CT seeks to understand and effectively solve problems, through a correct approach, the generation of solution alternatives filtered by the mechanism of explanation and the selection of a solution, all with the aim of achieving a desired change. The PENCRIASAL test is based on this defining framework of the CT (Saiz and Rivas, 2008; Rivas and Saiz, 2012). Therefore, if we start from this concept and look at the data, we can conclude that the CT is a good predictor of academic performance.

Table 2 shows a positive and moderate correlation (0.514) between the CT and academic performance, suggesting that an increase in the CT is associated with an improvement in academic performance. Meanwhile, Table 3 shows — with a B coefficient of 0.074 and a Beta of 0.473 — that CT has a stronger relationship with academic performance compared to PWBS. This means that for every unit increase in CT, academic performance increases on average 0.074 units, and this effect is considerably significant in the model. The robust correlation and the impact indicated as a dependent variable highlight that the CT is a determinant competence of academic performance and is suggested as a relevant diagnostic and formative tool in the educational field. Although it is not the only factor that influences academic performance, the CT is presented as a significant predictor and one that can be worked on or trained in the classroom.

Declaratively, the current study coincides with other results obtained and recorded in Rivas et al. (2023). On that occasion, the authors found that CT is a predictor of academic performance and that the benefits of instruction can be sustained over time. The study showed a

correlation between CT and academic performance of 0.32. The main difference between these two studies concerns the objectives. The previous study did not attend to the explicit discussion of how CT could influence well-being, or vice versa. The current work recovers this line and incorporates non-cognitive variables in the analysis framework to account for well-being, under the assumption that this construct should have a significant impact on academic performance.

More generally, if we consider that, although the construct intelligence is not the same as CT, they do have several points of convergence (Butler et al., 2017), then we can establish a dialogue with other studies on the factors that influence academic performance. Intelligence represents the intrinsic capacity to learn, understand, reason, and meet challenges through problem solving to adapt to the environment (Sternberg, 1985). This cognitive potentiality manifests itself in various ways, being the CT one of its most relevant expressions, particularly in situations that demand deep analysis, evaluation, and decisions based on logical reasoning (Saiz, 2024). The CT, therefore, acts as an essential tool that intelligence employs to effectively navigate through complex and challenging real-world situations (Halpern and Butler, 2018).

In this conceptual line, the current results partially coincide with studies that have shown that the best predictors of academic performance are cognitive components, such as measures of general intelligence, analogical reasoning, fluid intelligence, logical, verbal and quantitative reasoning (Morales-Vives et al., 2020; Mammadov, 2022); as well as scores on the diagnostic and university entrance test (Gilar-Corbi et al., 2020).

In our study the other factor of analysis was the PWB. Although due to its non-cognitive nature it would be *per se* at a disadvantage compared to cognitive factors, the data also show that its inclusion in educational research, especially to account for academic performance, is

significant. In Table 2, the analysis of the correlation between PWBS and academic performance reveals a positive relationship with a correlation coefficient of 0.336. Although the correlation is moderate and not as strong as that observed between CT and academic performance, it is still significant and should not be ignored in the pursuit of improving students' academic performance. Table 3 shows that PWBS has a positive and significant influence on the dependent variable. The standardized coefficient (Beta) of 0.271 indicates that there is a positive relationship between PWBS and academic achievement. The unstandardized coefficient (B) shows that, holding all other variables constant, for each unit increase in PWBS, academic performance increases on average 0.022 units. This relationship, supported by a low standard error of 0.007, points to a moderate but significant contribution of PWBS compared to other variables.

These findings show that the integration of some aspects of PWBS could be an effective strategy to improve academic performance, evidencing a beneficial and significant relationship between both aspects. PWB can influence academic performance through non-cognitive conditions or factors involved in learning, such as motivation, academic satisfaction, effective coping with stress or anxiety, and the acceptance and management of limitations related to the process of appropriation and adaptation to one's own identity.

However, it is important to emphasize that the PWB is a construct that requires careful theoretical and empirical review in the educational context, as the Ryff scale has open debates and the lack of uniqueness of criteria on the number of dimensions influences these results. To cite just one case, we have used three dimensions out of six, with statistical and literature support, but the data may be different with a different selection approach. This finding highlights

the importance of students' PWB as part of a comprehensive educational strategy, but also shows that the direct impact of PWB on academic performance may be less pronounced than the impact of cognitive skills, and that due to its very multidimensional and complex nature, it is not easy to converge in an instructional design. Despite this, higher education institutions can take care of the institutional and relational climate so that students feel good and take advantage of the formative and educational opportunities of the academic environment. In the case of CT, there are concrete and validated training strategies that make it possible to improve skills such as argumentation, explanation, problem solving and decision making (Guamanga et al., 2023; Saiz, 2024). On the PWB side, the same cannot be said due to the lack of empirical support; however, some studies have proposed a path that incorporates socio-emotional competences in the training of CT, a proposal characterized by the cognitive-emotional methodology, with interesting results that still need to be explored and debated (Hanna, 2013).

Table 2 shows low and non-significant correlations between PWBS and the different forms of reasoning (deductive, inductive and practical), as well as with decision making and problem solving. For example, the correlation between PWBS and deductive reasoning is -0.082 , which is not only low, but also lacks statistical significance. Additionally, the correlation between PWBS and decision making is -0.132 , which is also a low correlation and not significant. Although there is a positive correlation between PWBS and problem solving (0.040), it is very low and not statistically significant, so there is not enough evidence to claim a positive relationship between these variables. This reinforces the idea that there is not a direct and significant relationship between how a student feels psychologically and CT skills or, nuanced is not supported by the data from this sample. It is possible that there are unexamined mediating

factors that influence these relationships or that the relationship exists in a different context or with different measures.

The results of the present study do not coincide with other research that has shown positive relationships between decision-making and PWBS, especially with self-acceptance, environmental mastery, and purpose in life. The study by Páez-Gallego et al. (2020) addresses this issue by exploring how the PWBS of adolescents in Madrid, Spain, is linked to their decision-making methods. The research concludes that there is a positive correlation between the use of adaptive decision-making strategies and PWBS. Adolescents who opt for a rational and systematic evaluation of available options report higher levels of well-being. Specifically, adaptive decision-making style correlates significantly with overall well-being (0.544) and with aspects such as self-acceptance (0.485), positive relationships with others (0.242), environmental mastery (0.472), autonomy (0.359), purpose in life (0.473), and personal growth (0.346). In contrast, those who resort to maladaptive strategies, marked by impulsivity or avoidance, show reduced PWBS (−0.458).

The discrepancy in results with this study could be due to the difference between the instruments used to assess decision making. While Páez-Gallego et al. (2020) used the Flinders Adolescent Decision Making Questionnaire (FADMQ), which focuses on personal perceptions and experiences of decision making, our study uses the PENCRIASAL, which although not limited to decision making, does include this ability as an essential component of the CT. The latter measures the ability to identify, analyze and solve everyday problems through items that simulate real situations, assessing the ability to choose the best solution or action strategy. Because the PENCRIASAL responses are open-ended, it allows for a detailed assessment of how

participants describe or explain their decisions. Ultimately, the fundamental difference between these two measures is that one is a self-report of perceptions and experiences, while the other is a set of problems to be solved correctly; in other words, one collects impressions of decision making and the other collects realized decision making. Therefore, although both studies applied Ryff's PWBS, the differences between instruments and approach to decision making explain the variations in the results. This divergence evidences the relevance of considering the context and the specific instrument when interpreting the relationship between the PWBS and decision making.

Despite these findings, the need to further explore these interactions persists, especially given that the three selected dimensions-self-acceptance, environmental mastery, and life purpose-theoretically align with CT approaches focused on explanation and the development of post decisional skills, such as decision making and problem solving (Guamanga et al., 2023). A CT approach that emphasizes the development of these skills must consider effects that transcend immediate or tangible outcomes. Therefore, it is crucial to understand how the concept of PWB, as examined above, relates to CT. Specifically, it must be determined whether some of these dimensions align directly to foster effective CT, or whether they instead lean more towards a conception of well-being in a more general sense, which could include hedonic aspects.

The emphasis on CT oriented to decision making and problem solving through the analysis of explanations and causalities should be evaluated for its pragmatic effects on PWB. At first glance this idea seems to confront parallel concepts paradoxically united by the same diachronic nature. In the case of the CT, this nature explains the high demands placed on it. For example, it is not enough to say that it contributes to tangible improvements in academic

performance, but its usefulness is expected to transcend beyond academia and materialize in skills of interest to organizations in all sectors of the economy (Casner-Lotto and Barrington, 2006; Atanasiu, 2021). However, their practical impact still presents serious challenges, especially when students, as active subjects of learning, face limitations in anticipating the usefulness and applicability of these critical skills for the future. This is partly explained by the fact that the educational system prioritizes academic performance over the comprehensive development required later in the professional sphere (Saiz, 2020). Which means that the CT can be interpreted as an unfulfilled or partial promise. It is certainly a reading that omits the particular contexts, interests, motivations and concerns of students while they are part of these instructional programs and then the same factors analyzed by a student who knows that he or she must make the transition to the professional field.

