Ed Process Int J | www.edupij.com
ISSN 2147-0901 | e-ISSN 2564-8020
2023 | ÜNİVERSİTEPARK

EDUCATIONAL PROCESS
INTERNATIONAL JOURNAL

ARTICLE HISTORY
Received *October 13, 2022*
Accepted *March 06, 2023*
Published Online *March 26, 2023*

CORRESPONDENCE
Eva Morais
emorais@utad.pt
The Mathematics Department, University of Trás-os-Montes e Alto Douro, Portugal.

AUTHOR DETAILS
Additional information about the author is available at the end of the article.

How to cite: *Morais, E., Lopes, J., Silva, H., Dominguez, C., Payan-Carreira, R., Imaginário, C., & Santos, M. J. (2023). Dispositions toward Critical Thinking in Portuguese Undergraduate Students. Educational Process: International Journal, 12(1): 19-36.*

OPEN ACCESS

RESEARCH ARTICLE

Dispositions toward Critical Thinking in Portuguese Undergraduate Students

Eva Morais José Lopes Helena Silva Caroline Dominguez Rita Payan-Carreira Cristina Imaginário Maria José Santos

Background/purpose – The study aimed to identify differences in the level of critical thinking dispositions of undergraduate students in Portugal according to their sociodemographic (gender, age) and academic (study field) characteristics.

Materials/methods – A cross-sectional, descriptive correlational study was conducted with a convenience random sample of 1,017 students. Most of the participants were female (76.8%) and the average age of the respondents was 21.8 ± 4.22 years old. For data collection, the Critical Thinking Dispositions Scale (CTDS) was employed, which consists of 35 question items and was validated for the Portuguese population. In the statistical analysis, *t*-test, ANOVA, and hierarchical multiple regression model were used.

Results – The students showed an average positive disposition for critical thinking (average CTDS score was 279.1 ± 27.1). The results demonstrated that gender, age, and field of study influenced the students' dispositions for critical thinking. Older female students attending biomedicine courses had a higher disposition to think critically.

Conclusion – Female students generally show higher critical thinking scores dispositions, regardless of the study field.

Keywords – Critical thinking disposition, higher education, undergraduate students, sociodemographic effect, study field

To link to this article – https://dx.doi.org/10.22521/edupij.2023.121.2

1. INTRODUCTION

Rapid changes characterize contemporary societies, not only at the level of knowledge acquisition but also at the technical and attitudinal levels. Several authors consider critical thinking as one of the essential skills to ensure citizens in the 21st century is successful in their social, professional, and ethical performance (Dwyer et al., 2014; Vincent-Lancrin et al., 2019). Critical thinking is necessary for decisions to be made in all dimensions of human social and professional life, being better equipped to solve complex situations, to take and defend positions, and to take responsibility for one's actions (Organisation for Economic Co-operation and Development, 2018). This perspective leads to concerns about general education being relevant and meaningful to today's current economic and social context.

Educational institutions should drive their students to learn, think and reason critically. Higher education institutions should contribute to the development of students' critical thinking skills as, in this educational context, young adults are expected to improve their cognitive and motivational potential in order to reflexively build upon their knowledge in a way that is critical, autonomous, proactive, self-regulated, and continuous. When young adults actively integrate into society and their jobs, they aim to find the most effective alternatives and options, and to make the best, balanced decisions in order to solve the wide-ranging complex problems they face (Dumitr et al., 2018; Organisation for Economic Co-operation and Development, 2018).

Various authors have defined critical thinking over the decades. Facione (1990a) defined critical thinking as "intentional, self-regulated thinking that results in interpretation, analysis, evaluation and inference, as well as in explanation of the evidence, conceptual, methodological, criteriological or contextual considerations upon which this judgment is based" (p. 3). Halpern (2013) defined critical thinking as,

> Purposeful, reasoned, goal-directed thinking that requires the use of cognitive skills or strategies that increase the likelihood of a desirable outcome. It is the kind of thinking involved in problem-solving, formulating inferences, calculating probabilities and making decisions and which enables the outcome of the thought processes used to be evaluated. (pp. 450-451)

Ennis (1987) included in the concept of critical thinking not only cognitive skills but also dispositions. This was corroborated by the participants in a Delphi study by Facione (1990a), where the ideal critical thinker was described as curious, well-informed, open-minded, flexible, fair in evaluation, honest in observing personal biases, careful in decision making, able to reconsider, clear about issues, orderly in complex matters, dedicated in the search for relevant information, reasonable in the selection of criteria, research focused, and persistent in the search for results that are as concrete as the subject matter and circumstances. Thinking critically requires more than just the use of skills in differentiated contexts; it requires the dispositions (attitudes) necessary to elaborate upon the reasoning inherent in using those skills (Halpern, 2013).

Skills (the cognitive component of critical thinking) determine how an individual performs a task, whereas, dispositions (the motivational component of critical thinking) involve the predisposition, desire, willingness, and tendency for an individual to use the skills they possess (Facione et al., 2000; Nieto & Valenzuela, 2012). Although cognitive skills are fundamental to critical thinking, their mastery does not guarantee efficacy. One must also be

willing and motivated to perform such skills as and when circumstances demand. Possessing critical thinking dispositions, however, is deemed more valuable than just having the skills to think critically when considering their importance from a perspective of transferability and long-term use (Chaisuwan et al., 2021; Mousazadeh et al., 2021; Pu et al., 2019). According to Facione et al. (2000), critical thinking dispositions are personality traits that characterize an individual and can be considered as a consistent internal motivation to think critically. They determine engagement in problem-solving, in evaluating ideas and making decisions, and in enabling one to think critically and rigorously. They include an inclination, sensitivity, and capacity towards critical thinking (Perkins et al.,1993), as well as general orientations regarding objectivity, intellectual honesty and impartiality, use of principles, and also curiosity (Siegel, 1988).

As with skills, there are different taxonomies of critical thinking dispositions, although researchers have identified similar relevant sets. The most frequently identified include open-mindedness (Bailin et al., 1999; Dwyer et al., 2014; Ennis, 1985; Facione, 1990b; Facione et al., 2000; Halpern, 1998), intellectual curiosity (Bailin et al., 1999; Dwyer et al., 2014; Facione, 1990b; Facione et al., 2000), flexibility (Facione, 1990b; Halpern, 1998), impartiality (Bailin et al., 1999; Facione, 1990b), a propensity to seek reason (Bailin et al., 1999; Ennis, 1985), the desire to be well informed (Ennis, 1985; Facione, 1990a), and respect and willingness to attend to the views of others (Bailin et al., 1999; Facione, 1990b).

