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Identifying Critical Thinking Profiles Among Spanish University Students: A Cluster Analysis with the K-Means Method

Identificación de Perfiles de Pensamiento Crítico entre el Estudiantado Universitario Español: un Análisis de Conglomerados con el Método K-Medias

Identificação de perfis de pensamento crítico entre estudantes universitários espanhóis: uma análise de conglomerados com o Método K-Medias

识别西班牙大学生的批判性思维类型：基于 K-均值聚类方法的分析

تحديد أنماط التفكير النقدي بين الطلاب الجامعيين الإسبان: تحليل التجمعات باستخدام طريقة K-Medias

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Abstract

This study aims to evaluate the level of critical thinking among Spanish university students to identify distinct profiles through cluster analysis using the K-means method. To achieve this, a validated Likert-scale instrument with closed-ended questions was employed, developed based on solid theoretical foundations, expert evaluations, and a pilot study. The instrument demonstrated excellent reliability, both overall (α=0.86) and across dimensions (α=0.81 and 0.76). Moreover, the sample comprised 5,238 university students representing a range of academic disciplines and educational contexts. The findings show that Spanish university students generally display high critical thinking skills. However, significant differences were observed across sociodemographic factors, including gender, age, year of study, academic discipline, institutional type, and autonomous community. Furthermore, a positive correlation was identified between critical thinking and academic performance, as measured by students' academic record grades. Cluster analysis further identified three distinct profiles of critical thinking: high, moderately high, and medium, with distribution patterns influenced by the analysed variables. These results emphasise the importance for tailored educational programmes to strengthen critical thinking skills in Spanish universities. In this context, the study provides practical pedagogical insights and offers suggestions for further research in this area. While acknowledging its limitations, this research contributes to a deeper understanding of critical thinking competence and provides a solid foundation for designing educational interventions aimed at its improvement.

Keywords: critical thinking, validation, higher education.

Resumen

Este estudio tiene como objetivo evaluar el nivel de pensamiento crítico en el estudiantado universitario español para identificar diferentes perfiles mediante el análisis de conglomerados con el método K-medias. Para ello, se utilizó un instrumento validado de preguntas cerradas tipo Likert, diseñado a partir de fundamentos teóricos sólidos, la evaluación de expertos y un estudio piloto, que mostró una excelente fiabilidad global (α=0,86) y por dimensiones (α=0,81 y 0,76). La muestra incluyó a 5.238 estudiantes universitarios/as de diversas áreas y contextos educativos. Los resultados indican que, en general, el estudiantado universitario español muestra un nivel alto de habilidades en pensamiento crítico, aunque existen diferencias significativas asociadas a factores sociodemográficos como género, edad, año de estudio, área de estudio, propiedad institucional y Comunidad Autónoma. Además, se identificó una correlación positiva entre el pensamiento crítico y el rendimiento académico medido por las calificaciones del expediente. A través del análisis de conglomerados, se identificaron tres perfiles distintivos: alto, medianamente alto y medio en habilidades de pensamiento crítico, con una distribución influenciada por las variables analizadas. Estos resultados subrayan la importancia de diseñar programas educativos adaptados para fortalecer el pensamiento crítico en el contexto universitario español. Asimismo, el estudio ofrece implicaciones pedagógicas y orientaciones para futuras investigaciones en este ámbito. A pesar de sus limitaciones, esta investigación amplía nuestra comprensión sobre la competencia en pensamiento crítico y proporciona una base fundamentada para el desarrollo de intervenciones educativas dirigidas a su mejora.

Palabras clave: pensamiento crítico, validación, enseñanza superior.

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Resumo

O objetivo deste estudo é avaliar o nível de pensamento crítico nos estudantes universitários espanhóis, a fim de identificar diferentes perfis através da análise de conglomerados com o método K-medias. Para isso, foi utilizado um instrumento validado de perguntas fechadas tipo Likert, concebido com base em fundamentos teóricos sólidos, na avaliação de peritos e num estudo-piloto, que mostrou uma excelente fiabilidade global (α=0,86) e por dimensões (α=0,81 e 0,76). A amostra incluiu 5238 estudantes universitários de diversas áreas e contextos educativos. Os resultados indicam que, em geral, os estudantes universitários espanhóis apresentam um elevado nível de competências de pensamento crítico, embora existem variações significativas associadas a fatores sociodemográficos, tais como género, idade, ano de estudo, área de estudo, propriedade institucional e Comunidade Autónoma. Além disso, foi identificada uma correlação positiva entre o pensamento crítico e o desempenho académico, medido pelas qualificações do processo. Através da análise de conglomerados, foram identificados três perfis distintos: alto, médio-alto e médio em competências de pensamento crítico, com uma distribuição influenciada pelas variáveis analisadas. Estes resultados sublinham a importância de conceber programas educativos adaptados para reforçar o pensamento crítico no contexto universitário espanhol. O estudo oferece também implicações pedagógicas e orientações para investigações futuras nesta área. Apesar das suas limitações, esta investigação alarga a nossa compreensão sobre a competência de pensamento crítico e proporciona uma base fundamentada para o desenvolvimento de intervenções educativas destinadas a melhorá-la.

Palavras-chave: pensamento crítico, validação, ensino superior.

摘要

本研究旨在评估西班牙大学生的批判性思维水平，并通过K-均值聚类分析方法识别不同的批判性思维类型。研究采用了基于理论基础、专家评估及试点研究的封闭式李克特量表，整体显示出优异的整体信度（α=0.86）及维度信度（α=0.81和0.76）。研究样本包括来自不同学科领域和教育背景的5,238名大学生。研究结果表明，西班牙大学生整体上表现出较高水平的批判性思维能力，但在性别、年龄、学习年级、学科领域、学校性质以及自治区等社会人口变量上存在显著差异。此外，批判性思维与通过成绩衡量的学术表现之间呈现正相关关系。通过聚类分析，研究识别出三种具有代表性的批判性思维类型：高水平、中等偏高水平和中等水平。不同类型的分布与上述变量密切相关。研究结果强调了设计针对性教育项目以强化批判性思维的重要性，尤其是在西班牙高等教育环境中。此外，本研究为批判性思维的培养提供了教学启示，并为未来相关领域的研究提出了指导意见。尽管本研究存在一定局限性，但其丰富了我们对批判性思维能力的理解，并为制定提升批判性思维的教育干预措施提供了坚实基础。

关键词：批判性思维、验证、高等教育

ملخص

هذا البحث يهدف إلى تقييم مستوى التفكير النقدي لدى الطلاب الجامعيين الإسبان بهدف تحديد أنماط مختلفة من خلال تحليل لتحقيق ذلك، تم استخدام أداة مُعتمدة تتألف من أسئلة مغلقة على نمط ليكرت، صُممت بناءً .K-medias التجمعات باستخدام طريقة (α=0,81 وعلى مستوى الأبعاد (α=0,86 على أسس نظرية متينة، وتقييم الخبراء، ودراسة تجريبية أظهرت موثوقية عالية عامة شملت العينة 5,238 طالباً وطالبة من مختلف التخصصات والسياقات التعليمية. تشير النتائج إلى أن الطلاب الجامعيين .(و 0,76 الإسبان يظهرون بشكل عام مستوى عالياً من المهارات في التفكير النقدي، على الرغم من وجود اختلافات كبيرة مرتبطة بعوامل اجتماعية وديموغرافية مثل الجنس، العمر، سنة الدراسة، مجال التخصص، نوع المؤسسة التعليمية، والمنطقة ذاتية الحكم. بالإضافة إلى ذلك، تم تحديد وجود علاقة إيجابية بين التفكير النقدي والأداء الأكاديمي المقاس بالدرجات الدراسية. من خلال تحليل التجمعات، تم التعرف على ثلاثة أنماط مميزة: عالٍ، متوسط إلى عالٍ، ومتوسط في مهارات التفكير النقدي، حيث تأثرت التوزيعات بالمتغيرات التي تمت دراستها. تؤكد هذه النتائج على أهمية تصميم برامج تعليمية مُكيّفة لتعزيز التفكير النقدي في السياق الجامعي الإسباني. علاوة على ذلك، يقدم هذا البحث دلالات تربوية وتوجيهات للبحوث المستقبلية في هذا المجال. وعلى الرغم من حدوده، فإن هذه الدراسة توسع فهمنا لمهارات التفكير النقدي وتوفر أساساً مستنداً لتطوير تدخلات تعليمية تستهدف تحسينها

الكلمات الدالة :التفكير النقدي، التحقق، التعليم العالي

Introduction

Critical thinking is a multifaceted cognitive process that involves systematically and objectively analysing information to make informed decisions and formulate well-reasoned judgments (Ennis, 1985; Halpern, 2014). It is an intellectual endeavour that demands the deliberate application of cognitive skills in an organised, disciplined, and thoughtful manner. Unlike rote memorisation, critical thinking demands both disposition and knowledge (Scheie et al., 2022; Towfik et al., 2022). The dispositional aspect encompasses attitudes such as the desire to be well-informed (Facione, 1990), intellectual humility (Paul & Elder, 2006), and moral integrity (Paul, 1999), among others.

Cultivating these skills involves fostering a healthy level of scepticism (Danczak et al., 2020), where thoughtful questioning serves as a catalyst for deeper understanding and informed action rather than leading to analytical paralysis. The cognitive effort dedicated to critical thinking should be proportional to the significance of the decision at hand. Furthermore, individuals must recognise the limitations of their knowledge and the inherent uncertainties of complex topics. This recognition underscores the importance of epistemological awareness, particularly in fields that require deep expertise in specific mythologies, techniques, and knowledge domains (Singh et al., 2018; Thomas & Lok, 2015). For example, making well-founded decisions about the optimal cancer treatment requires a profound medical knowledge base, particularly within the field of oncology.

Moreover, the capacity for critical thinking is influenced by various contextual elements, including motivational, emotional, social, political, cultural, and educational dimensions (Ciftci et al., 2021; González-Cacho & Abbas, 2022). These factors can either facilitate or hinder an individual's ability to process and evaluate information critically. For example, motivational factors may determine the degree of commitment dedicated to critical thinking endeavours, emotional factors might compromise objectivity, and social, political, and cultural factors could introduce subjective biases. Despite extensive research, the impact of learning styles on critical thinking remains somewhat elusive. While certain studies indicate a correlation (Behzadi & Momennasab, 2023; Yang et al., 2023), others refute such claims (Rini et al., 2020; Purwanto et al., 2020). Importantly, educational factors significantly affect the quality and quantity of training received, thereby influencing one's ability to engage in rational and ethical thinking (Abrami et al., 2015; Ennis, 2018).

Consequently, fostering the development of critical thinking among students from environments that are unfavourable to intellectual autonomy, such as those rooted in cultures that discourage questioning and alternative perspectives, or in educational systems previously centred on rote memorisation and cognitive rigidity, can present significant challenges (Santos et al., 2021). However, it is important to emphasise that these challenges do not necessarily indicate a lack of critical thinking ability in these students. Instead, they highlight a mismatch between their cultural values and the cognitive patterns associated with critical thinking, which results in fewer opportunities to develop critical thinking. Therefore, it is essential to offer an education that not only addresses these disparities but also promotes the holistic development of critical thinking in all students, irrespective of their cultural or educational background.

