

## Unpacking Critical Thinking Skills in Moroccan Students

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Although a considerable body of research has been conducted on Critical Thinking (CT) globally, research on its development and measurement within the Moroccan educational context remains relatively limited. This study examined the CT proficiency of preparatory school students and examined the role of gender on their overall CT performance and across the three variables of the study: Analysis, Evaluation and Extension of Arguments. This study employed a quantitative research-design using the CAAP CT-test. 150 second-year preparatory school students participated in this study. Descriptive statistics, the independent sample t-test, ANOVA, MANOVA, Partial Eta Squared effect size, and Item Response Theory (IRT), were performed to analyse data. The findings revealed that students scored a general average to above the average level of CT, with the highest aptitude in the Analysis of Arguments. The analysis revealed no significant gender differences in students' overall CT aptitudes or in any of the variables examined. These findings carry important implications for both educational policy and instructional practice. Instructional reform is needed to support the development of students' CT by integrating learner-centered teaching practices and technology-based instruction. Future research should examine other variables that may affect students' CT-aptitudes and develop and validate assessment tools that are relevant to educational and cultural aspects of Arab students.

Keywords: critical thinking, gender differences, analysis of arguments, evaluation of arguments, extension of arguments

### INTRODUCTION

Critical thinking (CT) is recognized as a vital skill for students to cope with the requirements of the 21<sup>st</sup> century job-market (Lu, 2024). Many researchers have investigated the role of CT skills in preparing students to excel in the academic and professional domains (Lu & Xie, 2024; Meza et al., 2024). This need is fueled by an evolving learning environment in which technological advancement and global challenges require employees to demonstrate high CT abilities (Chen et al., 2024). These skills are among essential skills employers seek in potential employees, as stated by the National Association of Colleges and Employers (NACE, 2017). These skills enhance both individual success and overall organizational effectiveness, emphasizing the growing importance of transferable skills that can be used in different settings (Roosyanti & Suryarini, 2024). Consequently, these skills are key components of soft skills (Pavlenko et al., 2024) that can enhance efficiency and innovation across sectors such as education, health, and medicine (Mızrak & Çaylan, 2024).

The national agenda to integrate HOTS into Moroccan educational was guided by the “Vision Stratégique” (Strategic Vision) 2015-2030. Previous studies have highlighted numerous challenges in implementing these reforms effectively (khalil & Hellalet, 2024). Evidential research reports from major global educational evaluations have continuously cited the limited rate of reform in these areas;

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notably, from evaluations conducted by the Program for International Student Assessment (PISA), it was claimed that Moroccan learners consistently ranked lowest in complex inference and abstract problem-solving skills compared to other areas like memorizing basic knowledge (Organisation for Economic Co-operation and Development (OECD), (2019). The HOTS cited as needing major reform such as systemic pedagogic changes in learning systems due to deeply entrenched teaching methods which have always leaned towards the constructivist learning requirements to favor HOT processes in Moroccan educational systems despite official reform policy changes.

The evaluation and development of CT abilities have been the focus of contemporary educational frameworks, especially as global educational agendas increasingly focus on developing higher-order cognitive skills (Lu, 2024). In the Moroccan context, the integration and assessment of CT in education, in general, remains unexplored despite its recognized importance in preparing students for academic and professional success (Khalil & Hellalet, 2024). The nature of the courses in preparatory classes necessitates equipping students with Higher-Order Thinking Skills (HOTS) necessary for their advanced academic studies (Belghiti et al., 2017; Chana, 2022). Although Moroccan educational reforms have prioritized quality improvement and competency-based approaches, studies evaluating and measuring students' CT aptitudes in this context are scarce, and there is limited empirical research on this topic that can guide policy and practice effectively and accordingly.

The significance of this study stems from its promise to address this vital gap by examining and quantifying students' CT aptitudes in the Moroccan preparatory school context. Assessing these aptitudes is vital not only to diagnose students' CT skills but also to provide educators and policymakers with actionable feedback to enhance teaching strategies and educational interventions. Furthermore, this study contributes to the broader literature on CT by situating its findings within the unique sociocultural and educational context of Morocco, offering insights into how CT can be fostered in similar contexts. In doing so, it seeks to align Moroccan preparatory education with international standards, guaranteeing that students are well prepared to excel in their academic endeavors and meet the needs of the modern workforce. Therefore, the primary objective of this study was to evaluate the CT proficiency of preparatory school students and explore the role of gender on their overall CT performance and across the three variables of the study: Analysis of Arguments, Evaluation of Arguments, and Extending Arguments. The CAAP CT test was used as an assessment measure in this study. Therefore, the next two research questions were formulated:

1. How do preparatory school students perform in terms of critical thinking proficiency?
2. To what extent do gender differences influence the overall critical thinking aptitudes of preparatory school students and their performance in Analysis of Arguments, Evaluation of Arguments, and Extending Arguments?

Thus, the following hypothesis was formulated:

**H0:** Gender does not significantly influence the overall critical thinking aptitudes of preparatory school students and their performance in Analysis of Arguments, Evaluation of Arguments, and Extending Arguments.