A similar case happens with PWB as a diachronic phenomenon. An instant in time is not enough to understand and analyze students' PWB. It is necessary to focus on how it changes and evolves through different stages, including through feelings of achievement or frustration in the academic process. Thus, it is recognized that PWB is not static and, therefore, evolves through lived experiences, among them, those comprising the applicability of a series of learned skills. This implies that as diachronic phenomena they can evolve and influence each other over time. This approach requires longitudinal studies to follow the evolution of the impact of curricular interventions aimed at strengthening cognitive skills such as those of the CT, in order to understand how these may influence the PWB in the long term.

The limitations of this study, beyond having a small sample that prevents the generalization of the results or having examined only certain dimensions of the PWBS, added to

the theoretical impossibility of performing regression analyses with other performance measures, lie in the diachronic nature of the constructs studied. This characteristic makes it difficult, as has been argued, to give a definitive answer on the relationship.

Within the framework of the PWBS triad model we are analyzing, it is possible to theoretically group several key concepts. The development of the CT involves a process of self-acceptance, which is crucial given our inherent tendency for error. This process allows us, through a reflective evaluation of our past and present, to recognize and accept beliefs that we have discarded as erroneous. This self-acceptance facilitates deeper introspection, allowing us to see these errors as essential learning opportunities in our lives. On the other hand, any model that emphasizes post-decisional skills must also consider the non-linear complexity of our reality, and provide solid criteria for problem solving and decision making to master our environment more effectively. This is what allows us to adapt better, both biologically and socially. Finally, this approach to TC inevitably values purpose in life by seeking to ensure that it is in part determined by integrating the best tools of science, philosophy and education for a more effective life orientation, grounded in the principles of rationality. The importance of setting clear goals, recognizing that their achievement requires effort, discipline and determination, is essential to being an effective critical thinker.

Therefore, although each dimension proposed by Ryff's PWBS possesses a conceptual richness that requires empirical validation, the dimensions selected for this study are aligned with a model of CT focused on problem solving and real-world decision making. Although we aspired to discover stronger links between PWB and CT, and to deepen their interrelationship, the theoretical parallelism analyzed is also reflected in the empirical results. Moreover, PWB as an

operational concept, due to its complexity and multidimensionality, is subject to continuous revisions or possible unifications into a broader notion of well-being.

In future research on this topic, it is essential to include a broader set of variables predictive of academic performance. This includes, but is not limited to, students' selectivity record and cumulative grades in other subjects. In addition, a more solid and theoretically robust concept of well-being must be adopted, one that fits contemporary educational and professional demands. This concept must transcend the simple distinction between eudaemonic and hedonic well-being, and address its diachronic nature. It is important to explore how these dimensions of well-being are interrelated, either as cause or effect; and to examine whether CT fosters a virtuous circle with well-being.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding author.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

MG: Writing – original draft, Conceptualization, Investigation, Methodology, Writing – review & editing. CS: Investigation, Methodology, Project administration, Validation, Writing – original draft. SR: Data curation, Investigation, Supervision, Validation, Writing – review & editing. LA: Formal analysis, Methodology, Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Artículo 3

Guamanga, M. H., Saiz, C., Rivas, S. F., & Bueno, P. M. (2025). Critical Thinking and Metacognition: Pathways to Empathy and Psychological Well-Being. *Journal of Intelligence*, 13(3), 34. <https://doi.org/10.3390/jintelligence13030034>

Título

Pensamiento crítico y metacognición: caminos hacia la empatía y el bienestar psicológico

Resumen

Introducción. El PC es una competencia fundamental en la educación superior, particularmente cuando se concibe como una práctica explicativa orientada a la acción. Esta perspectiva permite explorar su interacción con habilidades metacognitivas y con variables socioemocionales como la empatía y el bienestar psicológico, componentes clave del desarrollo universitario.

Objetivos. Validar empíricamente un modelo explicativo en el que el PC ejerce un efecto directo sobre la metacognición, y esta, a su vez, incide en la empatía y en dimensiones específicas del bienestar psicológico.

Método. Participaron 155 estudiantes universitarios. Se emplearon cuatro instrumentos en su versión española: la prueba PENCRISAL para evaluar el PC, el Inventario de Habilidades Metacognitivas, el Cociente de Empatía (*Empathy Quotient*) y la escala de Bienestar Psicológico de Ryff. El análisis estadístico se realizó mediante modelos de ecuaciones estructurales (SEM) con estimación por máxima verosimilitud en el software IBM/SPSS versión 25.0.

Resultados. Los índices de ajuste del modelo fueron adecuados ($\chi^2/df = 1.484$; CFI = 0.938; RMSEA = 0.056). El PC tuvo un efecto directo y positivo sobre la metacognición ($\beta = .35$; $p = .003$). Esta, a su vez, se asoció significativamente con el bienestar psicológico ($\beta = .71$; $p < .001$) y con la empatía ($\beta = .64$; $p < .001$). No se estimaron efectos indirectos ni se introdujeron datos de mediación.

Conclusiones. Los resultados respaldan dos hipótesis centrales. En primer lugar, el PC incide de forma directa y significativa sobre la metacognición, lo que confirma su capacidad para fortalecer procesos de monitoreo, planificación y control cognitivo. En segundo lugar, la metacognición presenta efectos directos, positivos y significativos sobre dimensiones específicas del bienestar psicológico (dominio de entorno, propósito de vida y autoaceptación) y sobre la empatía, entendida como la capacidad para identificar estados mentales en los demás y responder adecuadamente. El programa ARDESOS-DIAPROVE, desde su enfoque explicativo y orientado a la resolución de problemas, demuestra ser un instrumento pedagógico eficaz para integrar competencias cognitivas y socioemocionales dentro de la formación universitaria. Los hallazgos refuerzan la necesidad de diseñar programas instruccionales que desarrollen el PC no solo como habilidad cognitiva, sino como componente clave del desarrollo personal y relacional.

Texto original

Critical Thinking and Metacognition: Pathways to Empathy and Psychological Well-Being

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Abstract

This study examines the relationships between critical thinking, metacognition, psychological well-being, and empathy using structural equation modeling. The study sample consists of 155 university students from a higher education institution in Spain, who completed the PENCRIAL, the metacognitive abilities inventory, the Ryff psychological well-being scale, and the empathy quotient, which assess these psychological constructs. The results indicate that critical thinking has a direct positive effect on metacognition, which, in turn, is significantly associated with higher levels of psychological well-being and empathy. These findings reinforce the essential role of critical thinking in fostering cognitive self-regulation and socioemotional competencies. Furthermore, this study provides empirical evidence supporting the integration of critical thinking into educational programs, emphasizing its potential to enhance reflective thinking, emotional awareness, and interpersonal understanding.

Keywords:

critical thinking; metacognition; psychological well-being; empathy

1. Introduction: Exploring the Relationships Between Critical Thinking, Metacognition, Empathy, and Psychological Well-Being

In the fourth edition of *Thought and Knowledge: An Introduction to Critical Thinking*, Diane F. Halpern (2003) suggests a connection between critical thinking (CT) and empathy, arguing that solving interpersonal problems, similar to addressing other complex issues, require cognitive processes inherent to CT: accurately formulating the problem, generating alternative solutions, and selecting the most effective option. Interpersonal conflicts often involve ambiguous information, competing perspectives, and the need for reasoned judgment—elements that CT helps to resolve. Since empathy involves perspective-taking and emotional regulation, CT contributes to these processes by promoting analytical reasoning and reflective decision-making in social interactions. This perspective aligns with later theoretical contributions, such as those of Walters (1992, 1994) and Paul and Elder (2020), who also propose a relationship between CT and empathy. However, despite these shared conceptual foundations, the empirical exploration of this connection remains limited, as none of these works have led to a robust research tradition.

Beyond its connection to empathy, CT has also been identified as a catalyst for the development of metacognitive skills. According to Dwyer (2017), Halpern (1998) and Halpern and Dunn (2023), CT training facilitates the refinement of cognitive knowledge and cognitive self-regulation, both of which are essential components of metacognition. This is because systematic problem-solving and assertive decision-making—core processes within CT—require active reflection on one’s own cognitive processes, including their monitoring and adjustment when necessary. As a result, CT intervention programs not only strengthen an individual’s

capacity for effective problem-solving, but also have the potential to contribute to an individuals' psychological development and socioemotional well-being (Peng 2024; Su and Shum 2019).

Consequently, this study aims to investigate how CT, as an independent variable, directly influences metacognition. Furthermore, it explores the relationships between metacognition and other socioemotional domains, such as empathy and psychological well-being (PWB). Given that empathy involves both perspective-taking—the ability to understand others' viewpoints—and emotional regulation—the capacity to manage affective responses in social interactions—these processes inherently require analytical reasoning and reflective decision-making. CT contributes to empathy by fostering deliberate perspective-shifting, evaluating alternative viewpoints, and regulating biases and emotional responses that may otherwise hinder objective understanding. By integrating these perspectives, this work seeks to provide a theoretical and empirical framework that elucidates these relationships and fosters practical applications in educational and social contexts.

Based on these objectives, the following section delineates the conceptual foundations of critical thinking, metacognition, empathy, and psychological well-being, aiming to articulate the theoretical bridges connecting these constructs.