The evaluative component of critical thinking is reflected in its name, where "critical" conveys the careful analysis and evaluation of an issue to form informed decisions about whether it should be accepted or pursued and why. This process is intertwined with ethical reasoning, which is essential for developing critical thinking (Davies & Barnett, 2015; Paul & Elder, 2019). In this regard, the process of critical thinking involves both rational and ethical considerations. The rational dimension involves the logical analysis and evaluation of arguments and problems, grounded in factual and objective evidence, free from biases, to reach well-informed conclusions. On the other hand, the ethical dimension of critical thinking involves developing an awareness of how our actions can impact others, being respectful and empathetic towards others, and making fair and just decisions. Developing ethical reasoning abilities can, therefore, help

reduce conflicts and minimise harm to individuals or society as a whole, enhance interpersonal relationships, foster a positive and collaborative environment, and promote a more just and inclusive society.

It is worth noting that critical thinking is not a dichotomous concept but a continuum. Since the criteria for critical thinking vary in quantitative dimensions, a person's level of critical thinking may be more or less advanced. This is a crucial aspect since acknowledging that critical thinking can manifest in varying degrees of intensity justifies its measurement and development. In this regard, after establishing critical thinking as a vital process for ethical and rational decision-making in beliefs and actions, and to ease its evaluation, it becomes apparent that it involves the combination of several skills, knowledge, and the willingness to apply them effectively. Despite the artificial nature of breaking down the continuous thinking process into discrete skills, it serves to aid in understanding, teaching, and evaluation. As such, it can be noted that critical thinking consists of two main dimensions: *Argument analysis and evaluation*, and *Problem-solving*. *Argument analysis* involves identifying and examining the different parts of an argument, their relationships, and the integrative principle, with the purpose of understanding the content and structure of the argument (Andrews, 2015; Chatfield, 2022; Dwyer, 2017; Halpern, 2014). *Argument evaluation* aims to assess the strength or weakness of the premise in supporting the conclusion, regardless of one's level of agreement with the conclusion. This involves detecting reasoning errors, constructing counter-arguments and alternative hypotheses, and identifying necessary additional information (Archila et al., 2022; Braun et al., 2020; Nagel et al., 2020).

Problem-solving is a logical and systematic approach to identifying and resolving problems. The process includes four phases: identifying and analysing the problem, identifying the strategy and alternatives, taking action guided by strategies, and evaluating both the process and the results (Aktoprak & Hursen, 2022; Braun et al., 2020; Dwyer, 2017; Halpern, 2014). Problem-solving skills involve recognising the basic elements of the problem, understanding its characteristics and the necessary knowledge for its resolution, selecting the best solution alternative, taking corrective actions when necessary, and critically and constructively evaluating the process and outcome. By promoting critical thinking skills, individuals can make more informed decisions and navigate complex problems more effectively.

Current study

Critical thinking has become a fundamental competence for success in both higher education and the professional field (Akpur, 2020; Cottrell, 2023). However, despite its importance, the assessment and development of critical thinking remain a significant challenge for educators and researchers worldwide (Berg et al., 2021). In Spain, no national study has yet been conducted to evaluate critical thinking skills among university students, nor have specific critical thinking profiles been identified. This gap in the research presents a unique opportunity to delve deeper into the analysis of critical thinking within the Spanish university context, considering relevant sociodemographic variables such as gender, age, academic year, academic record grade, field of knowledge, university ownership (public or private), and Autonomous Community.

The present study addresses this need by analysing these seven sociodemographic variables, which provide a robust framework for exploring the differences and similarities in the levels and profiles of critical thinking within the university student population. The primary aim of this research, therefore, is to assess the level of critical thinking skills in Spanish university students and to identify differentiated profiles through cluster analysis using the K-means method. Furthermore, it seeks to examine the distribution of these profiles based on the sociodemographic variables under consideration, offering a detailed and contextualised view of critical thinking in this population.

Ultimately, this study aims to contribute to the global body of knowledge on critical thinking and provide valuable insights for educators and researchers at both national and international levels. The findings will inform the development of effective educational strategies and guide future research, with a focus on Spanish university students.

Materials and methods

A quantitative research approach was utilised to achieve the research objective, employing an exploratory cross-sectional design with a non-experimental *ex post facto* approach.

Participants

A total of 5,238 student participants voluntarily opted to take part in the study through a convenience non-probability sampling method. This method involved selecting participants not randomly from the entire student population but based on their accessibility and willingness to participate. Although the instrument was distributed to various universities and their students, participant selection depended on the availability and willingness of university representatives to participate in the study. Consequently, not all students had an equal opportunity to be included in the sample, as those from universities that did not actively participate might have been excluded. This reliance on convenience rather than random selection renders the sampling method non-probabilistic, requiring careful consideration when generalising the results to the broader population of university students. However, the population size of 1,340,632 (Gobierno de España, 2022) was taken into account to determine the margin of error and confidence level. Consequently, a margin of error of 1.78% and a 99% confidence level were achieved through these considerations.

With regard to sociodemographic variables (Table 1), the sample comprised approximately 60.15% women, with 3.41% identifying as non-binary. Furthermore, the age distribution showed that the majority of the sample (85.53%) fell within the 17 to 24 age range, with the largest subgroup being 17 to 20-year-olds (50.17%), while approximately 9.34% of the participants were between 25 and 32 years old.

Table 1. Description of the sample based on the sociodemographic variables considered in the study

	N	%
Gender		
Women	3,151	60.15%
Men	1,961	37.44%
Non-binary	126	3.41%
Age		
17-20	2,628	50.17%
21-24	1,852	35.36%
25-28	357	6.82%
29-32	132	2.52%
+32	269	5.14%
Year		
1st	1,577	30.11%
2nd	928	17.72%
3rd	652	12.45%
4th	1,848	35.28%
5ºth	212	4.05%
6th	21	0.4%
Academic record grade		
A	333	6.36%
B	2,221	42.40%
C	1,007	19.22%
D	84	1.60%
F	15	0.29%
No data (1st-year students)	1,578	30.13%
Field of knowledge		
Social and Legal Sciences		31.54%
Sciences		22.04%
Engineering and Architecture		16.7%
Health Sciences		15.84%
Arts and Humanities		14.32%

	N	%
Ownership		
Public university	4,959	94.67%
Private university	273	5.21%
Autonomous community		
Madrid (Community of)	1,175	22.44%
Andalusia	841	16.06%
Valencian Community	617	11.78%
Catalonia	493	9.41%
Galicia	384	7.33%
Asturias (Principality of)	368	7.03%
Castile and León	321	6.13%
Basque Country	297	5.67%
Balearic Islands	235	4.49%
Canary Islands	221	4.22%
Aragon	76	1.45%
Castilla La-Mancha	70	1.34%
Cantabria	52	0.99%
Region of Murcia	29	0.55%
Chartered Community of Navarre	28	0.53%
La Rioja	16	0.31%
Extremadura	15	0.29%

In terms of academic year, 47.83% of the participants were in the first or second year, 47.73% were in the third or fourth year, and 4.41% were in the fifth or sixth year. Notably, the percentages of students in the first (30.11%) and fourth (35.28%) years stood out. Regarding academic record grade, the most common grade was a B (60.7%), followed by C+ (27.5%), A (9.1%), D (2.3%), and F (0.4%)[1]. Concerning the field of knowledge, Social and Legal Sciences had the highest representation at 31.54%, followed by Sciences at 22.04%. Engineering and Architecture accounted for 16.7% of the sample, while Health Sciences represented 15.84%. In contrast, Arts and Humanities had the lowest representation at 14.32%.

Furthermore, the study comprised participants from all Autonomous communities of Spain, with the majority (94.67%) attending public universities. Notably, Madrid (21.92%), Andalusia (16.06%), Valencia (11.78%), and Catalonia (9.41%) had the highest participation rates, possibly due to their larger populations and higher number of universities. Thus, these sample characteristics offer valuable insights into the study's results and their generalisation to the population as a whole.

Instrument

The development of a data collection instrument, named *CritiTest*, involved four sequential stages. First, a theoretical framework for critical thinking was established, defining it as a comprehensive cognitive process aimed at analysing and evaluating arguments or problems to reach valid conclusions or select the alternative with the highest probability of success (Dwyer, 2017; Ennis, 1985; Halpern, 2014). Subsequently, this framework was categorised into two dimensions: argument analysis and evaluation, and problem-solving (refer to Table 2; also see Appendix 1 for a detailed breakdown of dimensions, subdimensions, and indicators).

Table 2. Dimensions and Subdimensions of Critical Thinking Framework

Dimension	Subdimension
Analysis and evaluation of arguments	Argument analysis Argument identification and analysis Content identification and analysis Relationship identification and analysis Argument evaluation Passive evaluation Active evaluation
Problem-solving	Problem identification and analysis Strategy formulation and alternative generation Strategic implementation guidance Comprehensive evaluation

[1] The Spanish grade system categorises a score below 5 as "insuficiente" (equivalent to an "F" or "Fail" grade in the UK system), while a score of 5 is "suficiente" or a "D" or "Pass." "Bien" is assigned to a score of 6, which is equivalent to a "C" grade. "Notable" grades fall between 7-8, equivalent to a "B" or "2:1" grade, while a grade of 10 is labelled "excelente" (equivalent to an "A" or "1st" grade in the UK system).

Attributes reflecting the construct were determined through the assessment of proposed indicators by nine experts in argumentation, critical thinking, and measurement. Following this, item content was developed based on previously identified indicators. To assess the argumentative dimension of critical thinking, current and socially controversial topics were suggested, drawing on data analysis from diverse sources such as social networks, media, and search engines. For the problem-solving dimension, areas where university students typically engage in decision-making, such as family, studies, friendships, and travel, were identified. Subsequently, a preliminary instrument was designed, consisting of open-ended questions to maximise variability in individuals' constructs. To mitigate biases, the relationship between indicators and topics was randomised.

Administration procedures were developed following expert review and revisions. A pilot study involving 99 students analysed responses utilising Natural Language Processing (NLP) techniques, including Part of Speech Tagging (POS Tagging), Bag of Words (BOW), and a linguistic sentiment analysis model based on Transformers. These techniques were chosen for their ability to streamline data analysis, extract meaningful insights, ensure objectivity in evaluation, facilitate scalability, and provide advanced analysis capabilities.

Building upon these findings, the final instrument was designed, featuring 5-point Likert-type closed questions (refer to examples in Figures 1 and 2). This instrument was structured into two primary dimensions: Analysis and evaluation of arguments and Problem-solving. Cronbach's alpha coefficient affirmed good internal consistency (0.86 for the full scale, 0.81 for Analysis and evaluation, and 0.76 for Problem-solving).

Figure 1. Item of Analysis and evaluation of arguments

AMAIA (TV presenter): Following a spirited debate on the topic of Monarchy versus Republic, 54% of the participating viewers have expressed their support for the Monarchy, while 46% favour the Republic. What is particularly striking, however, is that 97% of all voters agree on the necessity of holding a referendum to allow the populace to decide the State model. Therefore, if we are to truly honour the will of the Spanish people, we should proceed with a referendum.

Please indicate your level of agreement with the following statements, on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree):

- A majority of Spaniards support holding a referendum to decide the State model (reverse item).
- The survey respondents provide an accurate representation of the Spanish population (reverse item).

Figure 2. Item of Problem solving

Your best friend is facing a challenging situation (...). During a heartfelt conversation, he confides in you about his severe cocaine addiction and seeks your help in finding a detox centre. After conducting thorough research, you are presented with two options:

1. The first centre is run by a former addict from France, who is slightly older than your friend. This centre reports that 90% of individuals who completed a year-long treatment successfully detoxed from cocaine.
2. The second centre is managed by a middle-aged German therapist with advanced training in the psychobiology of cocaine addiction, despite having no personal experience with cocaine. This centre reports that 30% of participants in the treatment program successfully achieved detoxification.