### **Conceptualizing Critical Thinking: Definition and Significance**

Dewey (1933) was among the first scholars who define CT based on the notion of "reflective thinking" (p. 9), as a higher-order cognitive skill in which individuals synthesize, analyze, evaluate, and create information in a sound and coherent manner, which is crucial for academic success and real-world application (Nanda et al., 2023). Facione (1990) defines the term as "a purposeful and self-regulated cognitive process that includes interpretation, analysis, evaluation, and inference" (P. 3), which encompasses offering explanations grounded in evidence, concepts, criteria, contextual factors and methodologies that substantiate the judgment being formed (p. 3). Therefore, CT is characterized as a reflective process applied to decision-making and problem-solving. In this context, Paul and

Elder (2006) also define CT as "the art of thinking about thinking while thinking in order to make thinking better: more clear, more accurate, more defensible" (p. 1). These metacognitive features refer to the dimensions of CT, which are self-regulatory aspects in which the processes of an individual's thought are subjected to continuous monitoring and refinement towards the attainment of more valid and reliable outcomes (Pereles et al., 2024).

In this investigation, CT is defined as the effective application of cognitive abilities to accurately evaluate, analyze, and synthesize data, arguments, or claims in order to develop well-reasoned decisions and conclusions in a deliberate and self-regulatory manner. This involves identifying assumptions, assessing evidence, recognizing logical relationships, and drawing valid conclusions. In higher education, CT is assessed to ensure that students can apply these skills across disciplines, communicate their reasoning effectively, and make informed decisions that reflect intellectual rigor and ethical considerations in academic and real-world contexts (Nguyen & Tran, 2024; Hamjilani & Sulisworo, 2024). This assessment guarantees that students acquire not only the knowledge but also the CT skills needed for success in academic, professional, and social contexts (Kek, 2022). This reflects the focus of higher education on developing critical, reflective, and independent thinking.

Arguably, CT skills allow learners to engage in independent and reflective thinking (Ennis, 2011), which are essential for academic achievement. Within an academic endeavor, CT skills allow students to engage in self-regulatory learning, thereby developing a deep understanding of their disciplines, enabling them to shift from traditional learning to analytical evaluation of information (Khalil et al., 2025). In this respect, Abrami et al. (2015) affirm that learners who gain high levels of CT are better equipped to manage academic problems and score higher marks on standardized tests. It enables students to immerse themselves in evaluating content, assessing its validity, and articulating reasoned perspectives (Halpern, 2014). In the contemporary world, where access to knowledge is extensive, the ability to question the credibility and acceptability of the given information is essential (Nakas, 2023).

The modern labor market is becoming increasingly complex due to globalization, demographic changes, and technological evolution, which significantly impact the professional development and adaptability required by employees in this dynamic environment (Jaffrezo, 2023). According to the World Economic Forum (2024), CT is one of the top five skills recommended in the global job market because it is considered an important aspect of decision and problem-solving. Similarly, Mihail (2022) supports this view, claiming that CT is considered a top skill highly appreciated by the business world and organizations. In business, experts argue that CT enables professionals to think deeply about the information presented to them, interpret the information from multiple angles, and make decisions that are beneficial to the organization (Imjai et al., 2025). Recent studies have stated that CT is essential for reducing decision-making errors and making better judgements in intricate situations (Vincent-Lancrin, 2024; Le, 2024). Therefore, there is an increasing need for employees to combine creative and CT skills to promote competitiveness and innovation across domains.

### **Critical Thinking Evaluation**

21st-century skills emphasize educational quality (Sulam et al., 2024). Educational institutions are expanding the integration of CT skills into their curricula to improve educational quality (Todorova, 2024; Alali, 2024). In this competitive era, attention has shifted towards HOTS such as CT, with increasing research dedicated to developing reliable methods for assessing these skills (Ridwan et al., 2022). Most studies in this area have focused on general CT skills rather than those specific to individual disciplines. However, findings indicate that students' CT abilities are often categorized as "poor" (Verawati et al., 2024; Cacik & Widiyanti, 2024), necessitating the need to assess CT in higher education. In this regard, Ennis (2015) highlights the importance of CT assessment in diagnosing students' abilities, providing constructive feedback, motivating students to improve, and enabling

educators to evaluate the impact of their teaching strategies and interventions on student outcomes (Todorova, 2024; Alali, 2024).

Assessing CT skills is a significant issue in research and educational environments, as it is increasingly recognized as a vital skill for success in the 21st century (Dwyer, 2023). Various frameworks and methodologies have been developed to evaluate CT, highlighting its importance and challenges associated with its assessment. Modern research emphasizes the employment of strong and relevant methods for measuring the cognitive skills of CT. Facione et al. (2020) pointed out that CT measures should encompass the ability to interpret information, evaluate evidence, and reach informed conclusions because such abilities are crucial in solving complex problems in different fields. Traditional tests, usually reliant on memorization or shallow knowledge, are increasingly criticized for not comprehensively considering the multidimensional nature of CT (Hamjilani & Sulisworo, 2024). Consequently, researchers opt for standardized tools, such as the Watson-Glaser Critical Thinking Appraisal, CAAP CT test, and California Critical Thinking Skills Test, to provide more comprehensive evaluations of students' cognitive abilities.

Research concerning gender and CT supports the hypothesis that there are no gender differences in the development of CT skills. In this regard, a study revealed the absence of substantive differences between the metacognitive and critical thinking abilities of male and females (Gula et al., 2024). Likewise, another study indicated that the performance of the participants in CT was neither predicted nor correlated with the participants' gender (Marni et al., 2021). Regarding this point, another study revealed the similarity of the performance in CT of undergraduate males and females in CT aspects of analysis and evaluation (Liu & Pásztor, 2023). However, a Spanish study revealed differences concerning the use of CT in written expressions of male and female students (Albarracín-Vivo et al., 2024). This inconsistency suggests that while gender may shape particular elements of CT, it is neither a consistent nor a determining factor. Rather, it is educational practices-such as collaborative learning, metacognitive scaffolding, and inquiry-based instruction-which appear to support CT development across genders (Marmani, 2021).