Considering the importance attributed to dispositions by various authors, it seems of increasing significance to understand which factors may impact critical thinking dispositions in order that higher education institutions can aim to contribute to their development by incorporating them into academic curricula (Dennett & DeDonno, 2021; Wang et al., 2019).

In the past decades, several empirical studies have been conducted in order to better understand the relationship between critical thinking dispositions and various individual characteristics in higher education students, namely cultural and contextual (Chaisuwan et al., 2021; Dennett & DeDonno, 2021; Salsali et al., 2013), psychological (Sosu, 2013), sociodemographic (Dennett & DeDonno, 2021; Ghadi et al., 2013; Lopes et al., 2021), and academic (Pu et al., 2019; Wang et al., 2019).

Other studies have also addressed the influence of sociodemographic variables (e.g., gender, age), academic variables (e.g., year, area of study), and professional variables (e.g., contribution to organization, emotional labor) as predictors of critical thinking dispositions (Delgado-Vásquez et al., 2019; Ekinci & Ekinci, 2017; Sahanowas & Santoshi, 2020; Wang et al., 2019; Zheng, 2021; Zhou & Lin, 2019).

The studies reached contradictory results regarding the influence of sociodemographic variables (e.g., gender, age, scientific field) on critical thinking dispositions. Regarding the relationship between age and essential thinking dispositions, some studies reported finding older students to be more willing to think critically (Mousazadeh et al., 2021), whereas other studies found the opposite (Azizi-Fini et al., 2015; Hunter et al., 2014; Mousazadeh et al., 2016). Most studies on the influence of gender on critical thinking dispositions have failed to identify any significant differences (Boso et al., 2021; Dennett & DeDonno, 2021; Ghadi et al., 2013; Hunter et al., 2014), whilst others reported female students as having higher mean scores for critical thinking dispositions than their male counterparts (Lopes et al., 2021; Mawaddah & Duskri, 2018). However, in studies published by Ozcan and Elkoca (2019) and

also Mousazadeh et al. (2021), the opposite was found, with male students having higher mean scores than females.

Also, the situation was found to be identical with regards to academic variables. In a preliminary study assessing critical thinking dispositions in a smaller population of Portuguese university students, undergraduates achieved higher scores than those attending master's level courses (Lopes et al., 2021). These differences, however, were not observed with nursing students in studies conducted at public universities in Ghana and Iran (Boso et al., 2021; Najafi et al., 2022).

To date, no consensus has been reached in respect to the influence of courses on the scientific field of critical thinking dispositions. Several studies have reported that scientific area (e.g., health sciences, STEM, or engineering) may be a predictor of critical thinking dispositions (Delgado- Vásquez et al., 2019; Escurra-Mayaute & Delgado-Vásquez, 2008; Lampert, 2006; Lopes et al., 2021; Wang et al., 2019); however, Cieza-Guevara and Palomino-Ccoillo (2020) and also Taşçı et al. (2022) found no effects of study field (academic majors) on students' critical thinking dispositions.

Given the limited literature, particularly in the Portuguese context, and evidence of contradictory results on predictors such as age, gender, and study field in critical thinking dispositions, the current research aimed to contribute to the existing knowledge in this research area. The study investigates how age, gender, and the area of study (course subject) influence critical thinking dispositions in Portuguese higher education students through five hypotheses:

Hypothesis 1: Gender affects critical thinking dispositions in students.

Hypothesis 2: Critical thinking disposition is not affected by participant age.

Hypothesis 3: No significant differences exist in students' critical thinking dispositions based on academic year.

Hypothesis 4: Critical thinking disposition of students varies according to their study field.

Hypothesis 5: Academic characteristics (study field) affects students' dispositions toward critical thinking, when controlling for demographic variables (gender, age).

The current study aims to identify if any significant differences exist in the level of students' dispositions to critical thinking, according to the sociodemographic (gender, age) and academic characteristics (study field) in a university undergraduate population.

2. METHODOLOGY

Participants

The study was applied with a convenience sample of 1,017 undergraduate students from five Portuguese public higher education institutions. The participants were assigned into three main study fields according to their study program, namely: biomedicine (veterinary medicine, nursing, psychomotor rehabilitation), social sciences (management, psychology, social services, sociocultural animation, languages and business relations, basic school teaching), and STEM (science, technology, engineering, and mathematics). However, the different study fields were unbalanced in terms of participant student numbers, with 489 (48.1%) enrolled to social science programs, 448 (44.0%) in biomedicine programs, and 80

students (7.9%) in STEM programs. Most of the participants were female (76.8%, *n* = 781) (see Table 1).

The participants' ages ranged between 18 and 60 years old. For the biomedicine students, their average age was 21.8 ± 4.22 years, whereas for social sciences students it was 20.5 ± 4.62 years, and the STEM students' average age was 19.6 ± 2.67 years.

Given the age distribution of the participants and considering that they were enrolled in either a 3-year or 5-year study program, statistical analyses involving the age of the students were performed using a recoded variable to which the value of 22 was assigned to students ≥22 years old, who had greater academic or professional experience.

Most of the participants were enrolled in 3-year study programs, with the exceptions being veterinary medicine (5 years) and nursing (4 years) (see Table 1).

Table 1. Study field and academic year: Count (% within study field)

	Academic year					
Study field	1	2	3	4	5	Total
Biomedicine	164 (36.6)	34 (7.6)	98 (21.9)	103 (23.0)	49 (10.9)	448 (100)
Social sciences	190 (38.9)	162 (33.1)	127 (26.0)	10 (2.0)	0 (0.0)	489 (100)
STEM	64 (80.0)	9 (11.3)	4 (5.0)	3 (3.8)	0 (0.0)	80 (100)
Total	418 (41.1)	205 (20.2)	229 (22.5)	116 (11.4)	49 (4.8)	1,017 (100)

Design

A cross-sectional descriptive-correlational study was conducted in order to explore the relationships between gender, age, academic year, and study field with critical thinking dispositions among social sciences, health sciences, and STEM undergraduate students.

Instrument

The Critical Thinking Dispositions Scale (CTDS) is a self-report instrument consisting of 35 Likert-type items designed to understand college students' dispositions. This instrument consists of a model of dispositions with a heptafactorial structure based on the Facione Delphi report: truth-seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness, and maturity of judgment (Facione & Facione, 1992. This instrument has previously been validated for the Portuguese population by Lopes et al. (2021), with the CTDS reliability found to be very good (α = .94) and the reliability of the seven subscales (each corresponding to a single disposition) found to be either good or acceptable (α ranges between .62 and .75). The total available score from the CTDS ranges from 70 to 350 points, with each disposition scored between 10 and 50 points. Lopes et al. (2021) established cut-off points for the score on the scale, rating individuals with high disposition towards critical thinking at a threshold CTDS score of 280, positive disposition with a score range between 210 and 279.9, an ambivalent disposition with a score range between 140 and 209.9, and low disposition to critical thinking under a threshold score of 140 points. The corresponding score cut-off points on each subscale are 39, 30, and 20 points.