Please indicate your level of agreement with the following statements, using a scale from 1 (Strongly Disagree) to 5 (Strongly Agree):

- The success rate should should carry more weight than nationality when selecting a centre.
- Achieving recovery is more likely at the first centre (reverse item).

Procedure

To facilitate the implementation of the instrument, communication was established with key stakeholders from all Spanish universities, including rectors, vice-rectors, deans, vice-deans, faculty members, and student representatives, inviting their collaboration in data collection via an online platform. Those who expressed interest were given access to the digital version of the tool to distribute among their respective student bodies.

Before completing the instrument, students were informed of the voluntary nature of participation and assured that they could withdraw at any time without repercussion. They were guaranteed anonymity and confidentiality of their responses, which would be used exclusively for research purposes. Additionally, compliance with Regulation (EU) 2016/679 of the European Parliament and of the Council of April 27, 2016, as well as Organic Law 3/2018 of December 5, of data processing, was emphasised. Explicit consent to participate in the study was required before accessing the instrument. Furthermore, records were anonymised, and analyses were conducted in an aggregated fashion.

Data analysis

After data collection was completed, a descriptive analysis was performed using statistical measures such as percentages, averages, and standard deviations. These measures provided valuable insights into the critical thinking performance of students and highlighted areas that require improvement. Additionally, both differential analyses (Student's t-test and ANOVA with a 99% confidence level) and correlational analyses (Pearson correlation coefficient with a 99% confidence level) were performed to further explore variations across sociodemographic factors and examine the relationship between critical thinking and academic record grades. To gain a more detailed understanding of individual student profiles, the K-means clustering method was utilised for cluster analysis at a 99% confidence level, using SPSS software. This approach enabled the identification of distinct clusters of students based on their critical thinking performance and provided a more nuanced understanding of their abilities. The combination of these analyses resulted in a comprehensive assessment of critical thinking skills among Spanish university students.

Results

This section presents the results of the study, including the descriptive, differential, correlational, and cluster analyses. Descriptive analysis outlines critical thinking skills among Spanish university students, while differential analysis explores variations across sociodemographic factors (gender, age, year of study, field of study, institutional ownership, and Autonomous Community). Correlational analysis examines the relationship between critical thinking and academic record grades. Lastly, cluster analysis identifies distinct student profiles, guiding tailored educational programs and future research.

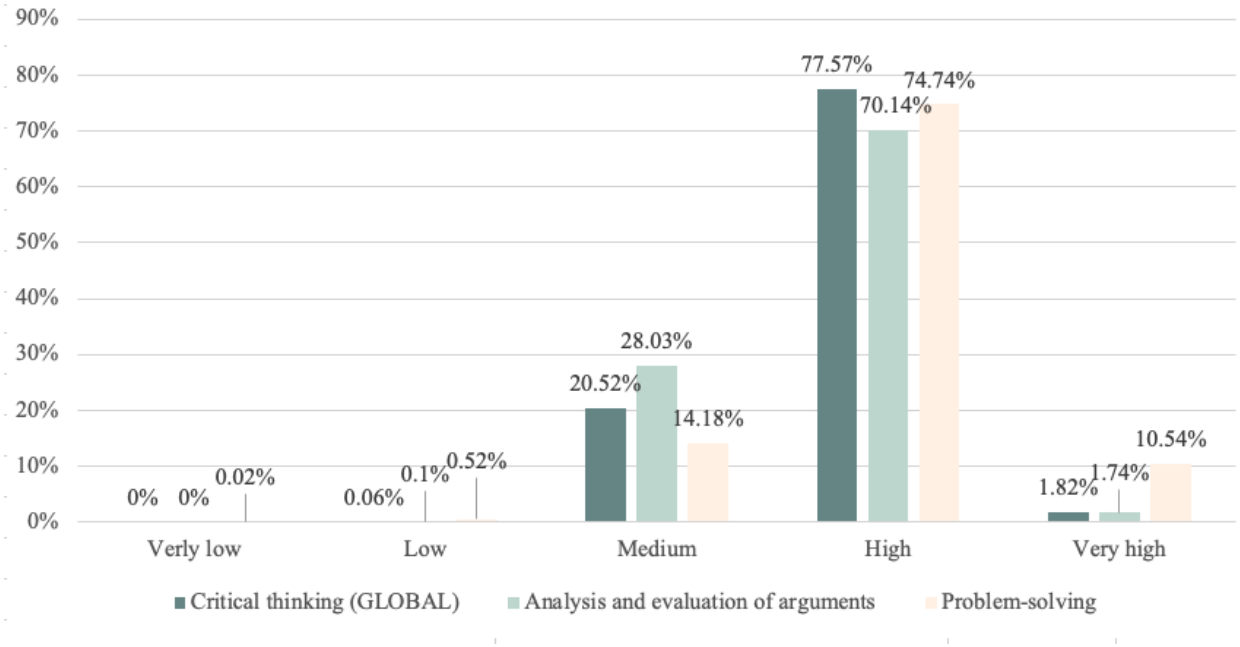
Descriptive analysis

The findings show that undergraduate students in Spain exhibit a high level of *Critical thinking* skills, as evidenced by an average score of 145.23 (SD = 16.28) on a scale ranging from 0 to 220. Specifically, 77.57% of students exhibit high levels of critical thinking skills, while 20.52% exhibit medium levels and 1.82% exhibit very high levels. In contrast, 0.06% of the students exhibited low levels (Figure 3). Further analysis of the data indicated that the level of *Analysis and evaluation of arguments* was also high, with a mean score of 95.46 (SD = 11.66) on a scale ranging from 0 to 148. Specifically, the results indicate that 0.1% of the sample exhibited low levels, 28.03% exhibited medium levels, 70.14% exhibited high levels, and 1.74% exhibited very high levels in this dimension.

Both sub-dimensions of *Analysis and evaluation of arguments* demonstrated high

levels of proficiency, with an average score of 50.89 out of 80 and 44.56 out of 68 points, respectively, and high consistency in responses (with standard deviations of 6.78 and 6.61, respectively). Regarding *Argument analysis*, the data indicated that undergraduate students exhibited high levels of proficiency in *Argument identification and analysis* and *Content identification and analysis*, as well as medium-high levels in *Relationship identification and analysis*. For *Argument evaluation* skills, both *Passive* and *Active evaluations* demonstrated high levels of proficiency, with an average score of 31.05 out of 48 and 13.5 out of 20, respectively. Furthermore, there was a high level of consistency in the distribution of scores among the subjects, as evidenced by the obtained standard deviations (Table 7).

Figure 3. Distribution of sample by level of Critical thinking (GLOBAL), Analysis and evaluation of arguments, and Problem-solving.



In terms of *Problem-solving skills*, the overall level was also high, with an average score of 49.76 (SD = 6.63) on a scale ranging from 0 to 72. Specifically, 10.54% of the sample exhibited very high levels, 74.74% exhibited high levels, 14.18% exhibited medium levels, 0.52% exhibited low levels, and 0.02% exhibited very low levels of problem-solving skills. The results showed high levels in all four phases of *Problem-solving*, including *Problem identification and analysis* (Phase 1), *Strategy formulation and alternative generation* (Phase 2), *Strategic implementation guidance* (Phase 3), and *Comprehensive evaluation* (Phase 4). The sample included 10.54% of participants exhibiting very high levels, 74.74% exhibiting high levels, 14.18% exhibiting medium levels, 0.52% exhibiting low levels, and 0.02% exhibiting very low levels of problem-solving skills.

Differential and correlational analysis

The results of the *Gender*-based differential studies (Table 3) indicate that women exhibit significantly lower levels ($p<0.01$, with a small effect size, as per López-Martín & Ardura-Martínez, 2022) of *Critical thinking* compared to men and non-binary individuals. These differences persist across *Argument analysis and evaluation*, *Argument analysis*, *Content identification and analysis*, *Argument evaluation*, *Passive evaluation*, and *Comprehensive evaluation*.

Table 3. Differential analysis by Gender and Age

	Gender				Age					
	M	**W**	**NB**	**η^2**	**17-20**	**21-24**	**25-28**	**29-32**	**+32**	**η^2**
Critical thinking (GLOBAL)	147.08	143.89	149.84	0.01	143.06	147.41	149.02	149.05	144.44	0.02
Argument analysis and evaluation	97.40	94.08	99.61	0.02	93.93	96.96	98.14	98.89	94.77	0.02
Argument analysis	51.79	50.25	52.87	0.01						
Content identification and analysis	21.69	20.92	22.15	0.01						
Argument evaluation	45.60	43.82	46.74	0.02	43.51	45.47	46.23	46.94	45.19	0.03
·Passive evaluation	32.01	30.39	32.74	0.02	30.06	31.85	32.60	33.14	32.18	0.03
Problem-solving					49.13	50.44	50.88	50.16	49.67	0.01
·Content identification and analysis					18.65	19.25	19.56	19.67	19.46	0.02
·Comprehensive evaluation	5.09	4.71	5.17	0.02						

Regarding *Age*-based differential studies (Table 3), findings indicate that students aged between 17 and 20 demonstrate significantly lower levels of *Critical thinking* and *Argument analysis and evaluation* ($p<0.01$, with a small effect size) compared to those aged between 21 and 32. Additionally, this younger age group shows significantly lower levels of *Problem-solving* ($p<0.01$, with a medium-low effect size) compared to their counterparts aged between 21 and 28, as well as lower levels of *Argument Evaluation*, *Passive Evaluation*, and *Strategy formulation and alternative generation* ($p<0.01$, with a small effect size) compared to other students.

Regarding academic progression (*Year*), the average scores across all dimensions and sub-dimensions tend to increase as students advance through their academic years (Table 4). Specifically, final-year students tend to achieve the highest scores, followed by students in lower years. ANOVA results reveal statistically significant differences ($p<0.01$; $\eta2=0.05$) in *Critical thinking* between students in different academic years, favouring higher-level courses in all cases.

Table 4. Differential analysis by Year

	Year						
	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**$\eta2$**
Critical thinking (GLOBAL)	140.91	143.05	147.32	148.47	151.13	157.38	0.05
Argument analysis and evaluation	92.33	94.07	96.97	97.69	100.02	102.42	0.05
Argument analysis	49.68	50.22	51.74	51.66	53.27	54.22	0.02
Argument identification and analysis	12.96	13.09	13.63	13.47	14.28	13.02	0.01
Content identification and analysis	20.66	21.06	21.41	21.64	22.08	23.43	0.02
Relationship identification and analysis	16.05	16.07	16.69	16.54	16.91	17.76	0.01
Argument evaluation	42.64	43.84	45.23	46.03	46.74	48.19	0.05
·Passive evaluation	29.20	30.42	31.60	32.47	33.24	34.38	0.06
·Active evaluation							-
Problem-solving	48.57	48.97	50.34	50.78	51.11	54.95	0.03
·Strategy formulation and alternative generation	18.50	18.67	19.10	19.43	19.68	21.15	0.02
·Strategic implementation guidance	4.69	4.85	5.15	5.15	5.21	6.10	0.01
·Comprehensive evaluation	4.60	4.77	4.95	5.08	5.01	5.92	0.02

In terms of *Field of study* (Table 5), results suggest that students in Social Sciences and Law obtain significantly lower scores in *Critical thinking* (p<0.01, with a medium-low effect size) compared to students in other fields of study. Similarly, students in Health Sciences score significantly lower than those in Arts and Humanities, with the latter scoring significantly higher than students in Engineering and Architecture. This trend persists, with slight variations, across different dimensions and sub-dimensions of the construct.