### **The CAAP Critical Thinking Test**

To assess the development of learners' CT skills and evaluate teaching interventions designed to foster these abilities, researchers frequently utilize validated commercially available assessment tools (Amuda et al., 2024). Studies have shown that these tools are effective in measuring higher-order cognitive skills including CT. Liu et al. (2023) found that standardized CT assessments are highly reliable in identifying students' abilities to analyze arguments and evaluate evidence, which are key components of CT. This study adopted the CAAP CT Test as a standardized measure of CT skills that aids post-secondary institutions in assessing, evaluating, and improving learners' learning performance and educational program outcomes. It serves as a standardized evaluative instrument aimed at assessing students' abilities to analyze, evaluate, and extend arguments to formulate reasoned conclusions (American Collegiate Testing (ACT), 2008). The test acts as both a diagnostic instrument and measure of educational output for the continuous improvement of teaching and learning (Liu et al., 2023). It presented test-takers with multiple-choice questions in the form of scenarios, where they were asked to infer information from the passages, determine assumptions, evaluate evidence, and determine the logical consistency of the conclusions. The theoretical framework of this study not only facilitates the assessment of CT skills, but also aligns closely with the objective of developing evidence-based insights into cognitive skill development in educational contexts.

### **Conceptual Framework**

RED Critical Thinking Model theory and Bloom's taxonomy align with the CAAP CT Test. All of these underlines the theoretical framework of the current study. Together, they guide the analysis and interpretation of students' CT skills. The RED model, developed by Pearson TalentLens, endorses a

methodical approach that guides the assessment of students' CT skills. It serves as a structured framework designed to enhance cognitive learning skills by dividing the CT process into three key components. First, *Recognizing assumptions* involves identifying and questioning underlying assumptions to uncover information gaps and address illogical reasoning (Pearson, 2017). Second, *Evaluating arguments* entails critically analyzing materials, assessing the credibility of evidence, and understanding the influence of emotions on the topic (Pearson, 2017). Finally, *Drawing conclusions*, which focuses on synthesizing diverse data and making well-reasoned decisions based on logical interpretations of the evidence. As Wulandari and Hindrayani (2021) highlight, the RED model incorporates essential questions within each category to foster and refine CT skills. Breaking down CT into these interrelated components provides a useful foundation for exploring cognitive processes in problem-solving and decision-making.

The revised Bloom's taxonomy is among the educational paradigms that emphasize the significance of CT as a cornerstone of 21<sup>st</sup> century skills. The instructional methods outlined in such paradigms require the acquisition of HOTS such as analysis, evaluation, and creation (Anderson & Krathwohl, 2001). Constructivist theory emphasizes the importance of student participation in learning experiences that promote knowledge creation and enhance cognitive processes (Cobb, 1994). Scholars (e.g., Boddy et al., 2003; de Bono, 1976) have focused on fostering learners' cognitive abilities and distinguishing between lower- and higher-order thinking. The latter involves skills, such as analysis, evaluation, synthesis, reasoning, and creativity (Resnick, 1987; Bloom et al., 1956; Wilks, 1995). These skills are developed through activities such as questioning, CT, and systematic problem solving (Dillon, 2002; Zohar & Dori, 2003).

The relationship between Bloom's taxonomy and the use of the CAAP CT test lies in their shared focus on higher order cognitive skills. Bloom's taxonomy provides a hierarchical framework for understanding CT, progressing from foundational skills such as remembering and understanding higher-order processes such as analyzing, evaluating, and creating. The CAAP CT test operationalizes this framework by specifically targeting skills aligned with the higher levels of taxonomy, particularly analysis of arguments, evaluation of arguments, and extending arguments. Through its emphasis on analyzing arguments, identifying logical inconsistencies, and evaluating the validity of evidence, the CAAP test reflects the taxonomy's focus on the advanced cognitive abilities necessary for CT. Additionally, the CAAP CT test implicitly incorporates foundational skills from Bloom's framework, such as understanding and application, because students must comprehend the presented information and apply it in the context of reasoning and problem-solving. This interconnection underscores the relevance of Bloom's taxonomy as a theoretical framework for framing and interpreting the cognitive processes assessed by the CAAP test. Therefore, this study situates assessment within a broader theoretical context, enabling a deeper exploration of how specific CT skills are measured and developed in an educational setting.

To provide a link between the basic cognitive theories and our research methodology, we introduce a conceptual framework (Figure 1). This comprehensive framework conceptually represents three different parts of the whole. First, there is Bloom's Revised Taxonomy, which develops the cognitive structure and specifies what intellectual levels of processing and performance are to be achieved. Next, the cognitive skills can be applied and supported using the RED Model, which represents the orderly and systematic step-by-step performance measures of CT skills in accordance with the CAAP CT test. From a methodological perspective, this conceptual framework was directly responsible for designing and determining the structure and parameters of differential analysis in our research design. Significantly, and essential to validating research findings, this conceptual framework represents and serves as the authoritative determinant with all ultimate interpretations regarding findings.