Data were collected through questionnaires distributed via Google Forms to all students at five Portuguese higher education institutions and completed were in-class.

Ethical considerations

This study followed the ethical requirements of the European Federation of Psychologists' Associations (EFPA) as well as the Ordem dos Psicólogos Portugueses (OPP). All ethical principles were respected, ensuring that the participants understood and accepted the principles of informed consent, voluntary participation, and confidentiality of their answers. Ethical approval of the study was obtained from the ethical committee of the authors' higher education institution (University of Trás-os-Montes e Alto Douro, Portugal).

Statistical analysis

The data analysis was conducted using IBM SPSS Statistics, version 25. The validity of all the assumptions required for the statistical analyses performed were confirmed.

Total CTDS scores and scores from the seven subscales were compared using students' *t*-tests and analysis of variance (ANOVA). Measures of the data are presented as mean ± standard deviation or *M* (*SD*). Whenever a statistical significance was revealed in the ANOVA, post hoc Tukey HSD was performed in order to identify which groups differed significantly. For the analysis of the correlation between the subscales' scores, the Pearson coefficients were computed. The significance level of .05 was used for all statistical testing.

3. RESULTS

In the present study, the analysis of the data for the 1017 participants indicates that the CTDS has high reliability (α=0.924), and that each subscale has a good or acceptable reliability, except for the disposition "cognitive maturity" (truth-seeking, α=0.639; open-mindedness, α=0.645; analyticity, α=0.621; systematicity, α=0.742; self-confidence, α=0.666; inquisitiveness, α=0.771; cognitive maturity, α=0.542).

Analysis of the data for the 1,017 participants indicates that the CTDS has a high level of reliability (α = .924), and that each subscale has either a good or acceptable level of reliability, except for the disposition of cognitive maturity (truth-seeking, α = .639; open-mindedness, α = .645; analyticity, α = .621; systematicity, α = .742; self-confidence, α = .666; inquisitiveness, α = .771; and, cognitive maturity, α = .542).

From analyzing the correlations between the different subscales and between the subscales and the total CTDS score, all scores were found to be correlated significantly (*r* values ranged from .291 to .821; $p < .05$). The dispositions subscales that had the lowest correlation with the total CTDS score were self-confidence ($r = .615$, $p < .001$) and systematicity ($r = .634$, $p < .001$).

The average CTDS score was 279.1 ± 27.1, thus it can be said that the students showed an average positive disposition for critical thinking, and almost all students in each study field had either high or positive disposition (see Table 2).

Table 2. CTDS score classification: Count (% within study field)

	Disposition towards critical thinking				
Study field	Low	Ambivalent	Positive	High	Total
Biomedicine	1 (0.2)	1 (0.2)	170 (37.9)	276 (61.6)	448 (100)
Social sciences	0 (0.0)	10 (2.0)	273 (55.8)	206 (42.1)	489 (100)
STEM	0 (0.0)	0 (0.0)	49 (61.3)	31 (38.8)	80 (100)
Total	1 (0.2)	11 (1.1)	492 (48.4)	513 (50.4)	1,017 (100)

According to a *t*-test for independent groups, it was concluded that the female participants presented statistically higher average scores than their male counterparts in truth-seeking, open-mindedness, analyticity, inquisitiveness, cognitive maturity, and in the total CTDS score (see Table 3). There were no statistical differences between male and female students in either systematicity or self-confidence.

Table 3. Statistics and analyses of the CTDS scores by gender

	Gender		
	Male *n* = 236	Female *n* = 781	*t*-test
Truth-seeking	41.7 ± 5.25	43.5 ± 4.80	$t(1015) = -5.09$, $p < .001$
Open-mindedness	40.8 ± 5.15	41.8 ± 5.05	$t(1015) = -2.82$, $p = .005$
Analyticity	40.2 ± 4.82	41.1 ± 5.07	$t(1015) = -2.32$, $p = .021$
Systematicity	36.2 ± 6.69	35.6 ± 7.35	$t(1015) = 1.12$, $p = .262$
Self-confidence	36.5 ± 4.73	36.3 ± 4.90	$t(1015) = 0.45$, $p = .652$
Inquisitiveness	40.2 ± 4.68	41.6 ± 4.47	$t(1015) = -4.09$, $p < .001$
Cognitive maturity	40.2 ± 4.75	41.1 ± 4.87	$t(1015) = -2.61$, $p = .009$
CTDS Total	275.7 ± 26.3	281.0 ± 27.2	$t(1015) = -2.66$, $p = .008$

The analysis of correlation between the age of the participants and their scores on the scale and subscales showed weak positive correlations between age and systematicity ($r = .142$, $p < .001$), self-confidence ($r = .078$, $p < .001$), and the total CTDS score ($r = .087$, $p < .001$).

Due to the positive correlation between students' age and the academic year ($r = .700$, $p < .001$), significant differences were found between students according to their academic year in the same variables: systematicity, self-confidence, and the total CTDS scores (see Table 4).

Table 4. Statistics and analyses of the CTDS scores by academic year

	Academic Year					ANOVA
	Year 1	Year 2	Year 3	Year 4	Year 5	
	n = 418	*n* = 205	*n* = 229	*n* = 116	*n* = 49	
Truth-seeking	43.1 ± 5.19	43.4 ± 4.87	42.7 ± 4.71	42.8 ± 5.09	44.1 ± 4.26	$F(4,1012) = 1.12$, $p = .343$
Open-mindedness	41.4 ± 5.11	42.2 ± 4.81	41.2 ± 4.91	42 ± 5.96	42 ± 4.58	$F(4,1012) = 1.45$, $p = .217$
Analyticity	40.7 ± 4.8	41.3 ± 5.28	40.5 ± 4.79	41 ± 5.73	42.2 ± 4.85	$F(4,1012) = 1.88$, $p = .112$
Systematicity	36.5^{c} ± 6.87	31.4^{e} ± 6.34	34.3^{d} ± 7.3	40.8^{b} ± 5.04	41.3^{a} ± 4.01	$F(4,1012) = 52.3$, $p < .001$
Self-confidence	$36.4^{a,b}$ ± 4.61	35.5^{b} ± 5.04	36.9^{a} ± 4.98	37.2^{a} ± 4.9	$35.4^{a,b}$ ± 4.97	$F(4,1012) = 3.86$, $p = .004$
Inquisitiveness	41.1 ± 4.51	41.5 ± 4.63	41.1 ± 4.56	41.5 ± 4.79	42.1 ± 4.01	$F(4,1012) = 1.03$, $p = .392$
Cognitive maturity	40.6 ± 4.72	41 ± 5.02	40.7 ± 4.89	41.5 ± 5.02	42.2 ± 4.54	$F(4,1012) = 1.82$, $p = .122$
CTDS Total	$279.7^{a,b}$ ± 25.7	276.3^{b} ± 26.8	277.4^{b} ± 27.5	286.9^{a} ± 30.8	289.6^{a} ± 23.6	$F(4,1012) = 4.95$, $p = .001$