Table 5. Differential analysis by Field of study

	Field of study					
	A&H	**SS&L**	**S**	**HS**	**E&A**	**η^2**
Critical thinking (GLOBAL)	147.69	141.16	149.68	143.97	145,.80	0.04
Analysis and evaluation of arguments	97.68	92.67	98.52	93.73	96.21	0.04
Argument analysis	97.68	92.67	98.52	93.73	96.21	0.03
· Identification and analysis of arguments	13.97	12.75	13.73	13.18	13.35	0.02
· Identification and analysis of content	13.97	12.75	13.73	13.18	13.35	0.01
Argument evaluation	45.57	43.1	46.43	43.43	44.92	0.04
· Passive evaluation	31.71	30	32.47	30.05	31.44	0.03
· Active evaluation	13.85	13.09	13.96	13.38	13.48	0.02
Problem-solving	50	48.48	51.16	50.24	49.58	0.02
·Problem identification and analysis	21.28	20.52	21.36	21.03	2.76	0.01
·Strategy formulation and alternative generation	19.15	18.41	19.56	19.41	18.76	0.03
· Comprehensive evaluation	4.77	4.67	5.08	4.85	4.98	0.01

Note: Abbreviations used in the table: A&H for Arts and Humanities, SS&L for Social Sciences and Law, S for Science, HS for Health Sciences, and E&A for Engineering and Architecture.

Regarding *Institutional ownership*, students in public universities demonstrate higher levels (p<0.01, with a very high effect size, according to Cohen, 1988) of *Problem-solving* ($\bar{X}_{Pr}$ =48,64; $\bar{X}_{Pu}$ = 49.83; d=0.18) and *Strategy formulation and alternative generation* ($\bar{X}_{Pr}$ =188.36; $\bar{X}_{Pu}$ = 19.03; d=0.23) compared to those in private institutions.

Analysis by *Autonomous Community* (Table 6) reveals significant variations in *Analysis and evaluation of arguments* scores, with students in Andalusia scoring lower than those in Catalonia and Asturias ($\bar{X}_{Andalucía}$ = 93.94; $\bar{X}_{Cataluña}$ = 97.86; $\bar{X}_{Asturias}$ = 98.35; η^2=0.02).

Finally, correlational analysis between *Critical thinking* (overall and its dimensions) and *Academic record grades* reveals a significant positive yet weak correlation (p<0.01; Dancey & Reidy, 2007). Specifically, *Critical thinking* (r=0.21), *Argument analysis and evaluation* (r=0.20), *Argument evaluation* (r=0.21), and *Passive evaluation* (r=0.22) demonstrate correlations. These findings suggest that students with higher grades tend to exhibit elevated levels of these aforementioned skills.

Cluster analysis

Following the differential and correlational analyses, a cluster analysis was conducted using the K-means method to identify distinct student profiles. Solutions with 2, 3, and 4 clusters were examined, and it was found that the 3-cluster solution yielded the most meaningful interpretation of the data (Table 7; Figure 4). Notably, the sub-dimension of *Relationship identification and analysis* was excluded from the interpretation of the clusters presented in Table 7 and Figure 4, as no significant variation was observed in this sub-dimension.

Table 6. Differential analysis by Autonomous Community

Analysis and evaluation of arguments			
Autonomous Community	**Mean**	**Autonomous Community**	**Mean**
Asturias (Principality of)	98.35	Canary Islands	94.70
Catalonia	97.86	Castile and Leon	94.47
Navarre (Chartered Community of)	97.49	Andalusia	93.94
Cantabria	97.08	Balearic Islands	93.27
Galicia	96.61	Aragon	92.65
Madrid (Community of)	95.90	La Rioja	91.66
Basque Country	95.54	Castile-La Mancha	91.10
Murcia (Region of)	95.45	Extremadura	86.47
Valencian Community	94.80		

Table 7. Means of the clusters based on dimensions and sub-dimensions of critical thinking

	Mean (Total sample)	**SD** (Total sample)	**Cluster 1**	**Cluster 2**	**Cluster 3**
Critical thinking (GLOBAL) (0-220)	145.23	16.28	162.55	144.18	122.94
Analysis and evaluation of arguments (0-148)	95.46	11.66	108.02	94.25	80.16
Argument analysis (0-80)	50.89	6.78	56.99	50.38	43.33
·Argument identification and analysis (0-20)	13.3	3.13	15.21	13.32	10.6
·Content identification and analysis (0-32)	21.24	3.57	23.89	20.93	18.12
·Relationship identification and analysis (0-28)	16.35	3.02	17,9	16,13	14,6
Argument evaluation (0-68)	44.56	6.61	51.02	43.87	36.83
·Passive evaluation (0-48)	31.05	5.86	36.35	30.53	24.64
·Active evaluation (0-20)	13.5	2.77	14.67	13.34	12.19
Problem-solving (0-72)	49.76	6.63	54.53	49.93	42.78
·Problem identification and analysis (0-28)	20.93	3.06	22.45	21.21	18.3
·Strategy formulation and alternative generation (0-28)	18.99	2.85	20.63	19.04	16.61
·Strategic implementation guidance (0-8)	4.96	2.06	5.73	4.91	4.01
·Comprehensive evaluation (0-8)	4.86	1.53	5.73	4.76	3.86

Note: All mean differences among the three clusters are significant with a confidence level of alpha=0.01, except for the sub-dimension *Relationship identification and analysis*, where the difference is not significant.

The results of the study led to the identification of three clusters, as follows:

- ***Cluster 1*** comprises 32.57% of the sampled students and is characterised by **high scores** in most dimensions and subdimensions of *Critical thinking*, as presented in Figure 4. Specifically, it demonstrated high scores in *Critical thinking*, the *Analysis and evaluation of arguments dimension* (which includes the subdimension of *Argument analysis, Argument identification and analysis Content identification and analysis, Argument evaluation, Passive evaluation* and *Active evaluation*) and the *Problem-solving* dimension (including the subdimensions of *Strategic implementation guidance* and *Comprehensive evaluation*).

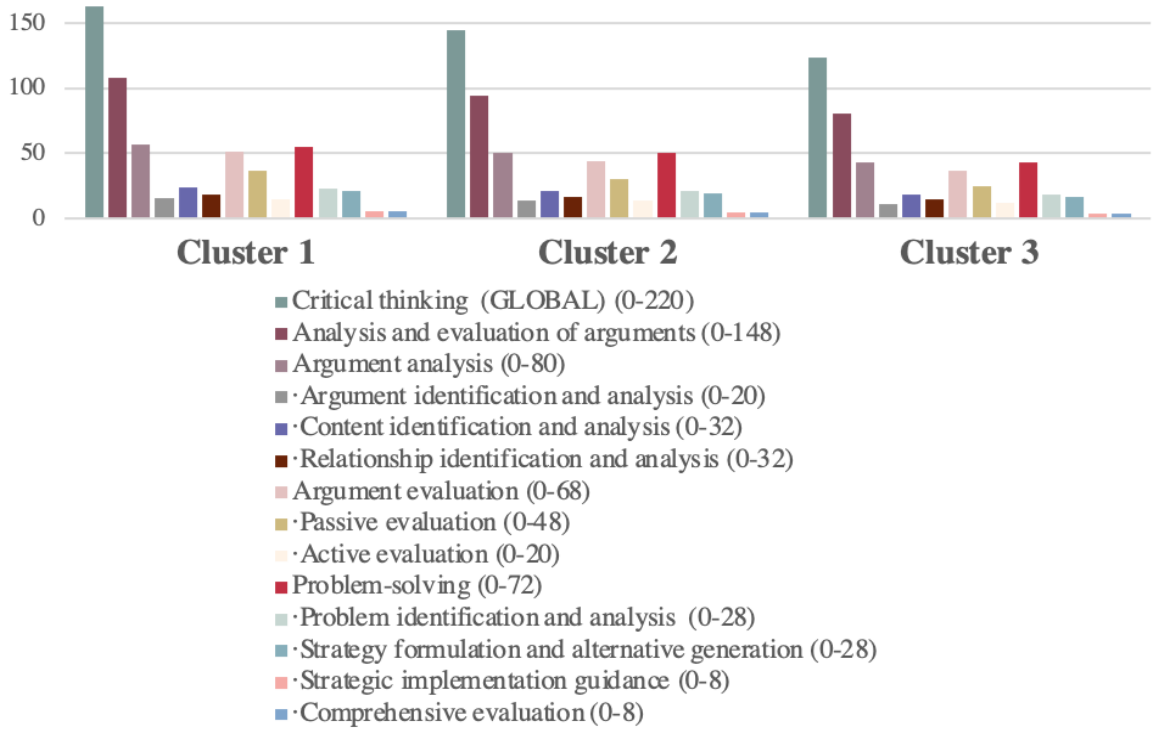
Furthermore, *Cluster 1* indicates medium-high scores in the *Strategy and alternative identification* subdimension

(which belongs to the *Problem-solving* dimension) and very high scores in the *Problem identification and analysis* subdimension (which also belongs to the *Problem-solving* dimension). As displayed in Table 7, *Cluster 1* displays significantly higher levels ($p<0.01$) in most dimensions and subdimensions in comparison to the other clusters. The only exception is observed in the subdimension of *Strategic implementation guidance* (belonging to the *Problem-solving* dimension), where no significant differences are evident in comparison to *Cluster 2*.

- ***Cluster 2*** comprises 22.22% of the sampled students and is characterised by exhibiting **medium-high scores** in most of the dimensions and subdimensions of critical thinking, as illustrated in Figure 4. Specifically, it demonstrates medium-high scores in all its dimensions and most of its subdimensions, except for the subdimension of *Problem identification and analysis*, belonging to the *Problem-solving* dimension, in which high scores are high instead of medium-high.

  Moreover, it is noteworthy that *Cluster 2* manifests significantly lower levels ($p<0.01$) than *Cluster 1* in most dimensions and subdimensions, except for the subdimension of *Strategy formulation and alternative generation*, which belongs to the *Problem-solving* dimension, where no significant differences exist between the two clusters. Additionally, as indicated in Table 7, *Cluster 2* exhibits significantly higher levels ($p<0.01$) than *Cluster 3* in most dimensions and subdimensions, except for the subdimension of *Active evaluation*, which belongs to the *Analysis and evaluation of arguments* dimension, where although differences are observed, they lack statistical significance.

Figure 4. Cluster means according to the dimensions and sub-dimensions of critical thinking



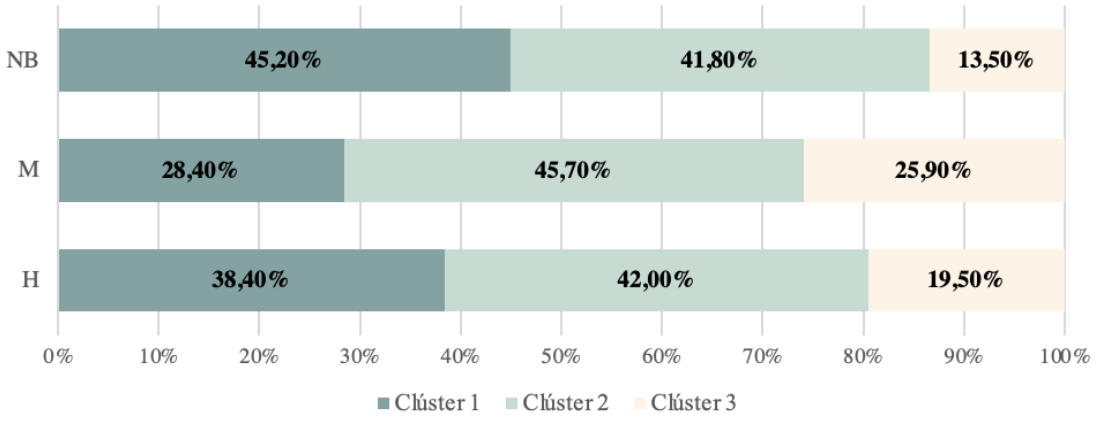
- ***Cluster 3***, which comprises 23.22% of the sampled students, is characterised by presenting **average scores** in most of the dimensions and subdimensions of critical thinking, as illustrated in Figure 4. Specifically, it demonstrates average scores in all of its dimensions and in most of its subdimensions, except for the subdimension of *Active evaluation*, which is part of the *Analysis and evaluation of arguments dimension*, and the subdimension of *Problem identification and analysis,* which is part of the *Problem-solving* dimension. In these two subdimensions, the scores are medium-high.