1.1. Critical Thinking: Foundations and Practical Applications

Critical thinking theorists agree that CT is a teachable competency with a significant impact on various dimensions of knowledge and everyday life, both at the individual and societal levels. Its integrative nature encompasses a combination of skills, knowledge, dispositions, and actions that can be developed and applied across diverse contexts (Davies and Barnett 2015; Ennis 2018; Facione 1990; Paul and Elder 2020; Saiz 2020).

Recently, Steinert et al. (2022) have emphasized the relevance of CT for the effective functioning of democratic systems. By enabling citizens to access and critically process information while avoiding manipulation or misinformation, CT emerges as a crucial resource for informed decision-making that benefits both individuals and society. Its applications extend beyond academia, encompassing practical scenarios such as decision analysis and the resolution of everyday challenges. Additionally, CT depends not only on identifiable cognitive skills that can be developed, but also on non-cognitive factors, such as emotions, attitudes, and motivations (Brookfield 2007; Facione 1990; Halpern and Dunn 2023). These non-cognitive aspects, including open-mindedness, commitment to truth-seeking, and self-confidence in judgment, influence both the application and timing of cognitive skills.

The development and strengthening of CT require both cognitive skills—such as analysis, evaluation, and inference—and intellectual dispositions, which refer to the habitual inclination to apply these skills effectively in various contexts (Ennis 2015; Facione 1990). These dispositions include open-mindedness, intellectual humility, empathy, and a willingness to reconsider one's beliefs, elements that influence how individuals engage in reasoning and decision-making (Hamby 2015; Perkins et al. 1993).

While this distinction may seem intuitive, it has been widely debated in the academic literature. Some scholars argue that CT instruction often prioritizes cognitive skills while neglecting these dispositional and affective components. A key critique of traditional CT instruction is that it adopts an overly formalistic and logic-based approach, potentially sidelining elements such as imagination and intuition, which also play a role in complex

reasoning. Walters (1992, 1994) contends that this logicist view of CT fails to account for the nuanced ways in which reasoning operates in real-world scenarios.

In response, more recent proposals emphasize the role of emotions and empathy within CT, particularly when addressing the ethical and social dimensions of complex problems, such as interpersonal conflicts (Elder 1997; Gallo 1989; Lipman 2003; Paul and Elder 2006). By integrating cognitive skills with intellectual dispositions, these perspectives suggest that CT is not only a tool for logical analysis, but also a means for navigating complex social and moral dilemmas.

Grounded in these perspectives, this paper adopts a conceptualization of CT that emphasizes real-world applications, particularly those involving personal well-being and interpersonal relationships. Thus, in contrast to relating CT to purely academic or abstract tasks, this focus recognizes that CT often arises in everyday problem-solving scenarios where individuals navigate emotional, social, and practical challenges that directly impact their lives. Saiz's proposal (Saiz 2024; Saiz and Rivas 2023; Guamanga et al. 2023) is particularly relevant in synthesizing these dimensions. According to Saiz, "to think critically is to arrive at the best explanation of a fact, phenomenon, or problem in order to know how to solve it effectively" (Saiz 2024, p. 19). This definition integrates cognitive components—such as analysis, inference, and evaluation—in the pursuit of the best explanation, along with non-cognitive elements like dispositions and motivations necessary for problem-solving (Ennis 2015). Furthermore, this definition expands the scope of CT beyond academic and professional boundaries, positioning it as a fundamental tool for addressing daily and interpersonal challenges with a practical and solution-oriented approach.

Given that CT involves systematic reasoning and problem-solving, this study examines how CT fosters the development of metacognitive skills, with a focus on enhancing cognitive self-regulation. Understanding this dynamic is key to clarifying the role of metacognition within the broader context of cognitive and socioemotional functioning.

1.2. Metacognition: The Mechanisms of Thought Monitoring and Regulation

Metacognition is present in all knowledge acquisition and plays a strategic role in problem-solving (Dwyer 2017; Flavell 1979; Halpern and Dunn 2023; Schraw and Moshman 1995). This implies that an individual must not only be aware of how cognitive processes work, but also be able to regulate and control these processes to optimize learning (Kratwohl 2002). In this sense, metacognition is directly related to the self-management and self-regulation of cognitive processes, manifesting itself in the ability to plan, monitor, and evaluate cognitive strategies (Flavell 1979; Schraw and Moshman 1995).

According to Flavell (1979), metacognition is defined as the ability to reflect on one's own cognitive processes in order to consciously control and regulate them. This involves understanding how information is acquired, processed, and applied. Part of this knowledge can be deliberately accessed through a conscious search of memories to identify strategies that enhance learning and problem-solving, depending on the demands of a particular task and an individual's cognitive abilities. Metacognition is distinguished primarily by two components: metacognitive knowledge and metacognitive control processes. Metacognitive knowledge includes three types: declarative (knowing the what about cognitive processes), procedural (knowing how to perform cognitive tasks), and conditional (knowing when and why to perform various cognitive actions). Metacognitive control processes involve the actions necessary to

regulate and monitor thinking, and include the following components: planning, which involves selecting appropriate strategies and allocating resources efficiently before performing a task; monitoring, referring to the continuous evaluation of comprehension and performance during task execution; organization, which involves structuring information and processes in a coherent manner; debugging, to identify and correct errors in real time; and evaluation, focused on analyzing both the results obtained and the strategies used to determine their effectiveness (Schraw and Dennison 1994; Schraw and Moshman 1995).

In this context, metacognition is understood as the ability to reflect on, monitor, and regulate one's own cognitive processes. This capacity allows for individuals to evaluate and adapt their learning and problem-solving strategies. Although metacognition is inherent, it can be further developed through targeted interventions. Specifically, when an intervention emphasizes CT, it often incorporates activities such as problem-solving and decision-making, which have been shown to significantly strengthen cognitive self-regulation skills (Dwyer 2017; Halpern and Dunn 2023). This promotes both the identification of effective strategies and their application to achieve optimal solutions and assertive decisions across diverse contexts, as could be the case in the socio-emotional domain, particularly in cognitive empathy.

1.3. Empathy: Cognitive and Affective Processes in Perspective-Taking

Empathy, according to various theories, comprises two main dimensions: cognitive empathy and affective empathy (Baron-Cohen 2022; Decety and Jackson 2004). The former refers to the ability to intellectually understand another person's mental state, while the latter involves an emotional response to their feelings. Although these dimensions can theoretically be differentiated, in practice, they are often intertwined within the same human experience. For

instance, understanding another person's feelings (cognitive empathy) should typically elicit an appropriate emotional reaction (affective empathy). However, cases such as individuals with psychopathy or autism illustrate that it is possible to possess one dimension without the other.

In this paper, we adopt Simon Baron-Cohen's perspective on empathy (Baron-Cohen 2003, 2022; Baron-Cohen et al. 2003; Baron-Cohen and Wheelwright 2004; Lawrence et al. 2004). Baron-Cohen (2022) conceptualizes empathy as a phenomenon that requires the decentering of personal focus to incorporate the perspective of others, a process he terms the double-minded approach. This decentering aligns with the concept of theory of mind, defined in psychology as the ability to attribute mental states to others—a fundamental skill for predicting behavior and responding appropriately. In practical terms, empathy enables a dual focus, allowing for individuals to balance their own perspective with that of others. In this context, Baron-Cohen describes empathy as a dimmer switch, capable of modulation based on an individual's attentional engagement with others.

Based upon the understanding of empathy as a key socio-emotional competency, it is equally important to explore psychological well-being, which encompasses the broader dimensions of personal functioning.

1.4. Psychological Well-Being: Conceptualization and Key Dimensions

The multidimensional model proposed by Ryff (1989, 2014) and Ryff and Keyes (1995) conceptualizes PWB as a construct that extends beyond the emotional state of happiness or life satisfaction. Grounded in a eudaimonic philosophical approach, Ryff's framework transcends traditional well-being indicators, such as life satisfaction or positive affect, and emphasizes the comprehensive functioning of the individual.

According to Ryff, PWB should not be confined to the subjective experience of feeling good or avoiding discomfort, but must be integrated into a broader perspective encompassing personal growth, the attainment of meaningful goals, and the effective management of life's challenges. Within this model, Ryff delineates six core dimensions that serve as the foundational pillars of PWB: self-acceptance, environmental mastery, positive relationships with others, purpose in life, personal growth, and autonomy.

Self-acceptance pertains to a positive evaluation of oneself and one's life, fostering emotional stability and a sense of personal fulfillment. Environmental mastery reflects the ability to effectively navigate and control external circumstances. Positive relationships emphasize the formation of meaningful bonds characterized by affection, trust, and mutual commitment. Purpose in life functions as a motivational force that guides actions toward the realization of significant goals. Personal growth involves openness to new experiences and overcoming challenges, contributing to self-actualization, while autonomy allows for greater alignment between personal values and actions, reinforcing independence and self-determination (Ryff 2014).

For the purposes of this paper, Ryff's psychological well-being scale is considered to offer a robust conceptual foundation for identifying the potential contributions of CT interventions aimed at developing and enhancing metacognitive skills. Additionally, Ryff's model serves as a practical operational framework, interwoven with essential processes such as decision-making and effective problem-solving, which are integral to well-rounded human development (Guamanga et al. 2024).