Different superscript letters indicate a significant difference among the mean scores in each row, according to Tukey HSD post hoc tests

Descriptive statistics of the students' CTDS scores are presented in Table 5. Additionally, ANOVA results are presented in order to verify if there are significant differences between the mean scores of students enrolled in the three study fields.

Table 5. Statistics and analyses of the CTDS scores by study field

	Study field			ANOVA
	Biomedicine	Social sciences	STEM	
	n = 448	*n* = 489	*n* = 80	
Truth-seeking	43.3^{a} ± 4.67	43.2^{a} ± 5.20	41.2^{b} ± 4.79	$F(2,1014) = 6.21$, $p = .002$
Open-mindedness	42.2^{a} ± 5.00	41.4^{a} ± 5.14	39.7^{b} ± 4.80	$F(2,1014) = 8.95$, $p < .001$
Analyticity	41.4^{a} ± 4.69	$40.7^{a,b}$ ± 5.29	39.3^{b} ± 4.78	$F(2,1014) = 6.31$, $p = .002$
Systematicity	40.4^{a} ± 5.00	30.8^{b} ± 6.03	39.3^{a} ± 3.52	$F(2,1014) = 387.8$, $p < .001$
Self-confidence	36.8^{a} ± 4.89	$36.3^{a,b}$ ± 4.72	34.9^{b} ± 5.31	$F(2,1014) = 5.01$, $p = .007$
Inquisitiveness	41.6^{a} ± 4.34	41.3^{a} ± 4.76	39.5^{b} ± 4.09	$F(2,1014) = 7.08$, $p = .001$
Cognitive maturity	41.3^{a} ± 4.63	40.8^{a} ± 5.11	39.2^{b} ± 4.03	$F(2,1014) = 6.88$, $p = .001$
CTDS Total	286.8^{a} ± 26.1	274.5^{b} ± 27.4	273.1^{b} ± 20.5	$F(2,1014) = 28.4$, $p < .001$

Different superscript letters indicate a significant difference among the mean scores in each row, according to Tukey HSD post hoc tests

The results show that significant differences were found in the scores for each subscale and in the total scale. Post hoc analysis using the Tukey HSD showed that the biomedicine students achieved mean scores that were significantly higher than the social science and STEM students in terms of the CTDS total; that the biomedicine and social science students

achieved mean scores that were significantly higher than the STEM students in four dispositions (truth-seeking, open-mindedness, inquisitiveness, and cognitive maturity); that biomedicine students achieved mean scores that were significantly higher than the STEM students in two dispositions (analyticity and self-confidence); and that biomedicine and STEM students achieved mean scores that were significantly higher than social science students in the disposition of systematicity.

In order to verify if the students' study field significantly contributed to their dispositions for critical thinking whilst controlling for demographic variables (gender and age), a hierarchical multiple regression analysis was performed. For each dependent variable (score for each disposition and for the CTDS score), model 1 considered the students' demographic data (age and gender) as independent variables, whilst model 2 added the academic data of the students (study field). The academic (curricular) year in which the students were enrolled was not added as an independent variable given the significant correlation with the students' age ($r = .700$, $p < .001$) that was already considered in model 1. The results of the multiple regression models are presented in Table 6, as well as the statistical changes seen from model 1 to model 2.

Table 6. Hierarchical multiple regression results

Disposition	Model 1	Model 2	Statistical change
Truth-seeking	$F(2,1014) = 12.9$, $p < .001$	$F(4,1012) = 7.68$, $p < .001$	$\Delta R^2 = .025$, $\Delta F(2,1012) = 2.37$, $p = .094$
Open-mindedness	$F(2,1014) = 5.13$, $p = .006$	$F(4,1012) = 5.42$, $p < .001$	$\Delta R^2 = .011$, $\Delta F(2,1012) = 5.67$, $p = .004$
Analyticity	$F(2,1014) = 3.75$, $p = .024$	$F(4,1012) = 3.84$, $p = .004$	$\Delta R^2 = .008$, $\Delta F(2,1012) = 3.90$, $p = .021$
Systematicity	$F(2,1014) = 11.1$, $p < .001$	$F(4,1012) = 195.3$, $p < .001$	$\Delta R^2 = .414$, $\Delta F(2,1012) = 371$, $p < .001$
Self-confidence	$F(2,1014) = 3.20$, $p = .041$	$F(4,1012) = 3.63$, $p = .006$	$\Delta R^2 = .008$, $\Delta F(2,1012) = 4.05$, $p = .018$
Inquisitiveness	$F(2,1014) = 10.2$, $p < .001$	$F(4,1012) = 6.43$, $p < .001$	$\Delta R^2 = .005$, $\Delta F(2,1012) = 2.64$, $p = .072$
Cognitive maturity	$F(2,1014) = 4.80$, $p = .008$	$F(4,1012) = 4.34$, $p = .002$	$\Delta R^2 = .007$, $\Delta F(2,1012) = 3.85$, $p = .022$
CTDS Total	$F(2,1014) = 7.50$, $p = .001$	$F(4,1012) = 15.8$, $p < .001$	$\Delta R^2 = .044$, $\Delta F(2,1012) = 23.8$, $p < .001$

According to these results, after controlling for the students' demographic characteristics, it can be concluded that the study field had a significant impact on the students' dispositions for critical thinking, and that a significant change of the model was not only found for truth-seeking and inquisitiveness. The highest impact of the study field was verified for the disposition of systematicity.

4. DISCUSSION

Given the relatively few studies that exist in the literature, and particularly for the Portuguese context, and the contradictory results that existing studies have presented on predictors such as age, gender, and area of study on critical thinking dispositions in the literature in general, the current study aimed to contribute to the knowledge on how gender, age, and study field could influence the critical thinking dispositions of undergraduate students in Portugal.