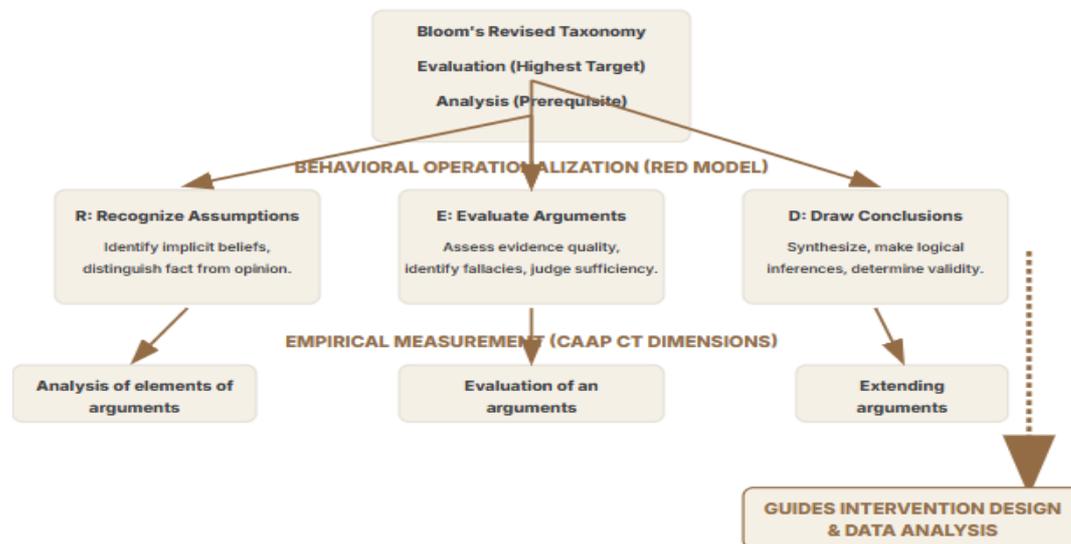


Figure 1  
Conceptual Framework

## METHOD

### Research Design

The present study employed a quantitative research design using the CAAP CT test to examine the CT proficiency and the role of gender on CT performance among preparatory school students. This quantitative approach helps gain a deeper understanding of the social world by systematically collecting numerical data and applying statistical analyses (Johnson, 2014). In this study, test scores were used as a quantitative measure to assess students' CT skills and to identify any gender-related differences. They also provided a meaningful estimate of the associations between the variables under investigation, serving as the primary data collection instrument for this study.

Relying on the principles of post-positivism, the researchers' role in this study was limited to collecting and objectively interpreting data, adhering to the principle that reality exists independently and can be observed consistently by unbiased observers (Shaw & Satalkar, 2018). Efforts have been made to minimize personal bias and maintain objectivity throughout the research process. The researcher functions as an impartial analyst, detached from influencing participants or collecting data (Scott, 2003; Shaw & Satalkar, 2018). This commitment to objectivity ensures that the study's findings are based solely on the data collected and free from subjective interference.

### Sample

The sample for this study consisted of 150 students enrolled in second-year preparatory classes, as illustrated in Table 1. They were selected using random stratified sampling. Of this sample, 45% were male and 55% were female. Most of them (94%) fell within the 19–20 age category, whereas 6% were in the 21–22 age range. Regarding their years of learning English, 53% of the students had been learning English for four to five years, 33% for six to seven years, and 14% for more than seven years. The sample included students from diverse socio-economic backgrounds and geographical areas, covering both urban and rural regions in Morocco.

Table 1  
Participants' Demographic Background

Gender	Age		Years of learning English			
	Frequency	Percent	Age category	Percent	Years	Percent
Male	68	45%	19-20	94%	4-5	53%
Female	82	55%	21-23	6%	6-7	33%
Total	150	100%	Total	100%	+7	14%

Prior to data collection, it was necessary to obtain written informed consent from institutional representatives in accordance with the ethical guidelines (Johnson, 2014; Sileyew, 2019; Mertler, 2021). In addition, all participants were provided with an informed consent form prior to the study, outlining its purpose and ensuring their voluntary participation, emphasizing that participation was entirely voluntary and included assurances regarding the confidentiality of their responses. They were assured that their answers would be utilized exclusively for research purposes and would not be directed toward any other purpose. Additionally, their right to withdraw from the study at any time without any concerns was explicitly communicated and emphasized. The results were reported only in terms of the CT skills assessed by the test, with no focus on individual student performance. This ensured that the confidentiality and anonymity of participants were maintained throughout the research process.

### Instrument

This study adopted the CAAP CT test as a core research instrument to measure preparatory class students' CT aptitudes in relation to the variables of the study. The CAAP CT test is a standardized test designed to evaluate CT skills of collegiate students (ACT, 2008). It was developed using the ACT Program in 2008. It is composed of 32 items with 40 min allotted (ACT, 2008). It was developed to assess HOTS and reasoning skills, including CT (analysis of arguments, evaluation of arguments, and extending arguments). The test has four consecutive reading passages based on everyday problems, followed by multiple-choice questions with four options (ACT, 2008). The structure of the questions requires students to employ their CT skills to analyze, evaluate, and develop conclusions (ACT, 2008). The question type represents multiple aspects of CT. Table 2 illustrates in detail the test specifications. The CAAP Critical Thinking Test was administered in person in one of the students' regular sessions. Students were given ninety minutes to complete the test under supervision while adhering to the explicit instructions given at the beginning.