1.5. Theoretical Links Between Critical Thinking, Metacognition, Empathy, and Psychological Well-Being

The interplay between metacognition and CT reveals a strong conceptual link. Halpern and Dunn (2023) assert that effective decision-making requires individuals to consistently monitor and reflect on their reasoning processes. This reflection involves planning, assessing, and adjusting strategies to address problems effectively, which are hallmarks of metacognitive capacity. These processes are essential for higher-order reasoning, as they enable individuals to critically evaluate their own thought patterns and refine their decision-making strategies. CT, in turn, relies on these metacognitive processes while simultaneously refining them through deliberate and structured practice. Moreover, CT strengthens metacognition by engaging components such as planning, monitoring, error detection, organization, and evaluation. These elements are not only practiced during CT tasks, but are continually refined, promoting cognitive self-regulation and enhancing problem-solving efficacy (Arslan 2018; Kuhn 1999).

In an analogy, metacognition is to CT what the canvas is to a painting, and the artist's technique is the metacognitive regulation. While metacognition is necessary in the acquisition of knowledge, as the canvas is to the artist, it is not sufficient. Technique is essential for the artist's tone, traditions, and uniqueness to be captured on the canvas. In the same way, metacognitive regulation operates as problem-solving strategies. Theoretically, knowledge constitutes the what, the how, and the what for, but it is the implementation of strategies that leads to the materialization of knowledge. The interaction between CT and metacognition demonstrates their interconnected and mutually reinforcing nature, where CT provides a structured framework for

reasoning, and metacognition facilitates the continuous monitoring, evaluation, and adjustment of these cognitive processes (Csíkos 2022).

Beyond its role in cognitive regulation, metacognition also plays a crucial role in socioemotional functioning, particularly in the development of empathy. Cognitive empathy, which requires a nuanced awareness of mental processes—both one’s own and those of others—depends on advanced cognitive self-regulation (Baron-Cohen 2022; Lawrence et al. 2004). This connection underscores the complexity of balancing an understanding of others’ emotions while effectively managing one’s own. This interplay demonstrates the essential role of metacognitive control in enabling empathy. The relationship between metacognition and empathy is another area of interest. Cognitive empathy, which requires a nuanced awareness of mental processes—both one’s own and those of others—depends on advanced cognitive self-regulation (Baron-Cohen 2022; Lawrence et al. 2004). This connection underscores the complexity of balancing an understanding of others’ emotions while effectively managing one’s own. This interplay demonstrates the essential role of metacognitive control in enabling empathy.

In addition to its influence on social cognition, metacognitive self-regulation plays a pivotal role in psychological well-being (PWB), as it allows for individuals to manage their thoughts, emotions, and behaviors in a constructive manner. The relationship between metacognition and PWB is grounded in the capacity for reflection and self-regulation, which are crucial for navigating life’s challenges. Key dimensions of PWB, such as self-acceptance, environmental mastery, and purpose in life, are strongly influenced by an individual’s ability to reflect on personal experiences and learn from them. Metacognition enables individuals to

identify their cognitive strengths and weaknesses, refine their strategies, and execute action plans that align with their goals (Guamanga et al. 2024).

1.6. Empirical Evidence on the Relationships Between Critical Thinking, Metacognition, and Socioemotional Skills

The reviewed studies on the relationship between CT and empathy highlight a notable conceptual interaction, particularly between CT and cognitive empathy. Martingano and Konrath (2022) reported positive correlations between rational thinking indicators, such as the Need for Cognition Scale (NFC), and dimensions of cognitive empathy, such as perspective-taking ($r = 0.33$; $p < .001$), measured using Davis' (1983) Interpersonal Reactivity Index (IRI). Conversely, when examining rational performance using the Cognitive Reflection Task (CRT), negative correlations were observed with emotional empathy dimensions, such as Personal Distress (PD; $r = -0.13$, $p = .006$). These findings suggest that cognitive empathy is closely aligned with deliberative and rational processes, whereas emotional empathy tends to be more automatic and, at times, may even conflict with rational thinking.

Lombard et al. (2020) found that critical thinking (CT) and cognitive empathy are linked through the concept of decentering, which fosters recognition of diverse perspectives and values. Zhao et al. (2024) further proposed that CT played a key role in shaping the relationship between multicultural experiences and empathy, with its influence being more prominent in fostering cognitive empathy than emotional empathy. This underscores the reliance of cognitive empathy on analytical processes, while emotional empathy remains tied to affective and automatic responses.

Other studies, such as Heiney et al. (2019), have explored the integration of these skills within specific educational contexts, demonstrating improvements in students. Similarly, Varghese (2018) proposed that CT, by challenging dominant ideologies, and empathy, by fostering social cohesion, can underpin educational practices aimed at promoting social justice

In addition to empathy, emotional intelligence (EI) has also been identified as a key socioemotional factor influencing psychological well-being (PWB). A substantial body of research demonstrates a robust conceptual and empirical link between EI and PWB. For instance, Augusto-Landa et al. (2011) reported that emotional clarity and emotional regulation are significant predictors of eudaimonic well-being, particularly in dimensions such as purpose in life ($\beta = 0.34$) and self-acceptance ($\beta = 0.46$). Additionally, emotional regulation exerts an indirect influence through optimism ($\beta = 0.63$) and pessimism ($\beta = -0.23$), together explaining 60% of the variance in PWB. These results underscore the importance of emotional clarity as a key resource for managing emotions and optimizing cognitive processes. They also open new pathways for exploring how other dimensions of EI, such as resilience and stress management, affect psychological and relational well-being.

In this same line of research, Burrus et al. (2012) emphasized that managing emotions is crucial for fostering resilience and coping with stress, both of which significantly contribute to overall well-being. The research, assessed using the Situational Test of Emotion Management (STEM), demonstrated significant correlations between emotional management and eudaimonic well-being ($r = 0.54, p < .001$). Furthermore, emotional management was positively associated with hedonic well-being, such as positive affect, and was negatively correlated with negative

affect ($r = -0.46$ to -0.18). These results show that individuals with higher levels of EI experience greater emotional balance, especially in activities like work ($r = 0.44$) and exercise ($r = 0.34$). Similarly, Altaras Dimitrijević et al. (2018) confirmed that emotional regulation was the strongest predictor of PWB, surpassing academic intelligence. Emotional management presented a direct association with PWB ($\beta = 0.32, p < .001$), adding 8% to its explained variance.

Guerra-Bustamante et al. (2019) strengthened this evidence, focusing on adolescents. They found that emotional clarity and repair significantly increased subjective happiness. Adolescents with high emotional clarity were 5.6 times more likely to report high levels of happiness ($OR = 5.64, p < .05$). This probability rose to 12 times for those with strong emotional repair skills ($OR = 12.13, p < .05$). However, excessive emotional mindfulness was found to be counterproductive, suggesting that balance is key.

The interaction between CT and PWB presents a more complex dynamic. While EI and PWB primarily align through emotional clarity and regulation, CT operates through distinct yet complementary cognitive mechanisms. Su and Shum (2019) observed that CT impacts PWB indirectly through mediators like cognitive distortions, moderated by mindfulness. In conditions of low mindfulness, CT was significantly associated with cognitive distortions ($\beta = 0.51, p = .01$), which, in turn, predicted higher levels of psychological distress ($\beta = 0.30, p < .05$). Conversely, high mindfulness mitigated these effects, reducing the negative impact of CT on distress.

This suggests that, while CT primarily engages analytical and reflective reasoning, its effectiveness in promoting PWB is influenced by how individuals regulate their emotions.

Managing emotions, particularly through emotional clarity, plays a crucial role in reducing cognitive distortions and enhancing the capacity for deliberate decision-making. In this way, emotional regulation acts as a supporting mechanism that enables individuals to apply CT more effectively in emotionally charged situations, reinforcing the connection between cognitive and affective processes.

Peng (2024) expanded this line of inquiry by exploring how CT and cultural intelligence jointly predicted dimensions of eudaimonic well-being, such as purpose in life and self-acceptance. Peng reported significant correlations between CT and dimensions like purpose in life ($r = 0.73, p < .01$), and between cultural intelligence and well-being ($r = 0.83, p < .01$). Among the factors contributing to cultural intelligence, cultural metacognition stood out ($r = 0.72, p < .01$). Together, they explained 45% of the variance, with CT contributing 47.3% ($\beta = 0.47, p < .001$) and PWB contributing 27.1% ($\beta = 0.27, p < .01$). These findings highlight the complementary role of cognitive skills and personal development in fostering academic and personal success.

From a theoretical perspective, integrating the cognitive domain of CT with the affective domain of socioemotional competencies enhances the interdisciplinary framework by establishing connections between analytical reasoning and emotional regulation. Pedagogically, validating this connection supports transformative learning strategies tailored to the demands of a globalized, complex environment. Preparing students to critically analyze problems, regulate their emotions, and maintain a clear sense of purpose is an educational priority that transcends traditional classroom boundaries.