Some studies have shown that the dimensions of analyticity, truth-seeking, self-confidence, and cognitive maturity most significantly affected critical thinking disposition in higher education students (Pu et al., 2019). In the current study, the results obtained from the CTDS scale revealed the undergraduate students in Portugal to have high global levels of critical thinking disposition. The analysis of the seven dispositions studied revealed truth-seeking and open-mindedness as having scored the highest. In contrast, systematicity and self-confidence scored the lowest. Systematicity was defined by Facione et al. (1994) as the habit of the mind to persistently address problems in a disciplined, orderly, and methodical way.

Hypothesis 1: Gender affects critical thinking dispositions in students.

The influence of gender on critical thinking dispositions has been evaluated in several earlier studies, and in most cases, it was shown that gender did not prove to be a significant predictor (Ghadi et al., 2013; Khandaghi et al., 2011; Lewis, 2012; Sahanowas & Santoshi, 2020). However, in the current study, the participant female students were found to have higher average scores across all dimensions of the CTDS scale, except in systematicity and self-confidence where the male students had higher scores. These results are in agreement with the report published by Fitriani et al. (2018), who also found gender-related differences in the dispositions of critical thinking in university biology students, with females obtaining higher scores in the dimensions of inquisitiveness and cognitive maturity, and males obtaining higher mean scores for self-confidence and open-mindedness, even though the instruments used were different to that of the current study.

Hypothesis 2: Critical thinking disposition is not affected by participant age.

The current study showed that age determined significant differences in the students' critical thinking dispositions based on total CTDS scale scores, with older students having higher scores. Also, significant differences were observed for the dimensions of systematicity and self-confidence.

These results seem to confirm the most recent study, by Mousazadeh et al. (2021), in which a positive and significant relationship was observed between critical thinking dispositions and age in nursing students. If we look at the relationship between critical thinking skills and age, researchers have shown that no relationship exists between these variables (Harrison, 2019; Hasanpour et al., 2018; Hunter et al., 2014), which may suggest the same tendency toward dispositions. However as critical thinking skills and dispositions are strongly correlated, students who have critical thinking dispositions are more likely to use these skills to think critically when solving specific problems (Dwyer et al., 2014; Ghadi et al., 2015). These results show that age can influence critical thinking dispositions, which can be explained by the fact that as students advance in age, greater cognitive development occurs

and dispositions to think critically increase (Yeh & Chen, 2003), enhancing students' autonomy (Knowles et al., 2005).

Hypothesis 3: No significant differences exist in students' critical thinking dispositions based on academic year.

The current study showed that significant differences exist between students depending on their academic year of study for the scale of critical thinking dispositions in general, and for the subscales of systematicity and self-confidence in particular. These results align with the aforementioned results on age and critical thinking dispositions, which seem expectable since generally students attending higher academic years are usually older.

Hunter et al. (2014), in a study involving nursing students, found higher levels of critical thinking dispositions in those attending their final course year, with year of study predicting higher critical thinking scores for all domains ($p < .001$), except for the subscale of analysis. Mousazadeh et al. (2021) also revealed a positive and significant relationship between the dispositions for critical thinking and the academic semester, with sixth-semester students presenting higher levels of critical thinking. However, the results of the current study disagree with that of Boonsathirakul and Kerdsomboon (2021), in which differences in students' critical thinking dispositions between academic years failed to be identified. This diverges from previous research in one Portuguese northern university (Lopes et al., 2021) in which students attending undergraduate programs presented higher scores than those attending master's classes. These differences, however, were not observed in a study with nursing students published by Boso et al. (2021).

Hypothesis 4: Critical thinking disposition of students varies according to their study field.

The results of the current study showed that with regard to the influence of the area of study on the dispositions of critical thinking, biomedicine had the highest average values, followed by human and social sciences, and then STEM fields. These results agree with those of Lopes et al. (2021), who revealed that students from science and technology courses presented lower overall scores in critical thinking dispositions when compared to those from agricultural and veterinary sciences, and also human and social sciences. There is, however, one exception: In the dimension of truth-seeking, students who attended social science and STEM courses presented higher values.

Similar to other variables, the influence of study field on critical thinking dispositions is not consensual. Delgado-Vásquez et al. (2019) did not find differences in critical thinking dispositions between students in the study fields of health sciences, basic sciences, engineering, economics and management, humanities and legal, and social sciences. Wang et al. (2019) compared dispositions for critical thinking among medical and nursing students in China, and found that medical students scored higher on overall critical thinking dispositions. Lampert (2006) reported that arts graduates scored significantly higher than other graduates on the CTDS subscales of truth-seeking, maturity, and open-mindedness.

In the current study, it can be said that biomedicine presents a higher correlation with critical thinking disposition since students in that area approach complex problems in order to make timely clinical judgments (maturity), seek relevant evidence to support decision making (truth-seeking), and are open to hearing other opinions that may differ from their own (open-mindedness) Although critical thinking dispositions may be influenced by sociodemographic

characteristics, according to Ghadi et al. (2015), the ability to be a critical thinker is a learned skill, which is greatly influenced by the learning environment.

Another hypothesis that might explain some of the differences between the biomedicine and other study fields is the fact that in general, in Portugal, students enter those programs under the national call with higher grades than for either STEM or human and social science programs. In a study with 12th-grade liberal studies' students in Hong Kong, Cheng and Wan (2017) revealed classroom learning environment as having a stronger relationship with critical thinking disposition than skills. Structural equation modeling analysis also showed a mediation effect of critical thinking disposition between the classroom learning environment and critical thinking skills. Nonetheless, further research is needed in order to address this hypothesis.

Hypothesis 5: Academic characteristics (study field) affects students' disposition toward critical thinking, when controlling the demographic variables (gender, age).

According to the results of the hierarchical multiple regression analysis models, the current study showed that field of study significantly impacts on students' dispositions to think critically, except for truth-seeking and inquisitiveness. The dimension which showed the greatest differences was systematicity, which may result from the specific characteristics of the study field, since decision making and solving complex problems in an organized and focused manner are promoted considerably in biomedicine (Escurra-Mayaute & Delgado-Vásquez, 2008).

Limitations

Although the convenient sample of 1,017 students might be considered a limitation of the current study, it possessed the required assumptions for statistical purposes. However, considering that the sampling procedure was not randomized, certain care should be taken when generalizing the results of the study. Another limitation may be the use of a scale based on students' perceptions of their critical thinking dispositions. In self-report questionnaires, bias may arise due to respondents' willingness to please and to select socially desirable responses (Wang et al., 2019). There may also be bias based on how the respondents understand the concept addressed in the questions, and the perception of their positioning with respect to the concept (Rosenman et al., 2011).