As previously mentioned, *Cluster 3* exhibits significantly lower levels ($p<0.01$) in all dimensions and most subdimensions compared to the other clusters. However, it is noteworthy that the subdimension of *Active evaluation*, which falls under the *Analysis and evaluation of arguments* dimension, does not present significant differences in average scores between the two clusters.

The following section will present the distribution of subjects among distinct clusters, which have been categorised based on sociodemographic and academic variables. Figures 5-11 will be utilised to present these insights, which will provide a clear understanding of the proportion of students assigned to each cluster.

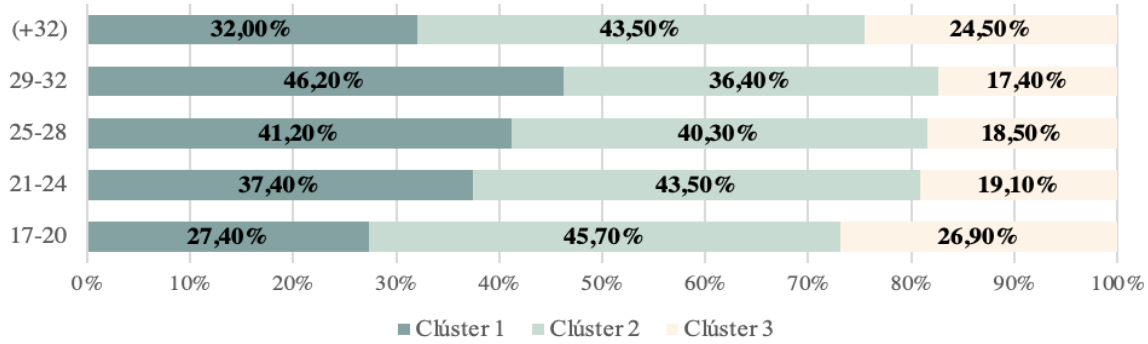
- Focusing on the *Gender* variable, as depicted in Figure 5, non-binary students exhibit the highest proportion of students in *Cluster 1*, with high scores (45.2%), and the lowest proportion in *Clusters 2* and *3*, with medium (41.8%) and low scores (13.5%), respectively. In contrast, women have the highest proportion in *Clusters 3* and *2*, with low (25.9%) and medium scores (45.7%), respectively, and the lowest proportion of students in *Cluster 1*, with high scores (28.4%). Lastly, men show an average proportion in all three clusters, indicating that they do not exhibit a significant higher or lower proportion of students in any of the clusters.

Figure 5. Distribution of students into clusters by Gender



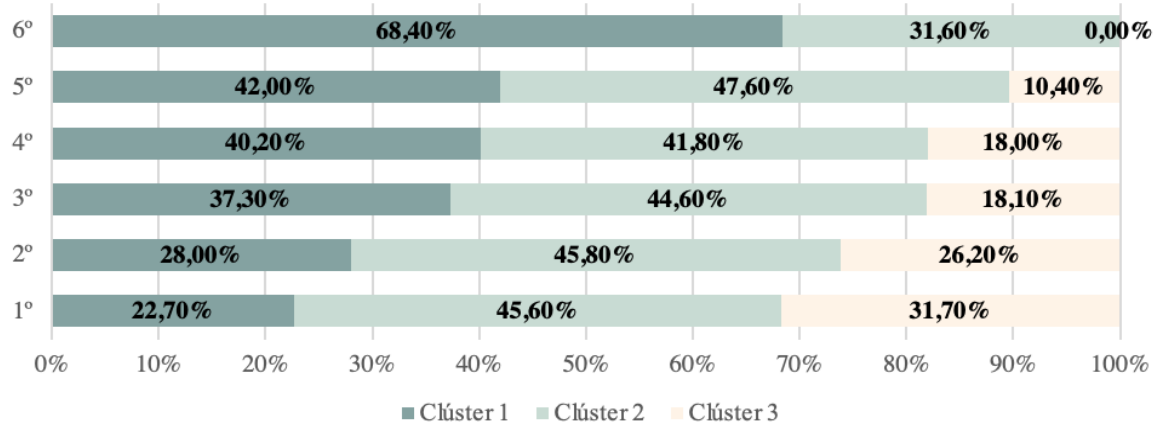
- Regarding *Age* (Figure 6), the age group of 29-32 has the highest percentage of students in *Cluster 1* (46.2%), characterised by high scores, while the proportion of students in *Clusters 2* and *3*, corresponding to medium and low scores, respectively, is lower (36.4% and 17.4%, respectively). In contrast, the age group of 17-20 has a higher proportion of students in *Clusters 3* and *2*, at 26.9% and 45.7%, respectively, while the percentage of students in *Cluster 1* is lower (27.4%).

Figure 6. Distribution of students into clusters by Age



- Concerning Y*ear* (Figure 7), students in their 5th and 6th year exhibit a higher proportion in *Cluster 1* (42% and 68.4%, respectively), indicating higher scores, and a lower proportion in *Cluster 3* (10.4% and 0%, respectively), indicating lower scores. In contrast, students in their 1st and 2nd year have a lower proportion in *Cluster 1* (22.7% and 28%, respectively), indicating higher scores, and a higher proportion in *Cluster 3* (31.7% and 26.2%, respectively), indicating lower scores. As for *Cluster 2* (indicating medium scores), students in their 2nd and 5th year have the highest proportion of students belonging to this cluster (45.8% and 47.6%, respectively), while those in their 4th and 6th year have the lowest proportion (41.8% and 31.6%, respectively).

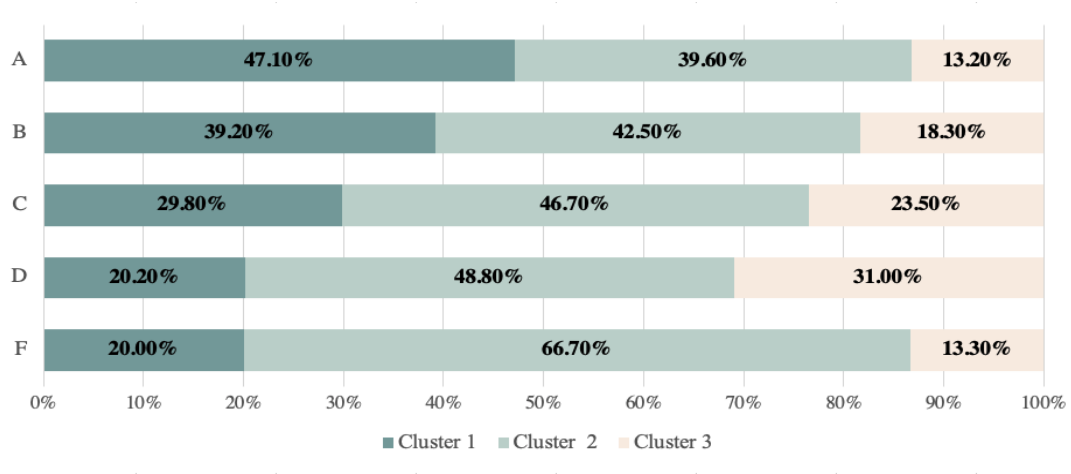
Figure 7. Distribution of students into clusters by Year



- Regarding the *Academic record grades* (Figure 8), students who earned an A or B grade have a higher proportion of subjects in *Cluster 1* (indicating higher scores, with percentages of 47.10% and 39.2%, respectively) and a lower proportion in *Cluster 2* (indicating medium scores, with percentages of 42.5% and 39.6%, respectively). Conversely, students with an F or D grade have a lower proportion of subjects in *Cluster 1* (indicating higher scores, with percentages of 20% and 20.20%, respectively) and a higher proportion in *Cluster 2* (indicating

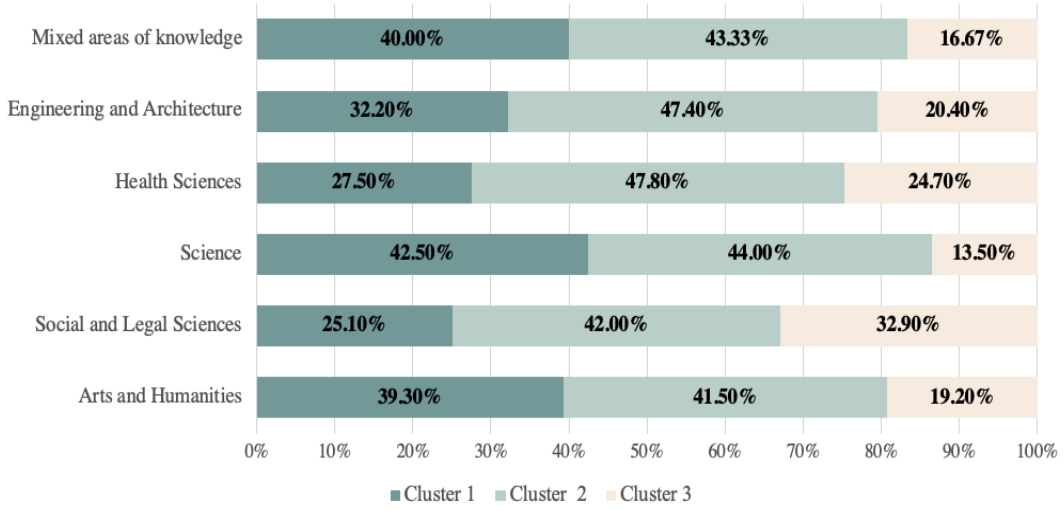
medium scores, with percentages of 66.7% and 48.8%, respectively). Furthermore, within *Cluster 3* (indicating lower scores), the group with the highest proportion of subjects is the one with a D and C grade, with percentages of 31% and 23.5%, respectively. On the other hand, the group with the lowest proportion is the one with an F and A grade, with percentages of 13.3% and 13.2%, respectively.

Figure 8. Distribution of students into clusters by Academic record grades



- Regarding the *Field of study* (Figure 9), the Science field and mixed fields exhibit a higher proportion of students in *Cluster 1* (indicating higher scores, with percentages of 42.5% and 40%, respectively), and a lower proportion of students in *Cluster 3* (indicating lower scores, with percentages of 13.5% and 16.6%, respectively).