The reviewed literature provides a robust foundation for understanding the dynamic relationships among CT, metacognition, empathy, and PWB. Studies highlight the conceptual relationship between CT and cognitive empathy, particularly through processes such as perspective-taking, where rational and analytical thinking facilitates the understanding of diverse perspectives and values (Martingano and Konrath 2022; Lombard et al. 2020). Additionally, CT has been linked to PWB through its capacity to promote reflective and deliberate decision-making, contributing to outcomes such as purpose in life and self-acceptance (Peng 2024; Su and Shum 2019). Collectively, these findings underscore the cross-disciplinary importance of CT and metacognition in fostering socioemotional development and resilience, particularly within educational contexts (Varghese 2018; Zhao et al. 2024).

With this empirical foundation as a basis, it becomes essential to adopt a methodological approach capable of capturing the complexity of these interrelated constructs and their dynamic interactions. Given the complex and multidimensional nature of the constructs involved, this study employs structural equation modeling (SEM). SEM is particularly well-suited for this analysis, as it enables the simultaneous estimation of multiple relationships among latent variables while accounting for measurement error, thereby providing a more accurate and reliable representation of the theoretical model (Kline 2023; Marôco 2014). By integrating measurement and structural components within a single analytical framework, SEM is expected to provide robust statistical evidence for the hypothesized relationships, potentially facilitating a comprehensive understanding of the dynamic interactions between cognitive and socioemotional processes.

According to the theoretical model designed, we propose the following hypotheses:

H1.

There is a significant positive relationship between CT and metacognition, such that students with higher CT skills demonstrate higher levels of metacognition.

H2.

Metacognition has a statistically significant positive direct effect on both empathy and PWB.

2. Materials and Methods

2.1. Participants

A total of 155 students ($M = 19.0$, $SD = 2.20$) from a university in the northeastern region of Spain participated in this study. Of these, 88.9% were women and 11.1% were men, all enrolled in either the first or final year of an undergraduate psychology program.

2.2. Instruments

The following tests were used for data collection.

2.2.1. Metacognitive Abilities Inventory

The Metacognitive Abilities Inventory (Schraw and Dennison 1994), validated in a Spanish-speaking sample by Huertas Bustos et al. (2014), is a psychometric tool designed to assess students' metacognitive abilities in terms of two main components: knowledge of cognition and regulation of cognition. Each of these components encompasses several subprocesses, which Schraw and Moshman (1995) identify as core dimensions of metacognition. Specifically, metacognitive knowledge consists of three main types—declarative, procedural, and

conditional—while the regulation of cognition includes planning, organization, monitoring, debugging (i.e., error correction), and evaluation of one’s own cognitive processes. The inventory comprises 52 items and demonstrated high reliability, with a Cronbach’s alpha of 0.94 in its validation.

2.2.2. Empathy Quotient (EQ)

The Empathy Quotient (EQ), created by Baron-Cohen and his team, is a self-assessment questionnaire designed to assess individual variations in empathy among adults of average intelligence (Baron-Cohen and Wheelwright 2004). The EQ includes 40 items focused on empathy and 20 additional items that act as control items but which are not used to calculate the empathy score. The assessment instrument is composed of three key factors: Cognitive Empathy (CE), which measures the ability to perceive and understand emotional and mental states of others; Emotional Reactivity (ER), which assesses the tendency to have emotional responses to the mental states of others; and Social Skills (SS), which examines the intuitive ability to interact in social situations (Baron-Cohen and Wheelwright 2004; Redondo and Herrero-Fernández 2018). The Empathy Quotient (EQ) demonstrated high internal consistency, with a Cronbach’s alpha of 0.92, confirming its reliability.

2.2.3. PENCRISAL

The PENCRISAL (Rivas and Saiz 2012; Saiz and Rivas 2008) consists of 35 items, each representing a problem situation, and is structured into 5 factors: deductive, inductive, and practical reasoning, decision-making, and problem-solving. The PENCRISAL test originated from the HCTA-Test (Halpern 2012), and its principles include the use of everyday situations, different domains, an open-ended response format, and the use of single-answer questions. For

the validation process, studies were conducted in 715 Spanish adults aged between 18 and 53 years. The results show reliability in internal consistency (Cronbach's $\alpha = 0.63$) and in test-retest reliability ($r = 0.79$).

2.2.4. Ryff's Psychological Well-Being Scale

The Spanish adaptation of the Ryff psychological well-being scale by Díaz et al. (2006), consisting of 39 items, was used. The results on internal consistency and construct validity indicated that the scales demonstrated adequate reliability, with Cronbach's alpha values ranging from 0.70 to 0.83 across dimensions. However, some studies have reported difficulties in replicating the six-factor model across different contexts and populations (Abbott et al. 2010). Consequently, based on prior research examining the relationship between critical thinking and psychological well-being (Guamanga et al. 2024), this study focuses on three dimensions: self-acceptance, purpose in life, and environmental mastery.

2.3. Intervention Program

For this research, the ARDESOS-DIAPROVE program was implemented. This program is an educational intervention designed to enhance critical thinking skills in areas such as argumentation, decision-making, and problem-solving (Saiz and Rivas 2011; Saiz 2020; Rivas and Saiz 2023; Guamanga et al. 2023). It was delivered in person over one semester (approximately 16 weeks), comprising about 58 h of instruction, and was facilitated by instructors with specialized training in CT. Throughout the sessions, participants engaged in problem-based learning (PBL) activities and employed metacognitive strategies, emphasizing (a) the identification and management of cognitive biases, (b) the combined use of factual

information and deductive reasoning, and (c) the application of hypothesis-refutation processes when evidence did not support specific claims.

2.4. Procedures

To collect data, digital questionnaires were administered at the beginning and conclusion of the first-year and fourth-year CT courses. Participants received detailed instructions and were assured of the confidentiality of their responses, thereby ensuring data integrity and reliability. For the present study, only the final assessment data were used in the statistical analyses, ensuring that the results reflect the participants' most developed CT competencies. Only those who completed all questionnaires were included in the final analysis, preserving the rigor and validity of the results.

2.5. Data Analysis

Data were analyzed using the IBM-SPSS Statistics v.28. The causal model was carried out using the maximum likelihood estimator available in AMOS 25.0 (Arbuckle 2016). To assess the models' goodness-of-fit, the following indicators were used: the Chi-square by degrees of freedom ratio (χ^2/df), the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA). Values below 5 for χ^2/df , above 0.90 for CFI and below 0.08 for RMSEA indicate an acceptable model data fit (Kline 2023; Marôco 2014).

3. Results

Table 1 presents the correlations between the variables of CT, empathy, metacognition, and PWB, as well as all of their dimensions. The data indicate that there are significant relationships of varying magnitude. The strongest correlation is observed between metacognition

and PWB ($r = 0.59, p < .01$), suggesting a moderate to high relationship between these variables. Conversely, the weakest correlation was found between CT and empathy ($r = 0.11$, not significant), reflecting a weak and non-significant relationship. Additionally, the correlations between CT and metacognition ($r = 0.26, p < .01$) and between CT and PWB ($r = 0.21, p < .01$) were significant, although of lesser magnitude compared to other relationships.