5. CONCLUSION

The investigations of the current study aimed to determine if the students age, gender, and field of study were predictors of critical thinking disposition, adding further insight to the discussion over previously published research. Regarding age, the results of the current study are along the lines of psychology and neurological science, in that cognitive maturity is gained over time; and therefore, older students showed higher critical thinking dispositions than their more junior counterparts. Female students generally showed higher scores for their critical thinking dispositions. However, in the dimensions of systematicity and self-confidence, it was the male students who realized the higher scores. Study field was found to be the best predictor on the students' critical thinking disposition scores, with those from biomedicine showing the better performance. One can hypothesize that the differences found are due to the research-promotion teaching strategies employed in that area, while for social sciences and STEM, priority is given more to applied and technical knowledge. The learning environment (here collected by the study field) seems crucial to developing critical thinking. Although dispositions are considered personality traits, they can also be explicitly nurtured.

6. SUGGESTIONS

A challenge for this field of investigation would be to measure or evaluate the actual critical thinking dispositions (and not just data based on students' perceptions). It would not be an easy task, but it could prove very helpful to the academic higher education community, considering the importance of fostering critical thinking dispositions in the development of students' critical thinking skills.

Author Contributions: The authors contributed equally to the current research in terms of the literature review, data collection, and data analysis. All authors have read and approved the published final version of the article.

Conflicts of Interest: The authors declare that they have no conflict of interest.

Funding: The research presented in this work was not funded.

Ethical Approval: This study followed the ethical requirements of the European Federation of Psychologists' Associations (EFPA), as well as the OPP (Ordem dos Psicólogos Portugueses). All ethical principles were respected, ensuring that all participants knew and accepted the principles of informed consent, voluntary participation, and confidentiality of their answers. Ethical approval of the study was obtained from the ethical committee of the higher education institution.

Data Availability Statement: Upon request to the authors.

Acknowledgments: Nothing to refer.

REFERENCES

Azizi-Fini, I., Hajibagheri, A., & Adib-Hajbaghery, M. (2015). Critical Thinking Skills in Nursing Students: a Comparison Between Freshmen and Senior Students. *Nursing and Midwifery Studies, 4*(1), 1-5. https://doi.org/10.17795/nmsjournal25721

Bailin, S., Case, R., Coombs, J. R., & Daniels, L. B. (1999). Conceptualizing critical thinking. *Journal of Curriculum Studies*, *31*(3), 285-302. https://doi.org/10.1080/002202799183133

Boonsathirakul, J., & Kerdsomboon, C. (2021). The Investigation of Critical Thinking Disposition among Kasetsart University Students. *Higher Education Studies*, *11*(2), 224-232. https://doi.org/10.5539/hes.v11n2p224

Boso, C. M., van der Merwe, A. S., & Gross, J. (2021). Critical thinking disposition of nursing students: A quantitative investigation. *Nurse Education in Practice*, *55*, Article 103167. https://doi.org/10.1016/j.nepr.2021.103167

Chaisuwan, C., Kelly, K., Kelman, G. B., & Continelli, T. (2021). The Relationship between Cultural Value and Critical Thinking Dispositions and their Difference among Nursing Students in Thailand and the United States. *Pacific Rim International Journal of Nursing Research*, *25*(2), 199-212. https://he02.tci-thaijo.org/index.php/PRIJNR/article/view/242571

Cheng, M. H. M., & Wan, Z. H.; (2017). Exploring the effects of classroom learning environment on critical thinking skills and disposition: A study of Hong Kong 12th graders in Liberal Studies. *Thinking Skills and Creativity*, 24, 152-163. https://doi.org/10.1016/j.tsc.2017.03.001

Cieza-Guevara, L., & Palomino-Ccoillo, R. (2020). Resiliencia y disposición al pensamiento crítico en estudiantes de una universidad privada de Lima Metropolitana [Resilience

and disposition towards critical thinking in students of a private university in Metropolitan Lima]. *Revista de Investigación En Psicología*, *23*(1), 109-125. https://doi.org/10.15381/rinvp.v23i1.18096

Delgado Vásquez, A. E., Escurra Mayaute, L. M., Atalaya Pisco, M. C., Pequeña Constantino, J., Solís Narro, R. S., Álvarez Flores, D. M., Torres Acuña, W. J., Cuzcano Zapata, A., Castro Celis, E. A., & Rodríguez Tarazona, R. E. (2019). Disposición hacia el pensamiento crítico en estudiantes de una universidad estatal de Lima Metropolitana [Critical thinking disposition among students of a public university in Lima metropolitan area]. *Persona*, *022(2)*, 67-92. https://doi.org/10.26439/persona2019.n022(2).4565

Dennett, S., & DeDonno, M. (2021). A comparison between Chinese and American male and female college students' critical thinking dispositions. *International Journal of Chinese Education, 10*(3), 1-14. https://doi.org/10.1177/22125868211046966

Dumitr, D., Bigu, D., Elen, J., Jiang, L., Railienè, A., Penkauskienè, D., Papathanasiou, I. V., Tsaras, K., Fradelos, E. C., Ahern, A., McNally, C., O'Sullivan, J., Verburgh, A., Jarošová, E., Lorencová, H., Poce, A., Agrusti, F., Rosaria, M., Puig, B.,…Paleigeorgiou, G. (2018). *A European collection of the Critical Thinking skills and dispositions needed in different professional fields for the 21st century*. CRITHINKEDU - Critical Thinking Across the European Higher Education Curricula. CRITHINKEDU ERASMUS EU Project. UTAD.

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity*, *12*, 43-52. https://doi.org/10.1016/j.tsc.2013.12.004

Ekinci, C. E., & Ekinci, N. (2017). A Study on the Relationships between Teachers' Critical Thinking Dispositions and Their Perceptions of Occupational Professionalism. *Educational Process: International Journal*, *6*(2), 53-78. http://dx.doi.org/10.22521/edupij.2017.62.5

Ennis, R. H. (1985). A logical basis for measuring critical thinking skills. *Educational Leadership*, *43*(2), 44-48. https://www.ascd.org/el/articles/a-logical-basis-for-measuring-critical-thinking-skills

Ennis, R. H. (1987). A taxonomy of critical thinking dispositions and abilities. In J. B. Baron & R. J. Sternberg (Eds.), *Teaching thinking skills: Theory and practice* (pp. 9-26). Freeman.