Table 2  
CAAP Critical Thinking Test Item Specifications

Indicators	Test number (item)	Total of the test items
Analysis of elements of arguments	2/3/4/7/8/9/10/11/13/14/17 / 19/20/21/25/26/29/31	18
Evaluation of an arguments	6/12/16/18/23/24/27/28/32	9
Extending arguments	1/5/15/22/30	5
Total		32

### Data Analysis

To analyze the data obtained from the test, the scores of the participating students were compared to a relevant normative test framework. The analysis in this study employed both descriptive and inferential statistics to examine the participants' CT aptitudes regarding their gender and the CT aspects of the test (analyzing arguments, evaluating arguments, and extending arguments). In this regard, descriptive statistical analyses were considered to address the first research question, while inferential statistical analyses, the independent sample t-test, ANOVA, MANOVA, Partial Eta Squared

effect size, and Item Response Theory (IRT) were performed to address the second research question. The significance level was set at  $P < 0.05$  to determine statistical significance. Data analysis was performed using IBM SPSS Software V.27.

The test results were analyzed using IRT, a mathematical model that explains the relationship between latent traits (unobservable attributes) and observed outcomes or performance (Zhu et al., 2025). This model links the qualities of the test items, individuals' responses, and the underlying construct being measured (Zhu et al., 2025). In this context, each test response offers insight into an individual's level of CT aptitude, which is considered a latent trait (Zhu et al., 2025). Therefore, the study is grounded in a post-positivist philosophical framework that emphasizes an objective ontological reality and relies on fact-based information obtained through empirical observation and measurement (Tripathi et al., 2024). By analyzing the CAAP CT test results, this study objectively evaluated the CT skills of students in preparatory classes without incorporating any intervention.

## FINDINGS

### Students' Critical Thinking Proficiency

Examining preparatory class students' CT proficiency as measured by the CAAP CT test was the focus of the first research question in this study. Accordingly, the descriptive statistics in Table 3 summarize the findings. They indicated that preparatory class students scored positively on average to above average on the CAAP CT test, showing a moderate overall performance of CT aptitudes ( $M=64$ ). Notably, the median was 66.00, with a standard deviation of 5.20, reflecting the degree of variation in students' scores. The minimum observed score was 48.00, whereas the maximum score was 72.50. These results indicate a moderate level of CT aptitude within the sample investigated, as measured using the CAAP CT test.

Students were placed at their appropriate CT level based on their scores obtained in the CAAP CT test. The findings of their overall CT aptitudes are shown in Table 3. The results indicated that the participating students demonstrated a moderate level of CT (64%). More specifically, 20% of the students fell into the category of having "High Critical Thinking," scoring between 68 and 80, and 27% of the sample demonstrated "Above Average Critical Thinking" (scores between 65 and 67). Besides, 37% of the students demonstrate "Average Critical Thinking," with scores ranging from 61 to 64. Conversely, 16% of students exhibited "Low Critical Thinking" (scores between 40 and 60). These findings suggest that most students (64%) exhibited an average or above-average CT level. In relation to the investigated variables of the study, as illustrated in Table 6, students had the highest mean value in Analysis of Arguments ( $M=65.5$ ) and scored the same mean value in Evaluating Arguments and Analyzing Arguments ( $M=64.00$ ), indicating students' average to above-average performance across all the test subscales of the CAAP CT test (Analyzing Arguments, Evaluating Arguments and Extending Arguments).

Table 3

Students' Level of Critical Thinking

No	Range of Scores	Category of Measurement	N	%				
1	68 - 80	High Critical Thinking	30	20%				
2	65 - 67	Above Average Critical Thinking	40	27%				
3	61 - 64	Average Critical Thinking	55	37%				
4	40 - 60	Low Critical Thinking	25	16%				
Students' aptitudes	overall CT		N	Mean	Median	Std. Deviation	Min	Max
			150	64.50	66.00	5.20	48.00	72.50

### The Role of Gender on Students' CT Aptitudes

The second research question in this research seeks to determine whether there is a significant difference in the overall CT aptitudes of male and female students, as well as whether gender-based differences exist in their performance across specific CT skills: analyzing arguments, evaluating arguments, and extending arguments. To address the first aspect of this question, an independent samples *t*-test was conducted, the results of which are presented in Table 4. The findings of the *t*-test indicated no statistically significant difference in the students' overall CT aptitudes between males and females ( $t(148) = -1.13, p = 0.261$ ).

Table 4  
The Results of the Independent Samples T-Test

Gender	N	Mean	Std. Deviation	t-Value	df	p-Value
Male	68	64.00	5.00			
Female	82	65.00	5.40	-1.13	148	0.261

Although the independent samples *t*-test indicated no statistically significant differences in students' overall CT aptitudes between males and females (Table 4), a Multivariate Analysis of Variance (MANOVA) was performed to further examine whether gender had a significant multivariate effect on the three variables of the study (Analysis of Arguments, Evaluation of Arguments, and Extending Arguments) simultaneously. Overall, the MANOVA analysis, as shown in Table 5, indicates that there were no statistically significant differences between males and females (Wilks' Lambda = 0.985,  $F(3, 146) = 1.23, p = 0.302$ ), suggesting that gender did not have a significant multivariate effect on Analysis of Arguments, Evaluation of Arguments, and Extending Arguments.