Table 1. Correlations of variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. CT	–	0.76 **	0.62 **	0.65 **	0.65 **	0.64 **	0.11	0.05	–0.07	0.27 **	0.26 **	0.23 **	0.16	0.15	0.15	0.28 **	0.13	0.23 **	0.16 *	0.21 **	0.21 **	0.20 *	0.20 *
2. DR	0.76 **	–	0.35 **	0.36 **	0.40 **	0.37 **	0.12	0.07	–0.04	0.24 **	0.20 *	0.22 **	0.08	0.12	0.14	0.18 *	0.09	0.25 **	0.08	0.22 **	0.21 **	0.21 **	0.20 *
3. IR	0.62 **	0.35 **	–	0.36 **	0.23 **	0.28 **	0.06	0.03	–0.07	0.17 *	0.24 **	0.15	0.17 *	0.20 *	0.13	0.26 **	0.18 *	0.09	0.16 *	0.16 *	0.19 *	0.14	0.11
4. PR	0.65 **	0.36 **	0.36 **	–	0.24 **	0.18 *	0.05	0.05	–0.04	0.10	0.11	0.07	0.11	0.00	0.07	0.19 *	0.03	0.12	0.05	0.11	0.07	0.10	0.14
5. DM	0.65 **	0.40 **	0.23 **	0.24 **	–	0.25 **	0.03	–0.05	–0.10	0.25 **	0.09	0.09	0.07	–0.03	0.00	0.17 *	0.04	0.15	0.04	0.00	0.01	–0.01	–0.01
6. PS	0.64 **	0.37 **	0.28 **	0.18 *	0.25 **	–	0.10	0.07	0.00	0.15	0.23 **	0.21 **	0.11	0.23 **	0.16	0.14	0.13	0.12	0.21 **	0.22 **	0.21 **	0.21 **	0.20 *
7. EMP	0.11	0.12	0.06	0.05	0.03	0.10	–	0.86 **	0.85 **	0.59 **	0.36 **	0.32 **	0.15	0.35 **	0.25 **	0.29 **	0.29 **	0.23 **	0.18 **	0.29 **	0.25 **	0.28 **	0.29 **
8. CE	0.05	0.07	0.03	0.05	–0.05	0.07	0.86 **	–	0.36 **	0.26 **	0.23 **	0.18 *	0.05	0.24 **	0.16	0.22 **	0.19 *	0.09	0.11	0.17 *	0.13	0.15	0.20 *
9. EE	–0.07	–0.04	–0.07	–0.04	–0.10	0.00	0.65 **	0.36 **	–	0.15	0.26 **	0.24 **	0.11	0.11	0.19 *	0.19 *	0.27 **	0.22 **	0.15	0.14	0.08	0.15	0.16 *
10. SS	0.27 **	0.24 **	0.17 *	0.10	0.25 **	0.15	0.59 **	0.26 **	0.15	–	0.34 **	0.31 **	0.22	0.41 **	0.22	0.21 **	0.19 *	0.25 **	0.15	0.36 **	0.36 **	0.35 **	0.30 **
11. MC	0.26 **	0.20 *	0.24 **	0.11	0.09	0.23 **	0.36 **	0.23 **	0.26 **	0.34 **	–	0.86 **	0.89 **	0.72 **	0.77 **	0.76 **	0.77 **	0.61 **	0.67 **	0.59 **	0.54 **	0.59 **	0.54 **
12. DK	0.23 **	0.22 **	0.15	0.07	0.09	0.21 **	0.32 **	0.18 *	0.24 **	0.31 **	0.66 **	–	0.49 **	0.56 **	0.35 **	0.46 **	0.32 **	0.46 **	0.21 **	0.57 **	0.52 **	0.56 **	0.52 **
13. PK	0.16	0.08	0.17 *	0.11	0.07	0.11	0.15	0.05	0.11	0.22 **	0.69 **	0.49 **	–	0.62 **	0.38 **	0.46 **	0.45 **	0.40 **	0.36 **	0.40 **	0.37 **	0.40 **	0.35 **
14. CK	0.15	0.12	0.20 *	0.00	–0.03	0.23 **	0.35 **	0.24 **	0.11	0.41 **	0.72 **	0.56 **	0.62 **	–	0.39 **	0.40 **	0.48 **	0.39 **	0.40 **	0.56 **	0.51 **	0.57 **	0.51 **
15. P	0.15	0.14	0.13	0.07	0.00	0.16	0.25 **	0.16	0.19 *	0.22 **	0.77 **	0.35 **	0.38 **	0.39 **	–	0.51 **	0.65 **	0.33 **	0.60 **	0.43 **	0.37 **	0.44 **	0.41 **
16. O	0.28 **	0.18 *	0.26 **	0.19 *	0.17 *	0.14	0.29 **	0.22 **	0.19 *	0.21 **	0.76 **	0.46 **	0.46 **	0.40 **	0.51 **	–	0.47 **	0.49 **	0.39 **	0.38 **	0.39 **	0.33 **	0.34 **
17. M	0.13	0.09	0.18 *	0.03	0.04	0.13	0.29 **	0.19 *	0.27 **	0.19 *	0.77 **	0.32 **	0.45 **	0.48 **	0.65 **	0.47 **	–	0.36 **	0.58 **	0.33 **	0.27 **	0.36 **	0.30 **
18. DS	0.23 **	0.25 **	0.09	0.12	0.15	0.12	0.23 **	0.09	0.22 **	0.25 **	0.61 **	0.46 **	0.40 **	0.39 **	0.33 **	0.49 **	0.36 **	–	0.21 **	0.36 **	0.36 **	0.34 **	0.30 **
19. E	0.16 *	0.08	0.16 *	0.05	0.04	0.21 **	0.18 *	0.11	0.15	0.15	0.67 **	0.21 **	0.36 **	0.40 **	0.60 **	0.39 **	0.58 **	0.21 **	–	0.37 **	0.30 **	0.37 **	0.36 **
20. PWB	0.21 **	0.22 **	0.16	0.11	0.00	0.22 **	0.29 **	0.17 *	0.14	0.36 **	0.59 **	0.57 **	0.40 **	0.56 **	0.43 **	0.38 **	0.33 **	0.36 **	0.37 **	–	0.94 **	0.93 **	0.93 **
21. SA	0.21 **	0.21 **	0.19 *	0.07	0.01	0.21 **	0.25 **	0.13	0.08	0.36 **	0.54 **	0.52 **	0.37 **	0.51 **	0.37 **	0.39 **	0.27 **	0.36 **	0.30 **	0.94 **	–	0.82 **	0.80 **
22. EM	0.20 *	0.21 **	0.14	0.10	–0.01	0.21 **	0.28 **	0.15	0.15	0.35 **	0.59 **	0.56 **	0.40 **	0.57 **	0.44 **	0.33 **	0.36 **	0.34 **	0.37 **	0.93 **	0.82 **	–	0.82 **
23. PL	0.20 *	0.20 *	0.11	0.14	–0.01	0.20 *	0.29 **	0.20 *	0.16 *	0.30 **	0.54 **	0.52 **	0.35 **	0.51 **	0.41 **	0.34 **	0.30 **	0.30 **	0.36 **	0.93 **	0.80 **	0.82 **	–

Note. ** $p < .01$; * $p < .05$. CT: critical thinking, DR: deductive reasoning, IR: inductive reasoning, PR: practical reasoning, DM: decision-making, PS: problem-solving, EMP: empathy, CE: cognitive empathy, EE: emotional reactivity, SS: social skills, MC: metacognition, DK: declarative knowledge, PK: procedural knowledge, CK: conditional knowledge, P: planning, O: organization, M: monitoring, DS: debugging strategies, E: evaluation; PWB: psychological well-being, SA: self-acceptance, EM: environmental mastery, PL: purpose in life.

In Table 1, positive and significant correlations were observed between several dimensions of CT and the social skills (SS) dimension of empathy. The correlation between CT general and SS is $r = 0.27, p < .01$; between decision-making (DM) and SS, $r = 0.25, p < .01$;

and for deductive reasoning (DR) with SS, $r = 0.24, p < .01$. Inductive reasoning (IR) also shows a significant correlation with SS ($r = 0.17, p < .05$). CT showed a positive and significant correlation with the overall psychological well-being (PWB) score ($r = 0.21, p < .01$), as well as with specific dimensions: self-acceptance (SA; $r = 0.21, p < .01$), environmental mastery (EM; $r = 0.20, p < .05$), and purpose in life (PL; $r = 0.20, p < .05$).

Furthermore, Table 1 shows positive and significant correlations between metacognition and empathy ($r = 0.36, p < .01$) and between metacognition and PWB ($r = 0.59, p < .01$), indicating moderate-to-strong associations across these cognitive and socioemotional constructs.

The findings indicate positive, albeit modest to moderate, associations between metacognition and both psychological well-being (PWB) and empathy, underscoring the relevance of metacognition as an independent cognitive construct across diverse psychological domains. Additionally, the total score of CT shows significant positive, albeit moderate, correlations with both metacognition and PWB. To analyze these relationships, a Structural Equation Model (SEM) was implemented, capturing associations among the constructs without presupposing mediating or moderating effects.

The SEM demonstrated an adequate model fit, as indicated by multiple goodness-of-fit indices aligning with the thresholds established by Marôco (2014). The chi-square to degrees of freedom ratio (χ^2/df) was 1.484, reflecting a good fit. The Comparative Fit Index (CFI) reached 0.938, exceeding the conventional threshold of 0.90 for a good fit and approaching the benchmark of 0.95 for an excellent fit. Furthermore, the Root Mean Square Error of Approximation (RMSEA) was 0.056, with a 90% confidence interval of [0.040–0.071], which falls within the acceptable fit range (0.05–0.08) and nears the threshold for a close fit (<0.05).

Collectively, these indices provide adequate evidence supporting the model's statistical validity and its alignment with the underlying theoretical framework.

The improved model fit was achieved by incorporating correlations between specific residual errors within the metacognition construct, as suggested by modification indices derived from a prior model. A detailed review of the associated items revealed their alignment with the domains of planning, monitoring, and evaluation, as operationalized in the Metacognitive Awareness Inventory (Schraw and Dennison 1994). These items exhibit overlap in their conceptual focus, as they all address critical aspects of metacognitive regulation. This shared foundation likely accounts for their residual variance, which is not fully explained by the latent variable.

The decision to model covariances between these residuals aligns with established practices in structural equation modeling, particularly when supported by both statistical evidence and theoretical justification (Kline 2023). Such covariances do not imply causality, but rather account for unmodeled interdependencies among observed variables, thereby enhancing the precision of the overall model. This adjustment ensures that the model provides an accurate representation of the relationships among constructs while preserving its theoretical integrity.

Figure 1 illustrates the final structural model. The structural model captures the direct effect of CT on metacognition, alongside the role of metacognition in shaping both empathy and PWB.

