

ARTICLE HISTORY

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RESEARCH ARTICLE

Dispositions toward Critical Thinking in Portuguese Undergraduate Students

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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

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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)

Study field	Academic year					Total
	1	2	3	4	5	
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 ($\alpha = .94$) 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 \pm 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 ($\alpha=0.924$), and that each subscale has a good or acceptable reliability, except for the disposition "cognitive maturity" (truth-seeking, $\alpha=0.639$; open-mindedness, $\alpha=0.645$; analyticity, $\alpha=0.621$; systematicity, $\alpha=0.742$; self-confidence, $\alpha=0.666$; inquisitiveness, $\alpha=0.771$; cognitive maturity, $\alpha=0.542$).

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

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)

Study field	Disposition towards critical thinking				Total
	Low	Ambivalent	Positive	High	
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		<i>t</i> -test
	Male <i>n</i> = 236	Female <i>n</i> = 781	
Truth-seeking	41.7 ± 5.25	43.5 ± 4.80	<i>t</i> (1015) = -5.09, <i>p</i> < .001
Open-mindedness	40.8 ± 5.15	41.8 ± 5.05	<i>t</i> (1015) = -2.82, <i>p</i> = .005
Analyticity	40.2 ± 4.82	41.1 ± 5.07	<i>t</i> (1015) = -2.32, <i>p</i> = .021
Systematicity	36.2 ± 6.69	35.6 ± 7.35	<i>t</i> (1015) = 1.12, <i>p</i> = .262
Self-confidence	36.5 ± 4.73	36.3 ± 4.90	<i>t</i> (1015) = 0.45, <i>p</i> = .652
Inquisitiveness	40.2 ± 4.68	41.6 ± 4.47	<i>t</i> (1015) = -4.09, <i>p</i> < .001
Cognitive maturity	40.2 ± 4.75	41.1 ± 4.87	<i>t</i> (1015) = -2.61, <i>p</i> = .009
CTDS Total	275.7 ± 26.3	281.0 ± 27.2	<i>t</i> (1015) = -2.66, <i>p</i> = .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 <i>n</i> = 418	Year 2 <i>n</i> = 205	Year 3 <i>n</i> = 229	Year 4 <i>n</i> = 116	Year 5 <i>n</i> = 49	
Truth-seeking	43.1 ± 5.19	43.4 ± 4.87	42.7 ± 4.71	42.8 ± 5.09	44.1 ± 4.26	<i>F</i> (4,1012) = 1.12, <i>p</i> = .343
Open-mindedness	41.4 ± 5.11	42.2 ± 4.81	41.2 ± 4.91	42 ± 5.96	42 ± 4.58	<i>F</i> (4,1012) = 1.45, <i>p</i> = .217
Analyticity	40.7 ± 4.8	41.3 ± 5.28	40.5 ± 4.79	41 ± 5.73	42.2 ± 4.85	<i>F</i> (4,1012) = 1.88, <i>p</i> = .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	<i>F</i> (4,1012) = 52.3, <i>p</i> < .001
Self-confidence	36.4 ^{a,b} ± 4.6	35.5 ^b ± 5.04	36.9 ^a ± 4.98	37.2 ^a ± 4.9	35.4 ^{a,b} ± 4.97	<i>F</i> (4,1012) = 3.86, <i>p</i> = .004
Inquisitiveness	41.1 ± 4.51	41.5 ± 4.63	41.1 ± 4.56	41.5 ± 4.79	42.1 ± 4.01	<i>F</i> (4,1012) = 1.03, <i>p</i> = .392
Cognitive maturity	40.6 ± 4.72	41 ± 5.02	40.7 ± 4.89	41.5 ± 5.02	42.2 ± 4.54	<i>F</i> (4,1012) = 1.82, <i>p</i> = .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	<i>F</i> (4,1012) = 4.95, <i>p</i> = .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 <i>n</i> = 448	Social sciences <i>n</i> = 489	STEM <i>n</i> = 80	
Truth-seeking	43.3 ^a ± 4.67	43.2 ^a ± 5.20	41.2 ^b ± 4.79	<i>F</i> (2,1014) = 6.21, <i>p</i> = .002
Open-mindedness	42.2 ^a ± 5.00	41.4 ^a ± 5.14	39.7 ^b ± 4.80	<i>F</i> (2,1014) = 8.95, <i>p</i> < .001
Analyticity	41.4 ^a ± 4.69	40.7 ^{a,b} ± 5.29	39.3 ^b ± 4.78	<i>F</i> (2,1014) = 6.31, <i>p</i> = .002
Systematicity	40.4 ^a ± 5.00	30.8 ^b ± 6.03	39.3 ^a ± 3.52	<i>F</i> (2,1014) = 387.8, <i>p</i> < .001
Self-confidence	36.8 ^a ± 4.89	36.3 ^{a,b} ± 4.72	34.9 ^b ± 5.31	<i>F</i> (2,1014) = 5.01, <i>p</i> = .007
Inquisitiveness	41.6 ^a ± 4.34	41.3 ^a ± 4.76	39.5 ^b ± 4.09	<i>F</i> (2,1014) = 7.08, <i>p</i> = .001
Cognitive maturity	41.3 ^a ± 4.63	40.8 ^a ± 5.11	39.2 ^b ± 4.03	<i>F</i> (2,1014) = 6.88, <i>p</i> = .001
CTDS Total	286.8 ^a ± 26.1	274.5 ^b ± 27.4	273.1 ^b ± 20.5	<i>F</i> (2,1014) = 28.4, <i>p</i> < .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.

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