Escurra-Mayaute, L. M., & Delgado-Vásquez, A. E. (2008). Relación entre disposición hacia el pensamiento crítico y estilos de pensamiento en alumnos universitarios de Lima metropolitan [Relationship between attitudes towards critical thinking and thinking styles on college students in metropolitan Lima]. *Persona, 0*(011), 143-175. https://doi.org/10.26439/persona2008.n011.929

Facione, N. C., & Facione, P. A. (1992). *California Critical Thinking Disposition Inventory: User Manual*. California Academic Press.

Facione, N. C., Facione, P. A., & Sanchez, C. A. (1994). Critical Thinking Disposition as a Measure of Competent Clinical Judgment: The Development of the California Critical Thinking Disposition Inventory. *Journal of Nursing Education*, *33*(8), 345-350. https://doi.org/10.3928/0148-4834-19941001-05

Facione, P. A. (1990a). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction* (The Delphi Report). California Academic Press.

Facione, P. (1990b). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction.* California Academic Press.

Facione, P. A., Facione, N. C., & Giancarlo, C. (2000). The Disposition Toward Critical Thinking: Its Character, Measurement, and Relationship to Critical Thinking Skill. *Informal Logic*, *20*(1), 61-84. https://doi.org/10.22329/il.v20i1.2254

Fitriani, H., Asy'ari, M., Zubaidah, S., & Mahanal, S. (2018). Critical Thinking Disposition of Prospective Science Teachers at IKIP Mataram, Indonesia. *Journal of Physics: Conference Series*, *1108*, Article 012091. https://doi.org/10.1088/1742-6596/1108/1/012091

Ghadi, I. N., Bakar, K. A., Alwia, N. H., & Taliba, O. (2013). Gender Analysis of Critical Thinking Disposition Instrument Among University Putra Malaysia undergraduate students. *Recent Technological Advances in Education*, 2, 27-33. http://www.prpi.upm.edu.my/IPR/Copyright/UPM6254_6101_copyright.pdf

Ghadi, I. N., Bakar, K. A., & Njie, B. (2015). Influences of critical thinking dispositions on critical thinking skills of undergraduate students at a Malaysian Public University. *Journal of Educational Research and Reviews,* *3*(2), 23-31. http://sciencewebpublishing.net/jerr/archive/2015/February/Abstract/Ghadi%20et%20al.htm

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American Psychologist*, *53*(4), 449-455. https://doi.org/10.1037/0003-066x.53.4.449

Halpern, D. F. (2013). *Thought and knowledge: An introduction to critical thinking*. Psychology Press.

Harrison, J. (2019). Student nurses' gender role is a predictor of caring behaviours and critical thinking. *Evidence Based Nursing*, *22*(3), 89-89. https://doi.org/10.1136/ebnurs-2018-103029

Hasanpour, M., Bagheri, M., & Ghaedi Heidari, F. (2018). The relationship between emotional intelligence and critical thinking skills in Iranian nursing students. *Medical Journal of the Islamic Republic of Iran*, *32*(1), 231-234. https://doi.org/10.14196/mjiri.32.40

Hunter, S., Pitt, V., Croce, N., & Roche, J. (2014). Critical thinking skills of undergraduate nursing students: description and demographic predictors. *Nurse Education Today*, *34*(5), 809-814. https://doi.org/10.1016/j.nedt.2013.08.005

Khandaghi, M. A., Pakmehr, H., & Amiri, E. (2011). The status of college students' critical thinking disposition in humanities. *Procedia - Social and Behavioral Sciences, 15,* 1866-1869. https://doi.org/10.1016/j.sbspro.2011.04.017

Knowles, M. S., Holton, E. F., & Swanson, R. A. (2005). *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development*. Taylor & Francis.

Lampert, N. (2006). Critical Thinking Dispositions as an Outcome of Art Education. *Studies in Art Education*, *47*(3), 215-228. https://doi.org/10.1080/00393541.2006.11650083

Lewis, C. Y. (2012). *Critical thinking dispositions of Tennessee agriculture teachers* [Master's thesis, Tennessee State University]. http://digitalscholarship.tnstate.edu/dissertations/AAI1510436

Lopes, J., Silva, H., & Morais, E. (2021). Construção e validação de uma escala de disposições de pensamento crítico para estudantes universitários (EDPC) [Development and validation of Critical Thinking Disposition Scale for college students (CTDS)]. *Revista Lusófona de Educação*, *53*, 119-138. https://doi.org/10.24140/issn.1645-7250.rle53.07

Mawaddah, A., & Duskri, M. (2018). Gender differences of mathematical critical thinking skills of secondary school students. *Journal of Physics: Conference Series*, *1088*, Article 012054. https://doi.org/10.1088/1742-6596/1088/1/012054

Mousazadeh, N., Momennasab, M., Sharif Nia, H., Nazari, R., & Hajihosseini, F. (2021). Effective Factors in Critical Thinking Disposition in Nursing Students. *Education Research International*, *2021*, Article 5580010. https://doi.org/10.1155/2021/5580010

Mousazadeh, S., Momennasab, M., Bakhtiari, T., & Reisi, M. (2016). Nursing Students' Disposition toward Critical Thinking and its Relationship with their Academic Performance. *Journal of Nursing Education*, *5*(4), 20-26. https://doi.org/10.21859/jne-05043

Najafi, M., Motlagh, M. K., Najafi, M., Kashani, A. S., Zarghi, N., & Shirazi, M. (2022). Trend of tendency to critical thinking among medical students in Tehran University of Medical Sciences, 2010–2015: A longitudinal study. *Journal of Education and Health Promotion*, *11*. https://doi.org/10.4103%2Fjehp.jehp_1373_20

Nieto, A. M., & Valenzuela, J. (2012). A Study of the Internal Structure of Critical Thinking Dispositions. *Inquiry: Critical Thinking across the Disciplines*, *27*(1), 31-38. https://doi.org/10.5840/inquiryct20122713

Organisation for Economic Co-operation and Development. (2018). *PISA - Preparing our youth for an inclusive and sustainable world*. https://www.oecd.org/education/Global-competency-for-an-inclusive-world.pdf

Ozcan, H., & Elkoca, A. (2019). Critical thinking skills of nursing candidates. *International Journal of Caring Sciences*, *12*(3), 1600-1606. https://internationaljournalofcaringsciences.org/docs/30_ozcan_original_12_3.pdf

Perkins, D., Jay, E., & Tishman, S. (1993). Beyond abilities: A dispositional theory of thinking. *Merrill Palmer Quarterly, 39*(1), 1-21.