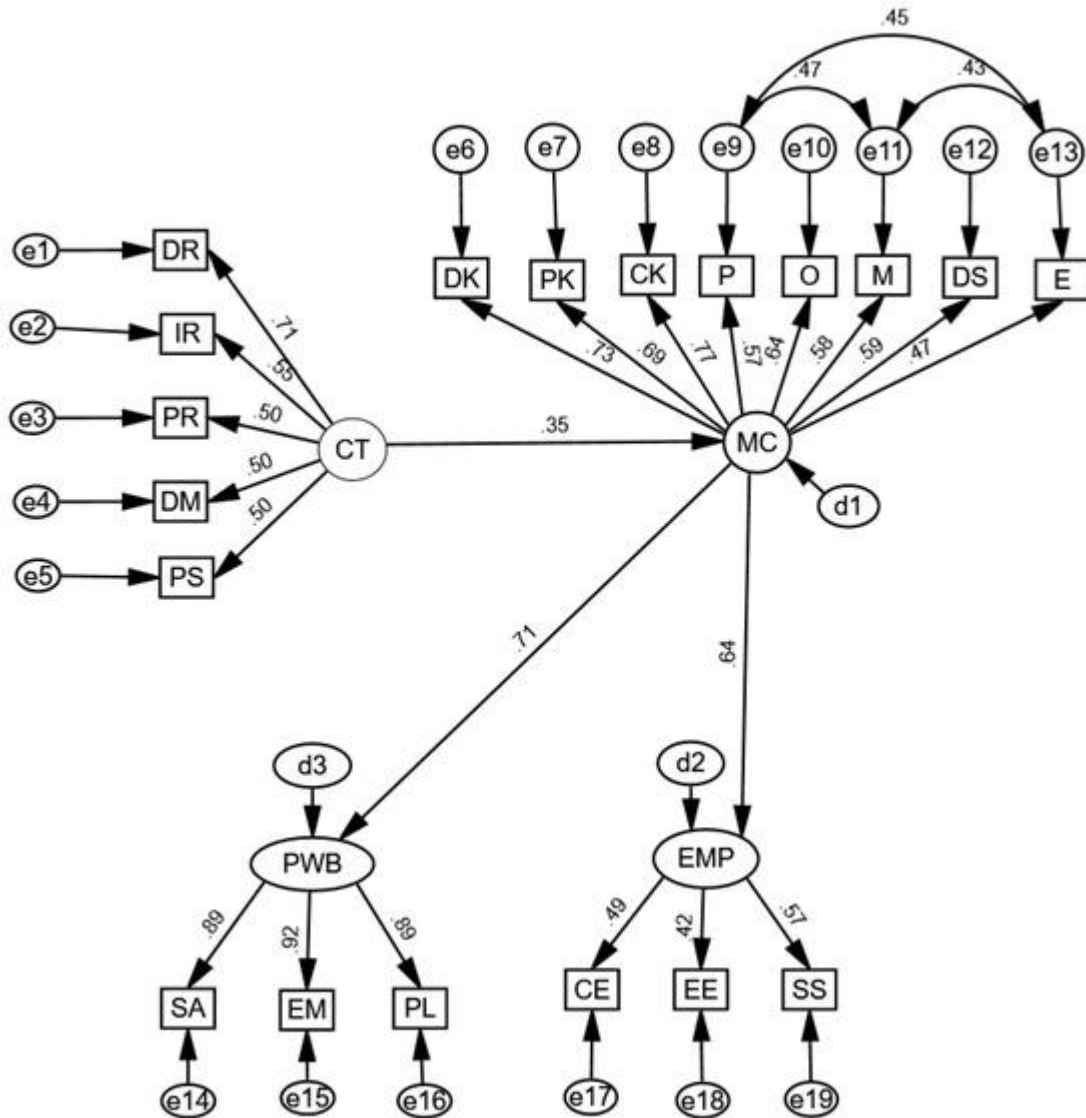


Figure 1. Path diagram. Structural equation model. CT: critical thinking, DR: deductive reasoning, IR: inductive reasoning, PR: practical reasoning, DM: decision-making, PS: problem-solving; EMP: empathy, CE: cognitive empathy, EE: emotional reactivity, SS: social skills; MC: metacognition, DK: declarative knowledge, PK: procedural knowledge, CK: conditional knowledge, P: planning, O: organization, M: monitoring, DS: debugging strategies, E: evaluation; PWB: psychological well-being, SA: self-acceptance, EM: environmental mastery, PL: purpose in life.

Table 2 presents the results of structural equation modeling (SEM), which examined the hypothesized relationships among the study variables. The path from CT to metacognition yielded an unstandardized estimate of 0.67 ($SE = 0.23$), with a critical ratio (CR) of 2.99, $p = .003$, indicating a moderate effect. This relationship is further supported by the standardized coefficient ($\beta = 0.35$). The path from metacognition to PWB demonstrated a stronger association, with an unstandardized estimate of 1.54 ($SE = 0.20$), a CR of 7.62, and $p < .001$, corresponding with a strong effect ($\beta = 0.71$). Similarly, the path from metacognition to empathy was statistically significant, producing an unstandardized estimate of 0.39 ($SE = 0.09$), a CR of 4.38, and $p < .001$, with a standardized coefficient of $\beta = 0.64$, indicating a strong relationship.

Table 2. Structural model paths.

Path	<i>b</i>	<i>SE</i>	95% CI	<i>t</i>	β	<i>p</i>
MC ← CT	0.67	0.23	[0.22, 1.12]	2.99	0.35	.003
PWB ← MC	1.54	0.20	[1.15, 1.93]	7.62	0.71	<.001
EMP ← MC	0.39	0.09	[0.21, 0.57]	4.38	0.64	<.001

4. Discussion

CT emerges in this study as a key factor in strengthening metacognitive processes, which are significantly associated with psychological well-being (PWB) and empathy. The results support the proposed hypotheses, demonstrating that interventions focused on developing CT, particularly those targeting problem-solving and decision-making, substantially enhance metacognitive self-regulation. Additionally, metacognition has a significant impact on socio-emotional skills, such as empathy, and on personal development dimensions related to PWB,

reinforcing its role in comprehensive human development. These findings align with previous research highlighting CT as both a fundamental cognitive skill and a resource for enhancing personal and socio-emotional functioning (Saiz 2020; Saiz and Rivas 2023). The structural equation model demonstrated strong fit indices (CFI = 0.938; RMSEA = 0.056), corroborating the robustness of these associations.

Regarding the first hypothesis, the results confirm that CT positively influences metacognition. This supports the view that CT fosters reflection and cognitive self-regulation. Consistent with prior studies, CT training improves metacognitive awareness by encouraging individuals to monitor, evaluate, and adjust their cognitive processes (Arslan 2018; Dwyer 2017; Halpern and Dunn 2023; Kuhn 1999; Saiz 2020). The ability to critically analyze situations, draw inferences, and evaluate decisions is closely linked to metacognitive regulation, underscoring the importance of integrating CT into educational programs to develop problem-solving skills across contexts.

With respect to the second hypothesis, the findings show that metacognition has a positive and significant effect on both PWB and empathy. This suggests that metacognitive skills are crucial for psychological well-being and interpersonal functioning. The association between metacognition and PWB aligns with research indicating that self-reflection and cognitive regulation contribute to self-acceptance, environmental mastery, and a clear sense of purpose (Augusto-Landa et al. 2011). The ability to evaluate personal experiences, regulate emotions, and adapt to life's challenges is fundamental to well-being.

Similarly, the relationship between metacognition and empathy highlights the cognitive dimension of empathy, particularly perspective-taking and understanding others' mental states.

This aligns with Baron-Cohen's (2022) assertion that cognitive empathy relies on the ability to understand and predict others' thoughts and emotions, a process dependent on developed metacognitive skills. Our findings support evidence that individuals with stronger cognitive self-regulation are better equipped to interpret and respond appropriately to others' emotions, enhancing social interactions (Lawrence et al. 2004; Martingano and Konrath 2022). From an applied perspective, these findings have significant educational implications. Integrating CT into curricula not only enhances cognitive competencies, but also strengthens metacognitive skills essential for emotional self-regulation and personal well-being (Rivas and Saiz 2023).

These findings reinforce the theoretical model, highlighting the role of CT in fostering metacognition, which subsequently influences socio-emotional domains. Given this empirical foundation, further examinations of the theoretical and conceptual framework of the CT–metacognition relationship is warranted to refine its explanatory scope.

The theoretical and empirical relationship between CT and metacognition is complex and subject to debate (Arslan 2018; Facione 1990; Halpern 1998; Magno 2010; Rivas and Saiz 2023). Our model posits that CT influences MC, which in turn impacts empathy and psychological well-being (PWB). This position is supported by three key arguments.

First, the dual nature of metacognition must be considered. Metacognition encompasses (1) the awareness of one's cognitive processes and (2) the ability to plan, regulate, and allocate cognitive resources to achieve goals (Flavell 1979; Schraw and Dennison 1994). Awareness of one's inner cognitive experiences develops through introspective practice, which requires intentionality. Problem-solving, for instance, demands introspection, particularly in constructing causal scenarios and engaging in counterfactual thinking (Kahneman 2013; Kahneman and

Tversky 1982; Saiz 2020; Tversky and Kahneman 1974). These cognitive abilities, essential for effective reasoning, are enabled by CT, particularly inferential skills, which allow for individuals to generate and assess plausible scenarios (Baron 2023; Ennis 2015; Facione 1990).