Table 5  
The Results of MANOVA Test

Effect	Wilks' Lambda	F-Value	df1	df2	p-Value
Gender	0.985	1.23	3	146	0.302

While the MANOVA findings (Table 5) indicated that gender did not have a statistically significant multivariate effect on the three variables, it is still relevant to follow up the univariate effects for each variable of the study. To this end, a subsequent Analysis of Variance (ANOVA) was conducted for each dependent variable (Analysis of Arguments, Evaluation of Arguments, and Extending Arguments) to determine whether gender influenced any of these CT dimensions. In this regard, the ANOVA test was performed, and the results of the analysis, as shown in Table 6, indicate that gender was not a statistically significant factor in the Analysis of Arguments,  $F(1, 148) = 1.15, p = 0.285$ , Evaluation of Arguments,  $F(1, 148) = 2.48, p = 0.117$ , and Extending Arguments,  $F(1, 148) = 0.89, p = 0.347$ .

Table 6  
The Results of the ANOVA Test

Variable	Mean		F-Value	p-Value
	Female	Male		
Analysis of Arguments	66.00	65.00	1.15	0.285
Evaluation of Arguments	65.00	63.00	2.48	0.117
Extending Arguments	64.00	64.00	0.89	0.347

The effect size was estimated using partial eta squared ( $\eta^2$ ) to determine the practical significance of gender differences across the three variables. As illustrated in Table 7, the effect sizes for the Analysis of Arguments ( $\eta^2 = 0.0077$ ), Evaluation of Arguments ( $\eta^2 = 0.0165$ ), and Extending Arguments ( $\eta^2 = 0.0060$ ) were all classified as small according to Cohen's guidelines (1988). This supports the fact

that, although minor differences were found, they were not large enough to be considered practically significant.

Table 7  
Effect Size (Partial Eta Squared  $\eta^2$ ) Results

Variable	F-Value	Partial Eta Squared ( $\eta^2$ )
Analysis of Arguments	1.15	0.0077
Evaluation of Arguments	2.48	0.0165
Extending Arguments	0.89	0.0060

While previous statistical analyses provide insights into students' overall CT aptitudes and their gender-based differences, they do not account for the difficulty and discrimination parameters of individual test items. To further analyze the performance of students at the item level, Item Response Theory (IRT) analysis was performed to understand how higher- and lower-performing test-takers respond to specific items on the CAAP CT test. The results of this test in Table 8 indicated that the CAAP CT test items exhibited good discrimination ( $\alpha = 0.85$ ) and moderate difficulty ( $\beta = -0.30$ ). The overall reliability of the test was high ( $\alpha = 0.91$ ), indicating strong internal consistency. In this respect, the IRT analysis confirms that the obtained results are due to true student performance differences and are not unlikely to be the result of measurement bias, further confirming the findings of the inferential statistical results obtained in this study.

Table 8  
Item Response Theory (IRT) Analysis Results

Parameter	Value
Discrimination ( $\alpha$ )	0.85
Difficulty ( $\beta$ )	-0.30
Test Reliability	0.91

## DISCUSSION

The findings of this study indicated that the participating preparatory class students demonstrated a general average to above the average level of CT (64%). The analysis highlighted three key aspects that students performed significantly on the CAAP CT test: Analysis of Arguments, Evaluation of Arguments, and Extending Arguments. The examination proved that the highest aptitude was in Analysis of Arguments and revealed parallel aptitudes in Evaluation and Extension of Arguments. These findings suggest that the students exhibited the ability to think critically, similar to previous studies, such as Intan et al. (2024), Abidin and Sulaiman (2024), As'ari and Suaidi (2023), Hardianti et al. (2023). In the Indonesian context, Hardianti et al. (2023) reported that students had a moderate level of CT skills, as assessed according to the attributes described by Facione and Facione (2013). Consistent findings were reported in an investigation conducted by Intan et al. (2024). Their findings highlighted a moderate level of CT abilities through interpretation, analysis, evaluation, inference, explanation, and self-regulation. In another study, Abidin and Sulaiman (2024) argued that students exhibited the ability to think critically by identifying, analyzing, and solving problems; thinking logically; making appropriate decisions; and drawing careful conclusions, as manifested through the implementation of problem-based learning. These findings are also in harmony with As'ari and Suaidi (2023) examination of students' CT skills. They contended that students demonstrated the ability to think critically by developing arguments, supporting details, and analyzing problems.

The researchers attributed these results to instructional approaches that promote CT, particularly within preparatory classes, where the students in this study were enrolled. Exposure to diverse educational experiences that cultivate CT skills may have contributed to these findings (Afrilyasanti et al., 2025). According to Chana (2022), teachers in preparatory schools employ various techniques and methods to enhance students' learning approaches, which in turn positively influences their CT skills.

Similarly, problem-based learning activities enhance students' development of CT skills (Khalil et al., 2025; Rokhmanet al., 2025). Regarding students' high performance in the analysis of arguments ( $M=65.5$ ), they effectively distinguished between strong and weak arguments in the test, demonstrating their ability to make critical judgments. Specifically, they were able to identify strong arguments that are both necessary and directly relevant to a given situation while recognizing weak arguments as those that are irrelevant, of minor importance, or that misinterpret correlation as causation. Furthermore, students' capacity to objectively analyze information, prioritize evidence-based reasoning, and minimize emotional biases in their evaluations aligns with the essential components of the CT process (Chen et al., 2024; Redaelli et al., 2024; Verawati et al., 2024) in relation to the RED model of CT, as discussed previously.