Pu, D., Ni, J., Song, D., Zhang, W., Wang, Y., Wu, L., Wang, X., & Wang, Y. (2019). Influence of critical thinking disposition on the learning efficiency of problem-based learning in undergraduate medical students. *BMC Medical Education*, *19*, Article 1. https://doi.org/10.1186/s12909-018-1418-5

Rosenman, R., Tennekoon, V., & Hill, L. G. (2011). Measuring bias in self-reported data. *International Journal of Behavioural and Healthcare Research*, *2*(4), 320-332. https://doi.org/10.1504/IJBHR.2011.043414

Sahanowas, S. K., & Santoshi, H. (2020). Critical thinking disposition of undergraduate students in relation to emotional intelligence: Gender as a moderator. *Heliyon, 6*(11), e05477. https://doi.org/10.1016/j.heliyon.2020.e05477

Salsali, M., Tajvidi, M., & Ghiyasvandian, S. (2013). Critical thinking dispositions of nursing students in Asian and non-Asian countries: a literature review. *Global journal of Health Science*, *5*(6), 172-178. https://doi.org/10.5539/gjhs.v5n6p172

Siegel, H. (1988). *Educating reason: Rationality, critical thinking and education*. Routledge.

Sosu, E. M. (2013). The development and psychometric validation of a Critical Thinking Disposition Scale. *Thinking Skills and Creativity*, *9*, 107-119. https://doi.org/10.1016/j.tsc.2012.09.002

Taşçı, Ö., Durmuş, M., Gerçek, A., & Kaya, A. (2022). Factors Affecting Critical Thinking Dispositions of Nursing Students. *Journal Neurology, 25*(1), 45-49. https://doi.org/10.54614/JANHS.2022.687987

Vincent-Lancrin,s., González-Sancho,C., Bouckaert,M., Luca,F., Fernández-Barrerra,M. Jacotin,G., Urgel,J., & Vidal, Q. (2019), *Fostering Students' Creativity and Critical Thinking: What it Means in School*. Educational Research and Innovation, OECD Publishing, Paris, https://doi.org/10.1787/62212c37-en

Wang, X., Sun, X., Huang, T., He, R., Hao, W., & Zhang, L. (2019). Development and validation of the critical thinking disposition inventory for Chinese medical college students (CTDI-M). *BMC Medical Education*, *19*(1), Article 200. https://doi.org/10.1186/s12909-019-1593-z

Yeh, M.-L., & Chen, H.-H. (2003). Comparison Affective Dispositions Toward Critical Thinking Across Chinese and American Baccalaureate Nursing Students. *Journal of Nursing Research*, *11*(1), 39-46. https://doi.org/10.1097/01.jnr.0000347617.29413.96

Zheng, Y. (2021). *A study of critical thinking dispositions of undergraduates in foreign language discipline at one private college in mainland China* [Doctoral dissertation, Chapman University]. https://doi.org/10.36837/chapman.000307

Zhou, F., & Lin, Y. (2019). A Comparative Study of Critical Thinking Skills Between English and Japanese Majors in a Normal University. *English Language Teaching*, *12*(12), 30-38. https://doi.org/10.5539/elt.v12n12p30

ABOUT THE CONTRIBUTORS

Eva Morais, PhD, is a professor of mathematics at the University of Trás-os-Montes e Alto Douro, Portugal, where she lectures on statistics and experimental design to engineering students. She has authored and co-authored several works in her main research fields of mathematical finance and critical thinking in higher education.
Email: emorais@utad.pt
ORCID ID: https://orcid.org/0000-0002-3815-9821

José Lopes, PhD, is professor of educational psychology at the University of Trás-os-Montes e Alto Douro, Portugal. His main research interests include critical thinking, cooperative learning, formative assessment, teacher-student/student-teacher feedback on student achievement, learning communities, and classroom management. He has published extensively in leading international journals and also authored books and chapters on education, critical thinking, cooperative learning, and formative assessment.
Email: jlopes@utad.pt
ORCID ID: https://orcid.org/0000-0002-6845-8371

Helena Silva, PhD, is professor of science of methodology at the University of Trás-os-Montes e Alto Douro, Portugal. Her main research interests include critical thinking, cooperative learning, formative assessment, teacher-student/student-teacher feedback on student achievement, and learning communities. She has published extensively in leading international journals and also authored books and chapters on education, critical thinking, cooperative learning, and formative assessment.
Email: helsilva@utad.pt
ORCID ID: https://orcid.org/0000-0003-2855-9634

Caroline Dominguez holds a PhD in socioeconomics from the University of Toulouse-Mirail, France. She lectures on business and industrial management for several engineering courses at the University of Trás-os-Montes and Alto Douro (UTAD), Portugal. She is a research fellow at the Research Center on Didactics and Technology in the Education of Trainers (CIDTFF), and at the Center for Transdisciplinary Development Studies (CETRAD), Portugal. She has coordinated/participated in several national and international academic projects on critical thinking in higher education curricula. She has edited books and special editions of

SCOPUS/JCR journals, published several articles in peer-reviewed international journals, has been a speaker at several national and international events, and trained teachers at all levels on critical thinking education. She is a member of the Portuguese Society for Engineering Education (SPEE).
Email: carold@utad.pt
ORCID ID: https://orcid.org/0000-0002-8486-4142

Rita Payan-Carreira, PhD, is a professor of veterinary medicine at the University of Évora, Portugal, where she lectures in the field of animal reproduction and reproductive medicine, as well as bioethics and deontology. Her research interests include critical thinking, clinical reasoning, and collaborative learning strategies. She has multiple publications in peer-reviewed international journals and has also authored multiple chapters on education, critical thinking, and clinical reasoning.
Email: rtpayan@uevora.pt
ORCID ID: https://orcid.org/0000-0001-5225-4510

Cristina Imaginário, PhD, is a professor at the School of Health of the University of Trás-os-Montes and Alto Douro, Portugal, where she lectures in the field of nursing. Her research interests include health of the older population, the self-care profile of older people, informal caregivers and, more recently, critical thinking in university students.
e-mail: imaginario@utad.pt
ORCID ID: https://orcid.org/0000-0002-7471-4503

Maria José Santos, PhD, is professor at the School of Health of the University of Trás-os-Montes e Alto Douro, Portugal, where she lectures in the field of nursing. Her research interests include sexual and reproductive health, clinical reasoning and, more recently, critical thinking in university students and their collaborative learning strategies.
Email: mjsantos@utad.pt
ORCID ID: https://orcid.org/0000-0003-1253-2912