In its second dimension, metacognition involves the awareness of strategies for addressing problems, encompassing organization, planning, and regulation. These metacognitive processes rely on prior CT competencies, both inferential and executive, including decision-making and problem-solving strategies (Halpern and Dunn 2021; Rivas and Saiz 2023). Metacognitive self-regulation provides clarity on pre- and post-decisional mechanisms, but cannot function independently of CT skills.

Second, evidence from CT training programs supports the functional dependence of metacognition on CT. These programs integrate cognitive skills, dispositions, and metacognitive strategies, highlighting how CT employs metacognition components as strategic tools for its development. The meta-analysis by Abrami et al. (2015) found that CT interventions enhance both analytical skills and metacognitive processes, such as self-monitoring. Similarly, Marin and Halpern (2011) reported that explicit CT instruction improves decision-making and critical analysis by incorporating reflective practices linked to metacognition. This suggests that, in educational contexts, metacognition develops as an integral part of CT rather than as an independent precursor or end goal. Enhancing CT skills increases awareness of cognitive processes, which in turn accelerates CT development, reinforcing a cyclical, rather than sequential, relationship. Without CT competencies, metacognition could not fully emerge.

Third, CT has been conceptualized as a theory of action, emphasizing problem-solving over isolated cognitive skills (Baron 2023; Facione 1990; Halpern and Dunn 2021; Saiz 2020).

Effective problem resolution requires activating metacognitive processes that, combined with cognitive skills and dispositions, increase the likelihood of achieving optimal solutions.

Individuals with high metacognition but insufficient analytical skills or dispositions may struggle to apply effective strategies, highlighting the necessity of integrating cognitive and non-cognitive components within CT. This perspective positions CT as an overarching construct that encompasses metacognition rather than a subordinate function.

From a theoretical standpoint, reversing the model's directionality would generate inconsistencies. If metacognition were posited as influencing CT, the role of CT in socio-emotional constructs such as empathy and psychological well-being (PWB) would be obscured. This inversion would weaken the causal link between CT and socio-emotional development, making it more difficult to explain how CT fosters these dimensions. Conversely, proposing CT as antecedent to MC maintains a coherent structure that allows for explorations of CT's indirect effects on non-cognitive domains, although empirical validation remains necessary.

In summary, prioritizing CT → MC is justified by empirical evidence from CT training programs and by theoretical consistency integrating cognitive skills, metacognitive strategies, and dispositions. While bidirectional interactions are not ruled out, establishing CT as a precursor to metacognition strengthens the model's validity and opens pathways for educational applications, particularly in designing interventions that make metacognitive strategies explicit. This approach, while promising, highlights the need for further research, especially on the intersection of CT with well-being and empathy, an area still underexplored in the literature.

However, this study has limitations. First, the sample size may restrict the generalizability of the findings, as small samples can affect parameter stability and introduce bias (Kretzschmar

and Gignac 2019). Future studies should replicate these results with larger and more diverse samples to improve external validity. Additionally, the correlational design limits causal inferences. Although structural equation modeling reveals significant associations, longitudinal studies are needed to examine how these relationships evolve over time and to clarify the direction of effects.

Another limitation of this study involves its reliance on self-report measures, which may be influenced by social desirability and subjective biases. Although objective assessments, such as PENCRIAL, were used to mitigate these biases, future research should adopt multi-method approaches combining self-reports, behavioral observations, and performance evaluations for a more comprehensive understanding of the constructs.

In conclusion, this study provides empirical evidence of the influence of CT on the enhancement of metacognitive processes and their significant associations with PWB and empathy. The findings advocate for integrating CT and metacognition into education to foster cognitive and socio-emotional growth.

Author Contributions

M.H.G.: Writing—original draft, Conceptualization, Investigation, Methodology, Writing—review & editing. C.S.: Investigation, Methodology, Project administration, Validation, Writing—original draft. S.F.R.: Data curation, Investigation, Supervision, Validation, Writing—review & editing. P.M.B.: Supervision, Validation, Writing—review & editing. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Universidad de Salamanca (Comité de Ética de la Investigación, protocol code 928 and 28 March 2023).

Informed Consent Statement

Informed consent was obtained from all subjects involved in this study.

Data Availability Statement

Data are contained within the article.

Conflicts of Interest

The authors declare no conflicts of interest.

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Conclusiones

1. El pensamiento crítico, concebido como una teoría de la acción que transita desde la explicación hasta la solución de problemas, permite trascender el enfoque argumentativo tradicional y dotar de sentido epistémico a la toma de decisiones en contextos reales. Esta caracterización se fundamenta en la lógica abductiva de la inferencia a la mejor y única explicación, y en el vínculo entre explicación científica y razonamiento práctico.
2. El programa ARDESOS-DIAPROVE ofrece un marco teórico y pedagógico sólido para el desarrollo del pensamiento crítico, al alinear habilidades cognitivas avanzadas con procedimientos de diagnóstico, pronóstico y verificación, lo que lo convierte en una propuesta formativa coherente con los estándares epistémicos de la explicación científica.
3. El pensamiento crítico tiene un efecto directo, positivo y estadísticamente significativo sobre el rendimiento académico en estudiantes universitarios, lo que refuerza su valor instrumental en la educación superior.
4. Si bien el pensamiento crítico mostró asociación con el bienestar psicológico, dicha relación no fue significativa en el segundo estudio, lo cual sugiere la existencia de mecanismos mediadores o moduladores que deben ser incorporados en modelos explicativos más integrados.
5. El pensamiento crítico tiene un efecto directo y significativo sobre la autorregulación metacognitiva, lo que confirma su capacidad para activar y perfeccionar procesos de planificación, monitoreo y evaluación del pensamiento.
6. La metacognición, a su vez, presenta efectos directos y significativos sobre dimensiones específicas del bienestar psicológico, tales como el dominio del entorno, el propósito de vida

y la autoaceptación, lo que evidencia su papel como componente estructural del desarrollo personal.

7. La metacognición incide positivamente sobre la empatía, entendida como una competencia multidimensional que integra la capacidad de identificar estados mentales ajenos y responder adecuadamente a ellos, lo que sugiere que la autorregulación cognitiva puede fortalecer habilidades socioemocionales clave.
8. Los modelos estadísticos aplicados —regresión lineal y ecuaciones estructurales (SEM)— ofrecen respaldo metodológico robusto que permiten trazar las relaciones explicativas entre pensamiento crítico, metacognición y variables afectivas relevantes del desarrollo personal.
9. El pensamiento crítico es un sistema complejo de razonamiento orientado a la comprensión profunda del entorno, la toma de decisiones acertadas y la resolución eficaz de problemas. De modo que cuando se entrelaza con la metacognición y proyecta hacia competencias socioemocionales como la empatía y el bienestar, esta caracterización y sus resultados supera enfoques fragmentarios y elevan su potencial transformador.
10. Se demuestra que la formación en pensamiento crítico requiere metodologías estructuradas, esto es, intencionadas y explícitas, orientadas a la acción y sensibles a la dimensión personal del aprendizaje, lo cual plantea una responsabilidad directa para el diseño de políticas educativas que promuevan su desarrollo como competencia transversal, medible y transferible.

Conclusions

1. Critical thinking, conceived as a theory of action that moves from explanation to problem-solving, transcends the traditional argumentative approach and provides epistemic grounding for decision-making in real-world contexts. This characterization is supported by the abductive logic of inference to the best and only explanation and by the link between scientific explanation and practical reasoning.
2. The ARDESOS-DIAPROVE program offers a rigorous theoretical and pedagogical framework for developing critical thinking by aligning advanced cognitive skills with procedures of diagnosis, prognosis, and verification, thereby establishing a formative proposal consistent with the epistemic standards of scientific explanation.
3. Critical thinking has a direct, positive, and statistically significant effect on academic performance in university students, reinforcing its instrumental value in higher education.
4. Although critical thinking showed a correlation with psychological well-being, this relationship was not statistically significant in the second study, suggesting the presence of mediating or moderating mechanisms that should be incorporated into more integrated explanatory models.
5. Critical thinking has a direct and significant effect on metacognitive self-regulation, confirming its capacity to activate and enhance processes of planning, monitoring, and evaluation of thought.
6. Metacognition, in turn, exerts direct and significant effects on specific dimensions of psychological well-being, such as environmental mastery, purpose in life, and self-acceptance, evidencing its role as a structural component of personal development.

7. Metacognition positively influences empathy, understood as a multidimensional competence that integrates the ability to identify others' mental states and respond appropriately to them, suggesting that cognitive self-regulation can strengthen key socioemotional skills.
8. The applied statistical models—linear regression and structural equation modeling (SEM)—provide robust methodological support, enabling the mapping of explanatory relationships between critical thinking, metacognition, and affective variables relevant to personal development.
9. Critical thinking constitutes a complex system of reasoning aimed at deep understanding of the environment, sound decision-making, and effective problem-solving. When interwoven with metacognition and extended to socioemotional competencies such as empathy and well-being, this characterization and its outcomes transcend fragmented approaches and enhance its transformative potential.
10. It is demonstrated that the development of critical thinking requires structured methodologies—intentional, explicit, action-oriented, and sensitive to the personal dimension of learning—which implies a direct responsibility for the design of educational policies that foster its development as a transversal, measurable, and transferable competence.

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