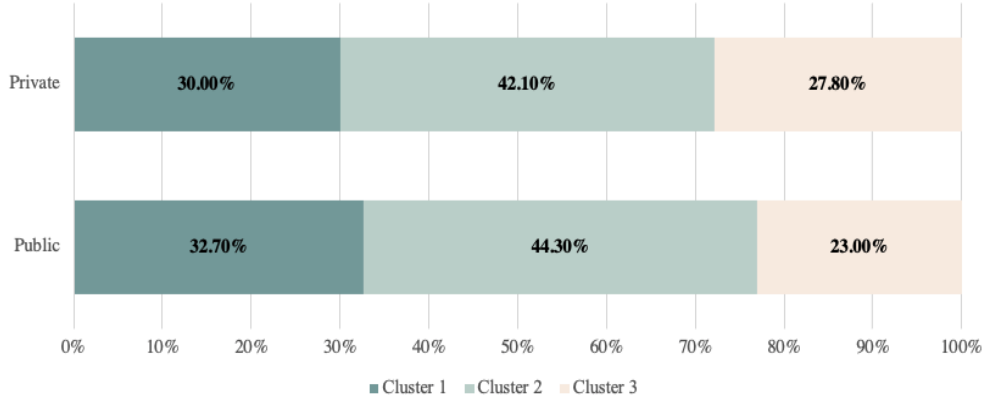
Figura 9. Distribution of students into clusters by Field of study



In contrast, the Social Sciences and Law field and the Engineering and Architecture field show a higher proportion of students in *Cluster 3* (indicating lower scores, with percentages of 32.9% and 24.7% respectively), and a lower proportion of students in *Cluster 1* (indicating higher scores, with percentages of 25.1% and 27.5% respectively). Additionally, Health Sciences and Engineering and Architecture have a higher proportion of students in *Cluster 2* (indicating medium scores) at 47.8% and 47.4%, respectively, whereas Social Sciences and Law and Arts and Humanities have the least proportion of students in *Cluster 2* at 42% and 41.5%, respectively.

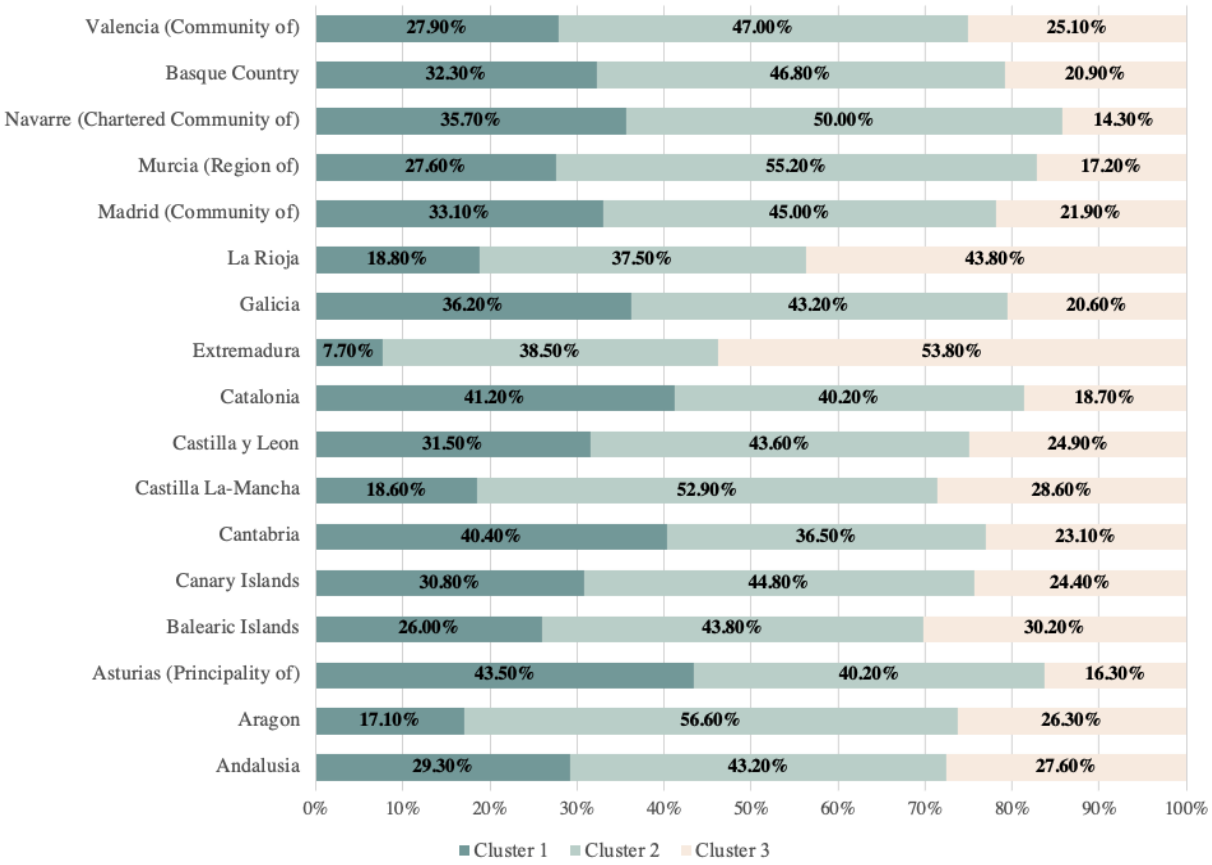
- With regard to *University ownership* (Figure 10), students enrolled in public universities have a higher proportion in *Clusters 1* (representing higher scores, at 32.7%) and *2* (indicating medium scores, at 44.3%), as well as a lower proportion in *Cluster 3* (indicating lower scores, at 23%), in comparison to students enrolled in private universities.

Figure 10. Distribution of students into clusters by University ownership



- The analysis of students across *Autonomous Communities* highlights considerable disparities in their performance levels. As depicted in Figure 11, the Principality of Asturias stands out with a significant prevalence of students in *Cluster 1*, indicating higher scores (43.5%), while also displaying the lowest proportion of students in *Cluster 3*, which encompasses students with lower scores (16.3%). In contrast, Extremadura is characterised by its highest concentration of students in *Cluster 3* (53.8%), indicating lower scores, and its lowest proportion of students in *Cluster 1*, which comprises those with higher scores (7.7%).

Figure 11. Distribution of students into clusters by Autonomous Community



Among the Autonomous Communities, Asturias, Catalonia, and Cantabria have the highest percentage of students in *Cluster 1*, corresponding to higher scores, with percentages of 43.5%, 41.2%, and 40.4%, respectively. In contrast, Extremadura, Aragon, and Castilla La-Mancha have the lowest percentage of students in this cluster, amounting to 7.7%, 17.1%, and 18.6%, respectively.

On the other hand, Aragon, Murcia, and Castilla La-Mancha have the highest proportion of students in *Cluster 2*, corresponding to medium scores, with percentages of 56.6%, 55.2%, and 52.9%, respectively. Conversely, Extremadura, La Rioja, and Cantabria have the lowest proportion of students in this cluster, accounting for 28.5%, 37.5%, and 36.5%, respectively.

Lastly, Extremadura, La Rioja, and the Balearic Islands are the regions with the highest percentage of students in *Cluster 3*, corresponding to lower scores, with percentages of 53.8%, 43.8%, and 30.2%, respectively. In contrast, Murcia, Asturias, and Navarra have the lowest percentage of students in this cluster, representing 17.2%, 16.3%, and 14.3%, respectively.

Discussion and conclusions

This study has successfully achieved its objective of evaluating the level of critical thinking and identifying associated profiles among university students in Spain, offering valuable insights into the critical thinking skills of Spanish students. Results indicate that Spanish undergraduate students exhibit a high level of critical thinking skills, which is consistent with previous studies conducted by Rodrigues et al. (2018), Shavelson et al. (2019), and Shaw et al. (2020), which found

medium to high levels of critical thinking skills among students from Portugal, Germany, Russia, and China. However, it is important to interpret these findings with caution, as high levels of critical thinking skills among students do not imply that critical thinking cannot be further developed. Continuous efforts are required to promote and improve critical thinking skills (Paul & Elder, 2019). Therefore, while the present study suggests that the Spanish education system is effectively developing critical thinking skills among undergraduate students, further support and promotion of these skills is necessary.

Despite the limitations of the non-probabilistic accidental sampling method employed to select participants, the present study provides valuable insights into the critical thinking skills of Spanish undergraduate students. Regarding gender, disparities in critical thinking proficiency are evident, with women exhibiting lower levels compared to men and those who do not identify as either male or female. These findings are consistent with prior studies such as Liu et al. (2019) and Vong and Kaewurai (2017), which also suggest gender-based differences in critical thinking abilities. Similarly, Howard et al. (2015) observed that males outperformed females in pre-tests but showed no differences in post-tests, potentially due to females' greater commitment to academic work. Consequently, it is imperative to delve deeper into gender-based distinctions in critical thinking and elucidate underlying factors, including the impact of societal stereotypes on cognitive differences. Addressing these findings is crucial for designing gender-sensitive pedagogical approaches that accommodate diverse cognitive styles, fostering equitable learning outcomes for all students.

Moreover, disparities in critical thinking, argument analysis, evaluation, and problem-solving abilities across different age groups suggest a potential developmental trajectory in these cognitive skills. Younger students may still be undergoing cognitive maturation, impacting their effectiveness in engaging in complex reasoning tasks. Conversely, older students may benefit from increased life experience, exposure to diverse perspectives, and academic or professional challenges. These findings are consistent with prior research by Howard et al. (2015) and Ricketts and Rudd (2005), highlighting age as a significant factor influencing critical thinking skills. Such insights underscore the importance for educators to adapt teaching methodologies to cater to students at various stages of cognitive development, thereby optimising learning outcomes.

Similarly, there is a discernible trend of increasing average scores across all dimensions and sub-dimensions as students progress through their academic journey, as supported by meta-analyses by Abrami et al. (2015) and Huber and Kuncel (2016). However, it is essential to recognise that the gains from university experience may be insufficient (Ennis, 2018). While educators are increasingly willing to integrate critical thinking instruction into their pedagogical approach (Bellaera et al., 2021), various obstacles hinder environments conducive to critical thinking, including inadequate resources, time constraints, implementation hurdles, entrenched biases, and insufficient training (Magrabi et al., 2018; Veliz & Veliz-Campos, 2019). These observations underscore the pressing need for educational institutions to prioritise the cultivation of critical thinking through comprehensive pedagogical strategies that address these challenges. By overcoming these obstacles, educators can create learning environments that foster critical thinking and empower students to navigate complex academic and professional landscapes effectively.

Moreover, the correlation between higher average academic grades and superior critical thinking skills can be attributed to various factors. Academic success often demands robust analytical, evaluative, and problem-solving abilities, which are essential components of critical thinking. Additionally, students achieving higher grades typically exhibit heightened dedication and motivation

in their studies, facilitating the gradual development of critical thinking. This positive relationship is extensively documented in the literature, as evidenced by studies such as those conducted by D'Alessio et al. (2019) and Kanwal and Butt (2021).

In terms of institutional ownership, students at public universities demonstrate higher levels of problem-solving and strategy identification compared to those at private universities. This disparity may stem from differences in the understanding of critical thinking by faculty members at both types of universities. Bezanilla et al. (2018) found that teachers at public universities emphasise decision-making and action-taking, while those at private universities focus more on evaluation. Therefore, teaching strategies for promoting critical thinking may vary based on faculty members' perceptions. It is crucial to define critical thinking within the institution, ensuring all members understand its components and objectives. This involves specifying which skills and dispositions to foster in students and planning their holistic development. The goal should be to fully cultivate critical thinking, rather than focusing on specific aspects. By establishing a shared understanding and comprehensive approach to critical thinking, educators can effectively nurture this competence in students, preparing them for academic and professional success.