The students' differential performance is highly consistent with established cognitive theories, which posits that foundational analytical skills must precede more advanced judgmental tasks. Because traditional academic settings routinely reinforce procedural comprehension and component identification, students naturally show greater proficiency in simple analysis. On the other hand, the Evaluation of Arguments calls for a sophisticated metacognitive judgment, requiring students to evaluate the arguments' quality, identify logical fallacies, and consider the veracity of implicit assumptions. Moreover, Extending Arguments is the ultimate form of CT, requiring innovative synthesis, inductive reasoning, and the deduction of new solutions from preexisting data. Furthermore, the students also showed the same level of proficiency in Evaluating and Extending arguments, reflecting their ability to determine the strength and validity of arguments and develop reasonable extensions or counterarguments. These results go hand in hand with the existing body of literature that emphasizes the significance of argument analysis and evaluation as essential elements of CT (Kerruish? 2025; Halpern, 2016; Jamil et al., 2024; Butt, 2010). The concurrent application in the Evaluation and Extension of Arguments demonstrates that students are not only able to critically evaluate well-established arguments but also to use logical reasoning to extend them in a coherent manner. Learners' competence to evaluate the soundness and strength of arguments aligns with the evaluation level of Bloom's taxonomy. At this level, students make critical judgments regarding the quality, logical coherence, and credibility of arguments based on accepted criteria (Anderson & Krathwohl, 2001). This indicates that students possess the ability to use logical reasoning and objective judgment, which reflects a high degree of cognitive processing (Ali, 2022; Saputro et al., 2020). On the other hand, students' ability to extend arguments reflects Bloom's taxonomy's top level of cognition and creation, whereby students create new ideas, develop new arguments, or synthesize information in a new manner (Anderson & Krathwohl, 2001). This includes having students integrate knowledge, applying logical reasoning, and developing cogent arguments outside the premises given, showing their ability to think critically and creatively in complicated scenarios (Le, 2024).

CT is a set of skills involving several cognitive levels, as proposed by Bloom's taxonomy (Yue, 2024) that can be taught and developed (Le, 2024; Xiang, 2024; Horálek & Distler, 2024), aligning with the guided inquiry and problem-solving pedagogical approaches in preparatory classes, where students are prepared with essential skills to analyze, infer, and interpret information (Irwanto et al., 2024; Horálek & Distler, 2024). This may explain the level of CT of preparatory class students who participated in the current study because they were being introduced to guided inquiry and problem-solving methods and techniques in their classes. However, the findings of this study contradict those of previous studies that assessed students' CT skills (Asrowi et al., 2025; Utomo et al., 2024; Dina et al., 2024). These studies have found that most students demonstrate low levels of CT aptitudes.

Regarding the second research question, the findings indicated no statistically significant differences between males and females overall CT aptitudes or in any of the specific variables (Analysis of Arguments, Evaluation of Arguments and Extension of Arguments) of the CAAP CT test, indicating that gender differences did not affect students' CT abilities. Gender roles have traditionally impacted

educational processes, affecting teachers' expectation from males and females. Studies have shown that females excel in languages, while males are keen towards learning math and sciences (Escolano-Pérez & Bestué, 2021). This imbalance impacted not only their performance but also their ability to learn CT skills. The importance of CT skills cannot be underestimated here; as it demands openness to questions and intellectual challenges. Lack of understanding and exploration in one gender definitely limits their ability to hone their CT skills. These findings confirm the null-hypothesis and are consistent with previous research, such as that of Salahshoor and Rafiee (2016), Raslan and Forawi (2024) and Alhowail and Albaqami (2024). In the Iranian context, Salahshoor and Rafiee (2016) claimed that there are no gender differences in students' CT skills. Similarly, Alhowail and Albaqami (2024) concluded that there are no gender differences in the overall CT ability among students, indicating that gender is not a factor in the CT skills of students in Saudi Arabia. In the United Arab Emirates, Raslan and Forawi (2024) concluded that gender differences had no significant effect on students' CT performance or in certain CT test subscales, such as inference, argument, and deduction, between males and females. These studies further support the conclusion that male and female students exhibit comparable CT abilities.

The absence of significant gender differences in the present study confirms the role of current pedagogical practices, such as active learning approaches (Bhuttah et al., 2024), inquiry-based instructional practices (Araújo et al., 2024. Grecu, 2022), and problem-solving activities (Manurung and Pappachan, 2025), in bridging possible gender gaps in students' CT skills. Moroccan educational practices, which are based on competency-based learning, give males and females equal opportunities to engage in inquiry-based and problem-solving activities. This could lessen the traditional gender disparities observed in various contexts by encouraging all students to question, assess, and defend their beliefs. Previous studies have emphasized that CT is an acquired skill, not a genetic factor, and that if both females and males are given equal training, pedagogical instruction, and experience in analytical tasks, their performance is comparable (Batdı et al., 2024; Proca, 2024; Darmaji et al., 2024). Moreover, these findings challenge previous studies that have suggested gender-based variations in students' CT skills, such as Darmaji et al. (2024), Setiawan et al. (2024), Aulia and Sutarni (2024), and Liu and Pásztor (2023). Darmaji et al. (2024) argued that there were gender differences in the CT abilities of high school students, claiming that gender significantly affects the overall CT ability of physics students. Similarly, other studies, such as those by Setiawan et al. (2024) and Aulia and Sutarni (2024), found significant gender differences in the students' ability to think critically, where female students had higher scores than male students, indicating that gender affects students' ability to think critically. Similarly, Liu and Pásztor's (2023) study attested to significant gender differences in the CT ability of university students, concluding that gender affects students' CT ability and necessitating the consideration of gender in pedagogical approaches to foster CT development. This substantiates the hypothesis that CT is a universal skill to be learned irrespective of cognitive gender differences. Furthermore, equal instructional approaches will enable all students, irrespective of gender, to attain high CT skills.

This study examined the role of gender on students' CT skills; however, other demographic variables such as specialization, academic achievement, socioeconomic status, educational level, English language proficiency, and educational background can offer valuable insights into this interplay, particularly in the Moroccan context. Socioeconomic status influences both the availability of educational resources and the quality of the learning context, which has an indirect or direct effect on the development of students' CT abilities (Lin, 2023). Specialized education improves students' CT by promoting analytical skills in specific disciplines (Pavlenko et al., 2024). In addition, there is a relationship between higher academic performance and better CT abilities, as indicated by research where upper classmen performed better than lower classmen (Burriss & Garton, 2006). More importantly, higher levels of education tend to affect students' CT skills, as they read complex materials from various perspectives (Park & Hoe, 2018). Moreover, educational experience, such as

previous exposure to CT training, has a significant effect on learners CT abilities (Park & Hoe, 2018). Therefore, future research should examine what determines students' CT skills by considering these variables to facilitate effective interventions in promoting CT skills. While these factors may collectively affect CT, it is essential to recognize that individual differences, such as personal motivation and anxiety levels, also play a critical role in shaping these abilities (Ningsih et al., 2024).

It is crucial to consider the development of CT measurement tools relevant to the Arabian cultural context. The widely known CT assessment tools are Western-based and do not reflect Arab students' culture. There is currently an overdependence on Western-based assessments that tap into context references to which Arab students are not exposed. Therefore, institutions and researchers must develop, validate, and implement culturally relevant CT assessment tools that reflect national and regional educational contexts. As this study highlighted, it was challenging to find a suitable CT measurement tool that reflected Moroccan students' academic and cultural contexts, echoing a call for more regional assessment tools worldwide. Furthermore, future meta-analytic studies must examine large representative samples from different cultures to determine global trends in CT development and discern contextually effective teaching practices.

## CONCLUSION AND SUGGESTIONS

The findings revealed that the participants had an average to above-average CT level in general, but there were no significant differences in the CAAP CT test subscales, specifically the Analysis of Arguments, Evaluation of Arguments and Extending Arguments between male and female students. These results have several implications for education. First, there is a need to create a learning environment that promotes HOTS in order to enhance students' CT abilities. Educators are central to this endeavor through the adoption of learner-centered teaching practices, such as collaborative learning, inquiry-based learning, and problem-solving pedagogies (Acharya et al., 2024). These practices play a crucial role in guiding students to think critically, make independent decisions, and achieve their academic potential. Second, preparatory schools should focus on highlighting the necessity of designing teaching tasks that nurture CT skills and develop a culture that prioritizes thinking critically throughout the curricula. In accordance with earlier research (Le, 2024; Yeni et al., 2023; Siddique et al., 2024), the integration of CT skills is greatly impacted by active student involvement, high academic expectations, and the careful adoption of relevant pedagogical approaches.

Furthermore, instructional reform is needed to support the development of students' CT, since developing these skills is a fundamental goal of modern education that prioritizes mixed teaching methods and real-world learning experiences, aiming to create innovative pedagogical techniques that enhance students' analytical thinking and problem-solving abilities (Chen, 2023; Akhvediani et al., 2023). Teachers should encourage student-centered learning. Instead of focusing on memorization of information, teachers should give learners the opportunity to question and learn from problem-solving activities. This can be achieved through class discussions, presentations, problem-solving, and class debates. The role of information technology can also be harnessed through online discussions and presentations that provide a platform for safe exchange of ideas and learning from each other through applications such as Google Classroom and Padlet. This use of instructional technologies, such as simulations, animations, and game-based learning environments, can also significantly improve students' analytical and evaluative reasoning abilities (Taliak et al., 2024).

Pedagogically, these results highlight the need for EMI classrooms to explicitly integrate CT skills into instructional practices. Activities such as analysis of arguments, evaluation of evidence, and constructing arguments could enhance students' ability to think critically, thereby improving their CT proficiency. Policymakers should ensure that preparatory-year programs include structured opportunities for students to develop CT skills, recognizing that these skills are critical for academic

success, particularly in second-language learning environments. Moreover, the central role of CT instructions suggests that EMI programs should incorporate reflective practices not only as a means of improving academic performance but also as a way of fostering lifelong learning habits. By encouraging students to take ownership of their learning, EMI programs can empower them to become autonomous thinkers capable of analyzing and evaluating knowledge critically.

Although the findings of this study are context-specific, they are a source of comparison to be used by other scholars in relation to the effect of cultural differences on improving CT abilities, thus enriching CT discussions. Similar to other studies, this study had inherent limitations that must be mentioned. First, the dependence on a single quantitative tool (CAAP CT test) without qualitative aspects limited the findings. Second, the lack of culturally adapted CT assessment tools represents a challenge in adequately measuring students' cognitive abilities in the Moroccan educational context. Third, this study did not address additional variables that could affect students' CT skills, such as specialization, educational level, English language proficiency, and educational background. As a result, future research could consider these variables to gain deeper insights into their impact on students' CT performance. Additionally, developing culturally relevant CT assessment tools would contribute significantly to advancing CT research in the Moroccan and broader Arab contexts. Despite these limitations, this study provides a foundation for further research and can assist in the development of culturally suitable evaluation instruments.

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