Additionally, variations in critical thinking proficiency are evident among Spanish university students across different Autonomous Communities. Specifically, students in Andalusia demonstrate lower levels of analysis and argument evaluation compared to their counterparts in Asturias and Catalonia. However, comparative data from other studies on proficiency levels based on Autonomous Communities are scarce, necessitating further investigations to validate these findings. The observed disparities may stem from differences in critical thinking conceptualisation and instructional practices across regions. Hence, additional research is necessary to uncover the underlying factors contributing to these variations.

Furthermore, three distinct critical thinking profiles among Spanish university students were identified based on the results of cluster analysis. These profiles were classified as high, medium-high, and average evaluations. Students in the high evaluation profile demonstrated high scores in most dimensions and sub-dimensions of critical thinking, with a particular emphasis on the problem identification and analysis sub-dimension of the problem-solving dimension. The medium-high evaluation profile demonstrated medium to high scores in most dimensions and sub-dimensions of critical thinking, with a specific focus on the problem identification and analysis sub-dimension of the problem-solving dimension. In contrast, students in the medium evaluation profile displayed medium scores in most dimensions and sub-dimensions of critical thinking, with medium-high scores in the active evaluation sub-dimension of the analysis and evaluation of arguments dimension and the problem identification and analysis sub-dimension of the problem-solving dimension.

These findings suggest that there is a need for targeted interventions to support students with lower critical thinking profiles to further develop their skills. For students in Cluster 1, strategies that enhance their already strong critical thinking skills in the analysis and evaluation of arguments and problem-solving dimensions could be emphasised. Such strategies may include encouraging students to question assumptions, providing opportunities for collaborative problem-solving, fostering metacognition, using case studies and simulations, and promoting creative thinking. Students in Cluster 2 may benefit from interventions focused on improving their performance in the identification and analysis of the problem sub-dimension, such as teaching problem-solving techniques like brainstorming, mind mapping, and SWOT analysis, and providing opportunities to practise real-world problems. For students in Cluster 3, interventions that target the development of their active evaluation and identification and analysis of the problem

skills may be most effective. Incorporating problem-based learning into the curriculum and encouraging Socratic questioning can also help promote critical thinking.

Regardless of their proficiency levels, all students can benefit from various teaching strategies that promote critical thinking skills. The use of real-life scenarios, collaborative learning, feedback, and formative assessments are effective ways to enhance students' critical thinking abilities (Abrami et al., 2015; Verburgh, 2019). By incorporating real-life scenarios and providing resources such as case studies and research articles, students can better understand the relevance of critical thinking in their daily lives and develop a deeper understanding of how to apply their critical thinking skills in practical situations (Pnevmatikos et al., 2019; Volman & ten Dam, 2015). Encouraging collaboration and providing regular feedback can also help students to develop their critical thinking skills (Abrami et al., 2015; Mohammed Alharbi et al., 2022), as it allows them to receive diverse perspectives and evaluate ideas from different viewpoints.

Furthermore, formative assessments can be used to provide ongoing feedback and help students identify areas of strength and areas that require improvement (Bhagat & Spector, 2017), enabling them to refine their thinking strategies accordingly. Additionally, with the growing reliance of young adults on digital environments, digital technology can be utilised to enhance critical thinking skills through the previously mentioned strategies (Meirbekov et al., 2022).

Ultimately, teachers have a crucial role in fostering students' critical thinking, and it is essential to create a learning environment that values inquiry, intellectual curiosity, and active learning (Heard et al., 2020; Joseph et al., 2017). Encouraging students to take calculated risks and learn from their mistakes can help develop a growth mindset and reinforce the importance of perseverance and resilience in enhancing critical thinking skills (Dwyer, 2017; Halpern, 2014). Moreover, modelling critical thinking skills by initiating thought-provoking discussions and challenging students to analyse and evaluate diverse perspectives can further enhance their critical thinking skills (Goodsett, 2020). By promoting a classroom culture that emphasises continuous learning and improvement, teachers can inspire students to take ownership of their learning and equip them with the skills necessary to thrive academically and beyond.

In summary, this study highlights the high levels of critical thinking showed by Spanish university students, attributing them to the collective efforts of the educational community. However, there remains room for improvement in the development of this skill, a responsibility that lies both with universities, through the implementation of effective pedagogical strategies, and with the students themselves, who must take an active and committed role in strengthening their critical thinking abilities.

Future research should focus on enhancing this competency in higher education, considering its multidimensional and non-binary nature. Moreover, it is crucial to translate theoretical intentions into concrete actions that contribute to improving the quality of education in Spain. The findings of this study provide empirical evidence and sound arguments to inform decision-making and should be utilised to drive significant changes in the promotion of critical thinking among Spanish university students.

By doing so, the education system will be better equipped to prepare students to tackle complex challenges and to contribute to the advancement of a more resilient, adaptable, and future-ready society.

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References

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A. y Persson, T. (2015). Strategies for Teaching Students to Think Critically: A Meta-Analysis. *Review of Educational Research*, *85*(2), 275–314. https://doi.org/10.3102/0034654314551063

Akpur, U. (2020). Critical, Reflective, Creative Thinking and Their Reflections on Academic Achievement. *Thinking Skills and Creativity*, *37*(July). https://doi.org/10.1016/j.tsc.2020.100683

Aktoprak, A. y Hursen, C. (2022). A bibliometric and content analysis of critical thinking in primary education. *Thinking Skills and Creativity*, *44*, 101029. https://doi.org/10.1016/J.TSC.2022.101029

Andrews, R. (2015). Critical thinking and/or argumentation in higher education. En M. Davies y R. Barnett (Eds.), *The Palgrave Handbook of Critical Thinking in Higher Education* (pp. 49–62). Palgrave Macmillan. https://doi.org/10.1057/9781137378057_3

Archila, P. A., Molina, J., Danies, G., Truscott De Mejía, A.-M. y Restrepo, Silvia. (2022). Using the Controversy over Human Race to Introduce Students to the Identification and the Evaluation of Arguments. *Science & Education*, *31*, 861–892. https://doi.org/10.1007/s11191-021-00299-8

Behzadi, S. y Momennasab, M. (2023). The relationship between learning style, thinking and critical thinking tendency with lifestyle improvement in controlling cardiovascular diseases in medical students of Islamic Azad University, Arsanjan Branch. *Revista Latinoamericana de Hipertension*, *18*(1), 1-9. https://doi.org/10.5281/zenodo.7775490

Bellaera, L., Weinstein-Jones, Y., Ilie, S. y Baker, S. T. (2021). Critical thinking in practice: The priorities and practices of instructors teaching in higher education. *Thinking Skills and Creativity*, *41*(5), 100856. https://doi.org/10.1016/j.tsc.2021.100856

Bezanilla, M. J., Poblete, M., Fernández, D., Arranz, S. y Lucía, C. (2018). *El Pensamiento Crítico desde la Perspectiva de los Docentes Universitarios. Estudios Pedagógicos*, *44*(1), 89–113. https://doi.org/10.4067/s0718-07052018000100089

Berg, C., Philipp, R. y Taff, S. D. (2021). Scoping Review of Critical Thinking Literature in Healthcare Education. *Occupational Therapy in Health Care*, *37*(1), 18–39. https://doi.org/10.1080/07380577.2021.1879411

Bhagat, K. K. y Spector, J. M. (2017). International Forum of Educational Technology & Society Formative Assessment in Complex Problem-Solving Domains: The Emerging Role of Assessment Technologies. *Source: Journal of Educational Technology & Society*, *20*(4), 312–317.

Braun, H. I., Shavelson, R. J., Zlatkin-Troitschanskaia, O. y Borowiec, K. (2020). Performance Assessment of Critical Thinking: Conceptualization, Design, and Implementation. *Frontiers in Education*, *5*(September), 1–10. https://doi.org/10.3389/feduc.2020.00156

Chatfield, T. (2022). *Critical thinking: Your guide to effective argument, successful analysis and independent study* (J. Seaman (ed.)). Sage.

Ciftci, B., Oktay, A. A., Erden, Y. y Kasikci, M. (2021). Comparison of Critical Thinking Levels of Nursing Students at Two Universities and the Influencing Factors. *International Journal of Caring Sciences*, *14*(1), 1–664.

Cottrell, S. (2023). *Critical Thinking Skills: Effective Analysis, Argument and*

Reflection (4th ed.). Bloomsbury Publishing. https://doi.org/10.2307/3471579

D'Alessio, F. A., Avolio, B. E. y Charles, V. (2019). Studying the impact of critical thinking on the academic performance of executive MBA students. *Thinking Skills and Creativity*, *31*, 275–283. https://doi.org/10.1016/j.tsc.2019.02.002

Dancey, C. P. y Reidy, J. (2007). Statistics Without Maths for Psychology (4ª ed.). Ashford Colour Press.

Danczak, S. M., Thompson, C. D. y Overton, T. L. (2020). Development and validation of an instrument to measure undergraduate chemistry students' critical thinking skills. *Chemistry Education Research and Practice*, *21*(1), 62–78. https://doi.org/10.1039/c8rp00130h

Davies, M. y Barnett, R. (2015). The palgrave handbook of critical thinking in higher education. En M. Davies y R. Barnett (Eds.), *The Palgrave Handbook of Critical Thinking in Higher Education*. Palgrave Macmillan New York. https://doi.org/10.1057/9781137378057

Dwyer, C. P. (2017). *Critical thinking: Conceptual perspectives and practical guidelines*. Cambridge University Press. https://doi.org/10.1017/9781316537411

Ennis, R. H. (1985). A Logical Basis for Measuring Critical Thinking Skills. *Educational Leadership*, *43*(2), 44–48. https://pdfs.semanticscholar.org/80a7/c7d4a98987590751df4b1bd9adf747fd7aaa.pdf

Ennis, R. H. (2018). Critical Thinking Across the Curriculum: A Vision. *Topoi*, *37*(1), 165–184. https://doi.org/10.1007/s11245-016-9401-4

Facione, P. A. (1990). *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. Research Findings and Recommendations*.

Gobierno de España, M. de U. (2022). Datos y Cifras del Sistema Universitario Español (Publicación 2021-2022). En *Datos y cifras*. https://www.who.int/es/news-room/fact-sheets/detail/obesity-and-overweight

González-Cacho, T. y Abbas, A. (2022). Impact of Interactivity and Active Collaborative Learning on Students' Critical Thinking in Higher Education. *IEEE Revista Iberoamericana de Tecnologias Del Aprendizaje*, *17*(3), 254–261. https://doi.org/10.1109/RITA.2022.3191286

Goodsett, M. (2020). Best practices for teaching and assessing critical thinking in information literacy online learning objects. *The Journal of Academic Librarianship*, *46*(5), 102163. https://doi.org/10.1016/j.acalib.2020.102163

Halpern, D. F. (2014). *Thought and Knowledge: An Introduction to Critical Thinking* (5th ed.). Psychology Press.

Heard, J., Scoular, C., Duckworth, D., Ramalingam, D. y Teo, I. (2020). Critical Thinking : Skill Development Framework. *The Australian Council for Educational Research (ACER)*, 1–26.

Howard, L. W., Tang, T. L. P. y Jill Austin, M. (2015). Teaching Critical Thinking Skills: Ability, Motivation, Intervention, and the Pygmalion Effect. *Journal of Business Ethics*, *128*(1), 133–147. https://doi.org/10.1007/s10551-014-2084-0

Huber, C. R. y Kuncel, N. R. (2016). Does College Teach Critical Thinking? A Meta-Analysis. *Review of Educational Research*, *86*(2), 431–468. https://doi.org/10.3102/0034654315605917

Joseph, K., Justine, N., Omar, A. M., Betty, A. y Faith, K. (2017). *Critical Thinking Through Participatory Learning : Analysing The Nature Of Freedom Of Expression In Makerere University Lecture Theatres*. *4*(5), 44–52. https://doi.org/10.14738/assrj.45.2718

Kanwal, A. y Butt, I. H. (2021). Impact of Critical Thinking Skills on Prospective Teachers' Academic Achievement. *Review of Applied Management and Social Sciences*, *4*(4), 773–781.

https://doi.org/10.47067/ramss.v4i4.182

Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales. *Boletin Oficial del Estado*, núm. 294, de 6 de diciembre de 2018, pp. 119788-119857. https://www.boe.es/buscar/doc.php?id=BOE-A-2018-16673

Liu, N. Y., Hsu, W. Y., Hung, C. A., Wu, P. L. y Pai, H. C. (2019). The effect of gender role orientation on student nurses' caring behaviour and critical thinking. International Journal of Nursing Studies, 89(April 2018), 18–23. https://doi.org/10.1016/j.ijnurstu.2018.09.005

López-Martín, E. y Ardura-Martínez, D. (2022). The effect size in scientific publication. *Educación XX1*, *26*(1), 9-17. https://doi.org/10.5944/educxx1.xxx.

Magrabi, S. A. R., Pasha, M. I. y Pasha, M. Y. (2018). Classroom Teaching to Enhance Critical Thinking and Problem-Solving Skills for developing IOT Applications. *Journal of Engineering Education Transformations*, *31*(3), 152–157.

Meirbekov, A., Maslova, I. y Gallyamova, Z. (2022). Digital education tools for critical thinking development. *Thinking Skills and Creativity*, *44*(March), 101023. https://doi.org/10.1016/j.tsc.2022.101023

Mohammed Alharbi, S., Ibrahim Elfeky, A. y Sultan Ahmed, E. (2022). The Effect Of E-Collaborative Learning Environment On Development Of Critical Thinking And Higher Order Thinking Skills. *Journal of Positive School Psychology*, *6*(6), 6848–6854. http://journalppw.com

Nagel, M., Zlatkin-Troitschanskaia, O., Schmidt, S. y Beck, K. (2020). Performance Assessment of Generic and Domain-Specific Skills in Higher Education Economics. In *Student Learning in German Higher Education*. Springer VS. https://doi.org/10.1007/978-3-658-27886-1_14

Paul, R. (1999). Critical Thinking, Moral Integrity, and Citizenship: Teaching for the Intellectual Virtues. In B. A. Pescosolido & R. J. Aminzade (Eds.), *The Social Worlds of Higher Education. Handbook for Teaching in a New Century*. SAGE Publications.

Paul, R. y Elder, L. (2006). *The Miniature Guide to Critical Thinking. Concepts and Tools* (4th ed.). The Foundation for Critical Thinking.

Paul, R. y Elder, L. (2019). *A Guide For Educators to Critical Thinking Competency Standards: Standards, Principles, Performance Indicators, and Outcomes With a Critical Thinking Master Rubric*. The Foundation for Critical Thinking. www.criticalthinking.org; https://doi.org/10.5771/9781538133934

Pnevmatikos, D., Christodoulou, P. y Georgiadou, T. (2019). Promoting critical thinking in higher education through the values and knowledge education (VaKE) method. *Studies in Higher Education*, *44*(5), 892–901. https://doi.org/10.1080/03075079.2019.1586340

Purwanto, W. R. y Waluya, S. B. (2020, March). Analysis of mathematical critical thinking ability in student learning style. *Journal of Physics: Conference Series*, *1511*(1), 012057. https://doi.org/10.1088/1742-6596/1511/1/012057

GDPR (2016) Regulation (eu) 2016/679 of the european parliament and of the council of 27 april 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing directive 95/46. Official Journal of the European Union (OJ) 59:1–88

Ricketts, J. C. y Rudd, R. D. (2005). Critical Thinking Skills of Selected Youth Leaders: The Efficacy of Critical Thinking Dispositions, Leadership, and Academic Performance. *Journal of Agricultural Education*, *46*(1), 32–43. https://doi.org/10.5032/jae.2005.01032

Rini, D. S., Adisyahputra, D. V. S. y Sigit, D. V. (2020). Boosting student critical

thinking ability through project based learning, motivation and visual, auditory, kinesthetic learning style: A study on Ecosystem Topic. *Universal Journal of Educational Research, 8*(4), 37-44. https://doi.org/ 10.13189/ujer.2020.081806

Rodrigues, A., Soares, P. y Da Silva, L. (2018). Translation, adaptation, and validation of the Halpern Critical Thinking Assessment to Portugal: Effect of disciplinary area and academic level on critical thinking. *Anales de Psicología*, *34*(2), 292. https://doi.org/10.6018/analesps.34.2.272401

Santos, L. F., Gyenes, A., Fujisaki, S. y Gay, S. (2021). *Critical Thinking*. *viii*(1).

Scheie, E., Haug, B. y Erduran, S. (2022). Critical thinking in the Norwegian science curriculum. *Acta Didactica Norden*, *16*(2), 1–27. https://doi.org/10.5617/adno.9060

Shavelson, R. J., Zlatkin-Troitschanskaia, O., Beck, K., Schmidt, S. y Marino, J. P. (2019). Assessment of University Students' Critical Thinking: Next Generation Performance Assessment. *International Journal of Testing*, *19*(4), 337–362. https://doi.org/10.1080/15305058.2018.1543309

Shaw, A., Liu, O. L., Gu, L., Kardonova, E., Chirikov, I., Li, G., Hu, S., Yu, N., Ma, L., Guo, F., Su, Q., Shi, J., Shi, H. y Loyalka, P. (2020). Thinking critically about critical thinking: validating the Russian HEIghten® critical thinking assessment. *Studies in Higher Education*, *45*(9), 1933–1948. https://doi.org/10.1080/03075079.2019.1672640

Singh, R. K. A., Singh, C. K. S., Tunku, M. T. M., Mostafa, N. A. y Singh, T. S. M. (2018). A Review of Research on the Use of Higher Order Thinking Skills to Teach Writing. *International Journal of English Linguistics*, *8*(1), 86–93. https://doi.org/10.5539/ijel.v8n1p86

Thomas, K. y Lok, B. (2015). Teaching Critical Thinking: An Operational Framework. En M. Davies y R. Barnett (Eds.), *The Palgrave Handbook of Critical Thinking in Higher Education*. Palgrave Macmillan. https://doi.org/10.1057/9781137378057_6

Towfik, A. F., Mostafa, G. M. A., Mahfouz, H. H. E.-S. y Salwa, M. (2022). Effect of Self-Learning Package about Critical Thinking on Intern-Nurses' Knowledge, Disposition and Skills. *International Egyptian Journal of Nursing Sciences and Research*, *2*(2), 548–567. https://doi.org/10.21608/ejnsr.2022.212570

Veliz, L. y Veliz-Campos, M. (2019). An interrogation of the role of critical thinking in English language pedagogy in Chile. *Teaching in Higher Education*, *24*(1), 47–62. https://doi.org/10.1080/13562517.2018.1456424

Verburgh, A. (2019). Effectiveness of approaches to stimulate critical thinking in social work curricula. *Studies in Higher Education*, *44*(5), 880–891. https://doi.org/10.1080/03075079.2019.1586336

Volman, M. y ten Dam, G. (2015). Critical Thinking for Educated Citizenship. In M. Davies & R. Barnett (Eds.), *The Palgrave Handbook of Critical Thinking in Higher Education* (pp. 593–603). Palgrave Macmillan. https://doi.org/10.1057/9781137378057_35

Vong, S. A. y Kaewurai, W. (2017). Instructional model development to enhance critical thinking and critical thinking teaching ability of trainee students at regional teaching training center in Takeo province, Cambodia. *Kasetsart Journal of Social Sciences*, *38*(1), 88–95. https://doi.org/10.1016/J.KJSS.2016.05.002

Yang, L., Xu, Y., Hu, Y., Wang, L., Han, Y. y Luo, Z. (2023). The relationship between learning style and critical thinking based on learning modes. *Research Square*, *13*. https://doi.org/10.21203/rs.3.rs-2665704/v1]

Annex

Table 1. Indicator system - Dimension 1: Analysis and evaluation of arguments

Dim.	Subd. I	Subd. II	Indicators
Analysis and evaluation of arguments	Argument analysis	Argument identification and analysis	Argument identification 1. Argument detection 2. Argument reconstruction Identification of fundamental components 3. Conclusion identification: expressed and implied 4. Premise identification: explicit and implicit 5. Recognition of circular arguments and tautologies
		Content identification and analysis	Information decoding. this includes identifying: 6. Fact-based information versus opinions or speculations 7. Language clarity: lexical and grammatical precision, repetition, and detail 8. Definitions: necessary and sufficient conditions, over-inclusion, or ambiguity 9. Neutrality: emotive language, visual, and auditory influences Meaning Interpretation. This involves identifying: 10. The central thesis 11. Underlying assumptions, implications, preconditions, inferred values, beliefs, biases, and stereotypes 12. Intent, purpose, objective, or function 13. Outcomes or consequences of the conclusions
		Relationship identification and analysis	Intra-argumentative. This involves identifying and interpreting: 14. Nature of the Premise -> Conclusion relationship 15. Connections between various premises Inter-argumentative. This involves identifying and interpreting: 16. Chain of arguments 17. Dual argumentation 18. Objection 19. Rebuttal 20. Refutation
Análisis y evaluación de argumentos	Argument evaluation	Passive evaluation	Criterion 1: Credibility (Truthfulness and Acceptability) 21. Differentiating true, probable, and misleading premises 22. Identifying common credibility fallacies 23. Assessing confidence in premise probability or truthfulness 24. Investigating potential biases in presented evidence Criterion 2: Relevance 25. Spotting common relevance fallacies: source over substance 26. Detecting relevance fallacies: inappropriate standards 27. Highlighting relevance fallacies: diversion from the main argument Criterion 3: Sufficiency 28. Pinpointing common sufficiency errors: overgeneralization 29. Pinpointing common sufficiency errors: faulty analogies 30. Pinpointing common sufficiency errors: incorrect causality 31. Challenging arguments from ignorance Criterion 4: Ethics 32. Condemning unethical practices
		Active evaluation	Strengthening and weakening arguments 33. Gathering additional supportive information 34. Acknowledging the need for contrary evidence 35. Proposing credible alternative interpretations or explanations Questioning development and additional information identification 36. Sourcing additional data 37. Allocating burden of proof responsibility

Table 2. Indicator system - Dimension 2: Problem-solving

Dimension	Subdimension	Indicators
Problem-solving	[Phase 1] Problem identification and analysis	38. Basic problem elements identification 39. Problem representation and formulation 40. Relevant factors identification 41. Knowledge requirements identification 42. Relevant information identification 43. Pursuit of understanding and insight 44. Information integration
	[Phase 2] Strategy formulation and alternative generation	45. Potential problem-solving strategy identification 46. Optimal strategy selection 47. Multiple criterion identification 48. Criteria prioritisation 49. Assessment of alternatives 50. Best alternative selection 51. Rationale for selected alternative
	[Phase 3] Strategic implementation guidance	52. Strategic planning 53. Implementation and corrective action execution
	[Phase 4] Comprehensive evaluation	54. Critical and constructive procedure assessment 55. Critical and constructive result analysis and interpretation

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