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Assessing critical thinking disposition through text analysis in traditional Chinese: An empirical study of tourism and gaming undergraduates in Macao

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Critical thinking disposition (CTD) is increasingly recognized as an important trait in education, reflecting the inclination and habits necessary for addressing complex challenges in today's world. This study assessed the CTD of students enrolled in a tourism and gaming management programme, focusing on two key dimensions: Analyticity and Open-Mindedness. This study was conducted at a university in Macao and involved 65 participants. The students were presented with an article relevant to their major, written in Traditional Chinese, and were asked to provide their opinions on each statement in the article. A rubric was designed to analyze their responses and assess their Analyticity and Open-Mindedness within the CTD framework. The results demonstrated high reliability (Cronbach's $\alpha = 0.91$) and revealed an association between Analyticity and Open-Mindedness. Using Python programming, the study analyzed the frequency of parts of speech (POS) in students' responses, introducing a novel approach for evaluating CTD in Traditional Chinese. Regression modeling showed that parallel and adversative conjunctions significantly predicted Analyticity, while the frequency of conjunction use varied across Open-Mindedness classifications. These findings highlighted an innovative and objective method for assessing CTD through text analysis, offering promising applications for educational research in Traditional Chinese-speaking contexts.

KEYWORDS

critical thinking disposition, text analysis, traditional Chinese, tourism and gaming education, educational assessment

1 Introduction

1.1 Research background

As a result of the increased legalization and expansion of gambling since the 1980s, there is always a need for professionally trained employees. To cope with this demand, many universities have been offering gaming-related degree programmes so that students can learn the fundamentals necessary for the tourism and gaming industry. Such programmes are often driven by the demands of the industry to ensure students leave their respective programmes with a skill-set that will enable them to be successful in the industry (Belhassen and Caton, 2011). While Tribe (2002) and others (Boluk et al., 2019; Dredge et al., 2012) consider this model of education too focused on employment and

business-oriented, scholars like [Facione \(1990\)](#) and [Dunne \(2015\)](#) have argued that higher education should be about developing critical thinking (CT) in life, leading to the ideal goal of developing higher-level thinking and enhancing preparedness for the industry.

Since employees in the tourism and gaming industry need to interact with patrons, they are expected to have certain attitudes, be willing to interact and have the capacity to assess information from diverse sources ([Byram, 2020](#); [Halpern, 2014](#)). Given that CT involves evaluating information sensibly to reach sound conclusions or finding alternative solutions to problems ([Halpern, 2016](#)), these employees need to have certain traits and attitude, i.e., the critical thinking disposition as indicated by [Stedman and Andenoro \(2007\)](#) and [Halpern \(2014\)](#), to use the skill-set effectively. Following this, encouraging the development of such traits and attitudes is essential to prepare the employees for improved interaction with patrons.

Macao, once an obscure Chinese fishing village, has been open to the outside world with the Portuguese settlement since the 1550s, thereby constituting its identity as a cultural crossroads between East and West ([Cheng, 1999](#)). With the creation of the Portuguese maritime trade routes, Macao had traded principally with the Portuguese and the Chinese races as a global entrepôt, thus creating its primarily bilingual, and multicultural environment as evidenced in its language ([Bhabha, 2012](#); [Cheng, 1999](#)). With the success of the British Hong Kong in entrepôt trade since the 1840s, Macao has resorted to licensed gambling to revive its economy. Given Macao's multicultural environment, the issue of understanding the CT disposition through analysis of the native language (Traditional Chinese), as a cultural representation to convey ideas and feelings, used by these tourism and gaming undergraduates has become particularly significant with the paucity of such research in Macao.

With China's support, Macao had already overtaken Las Vegas as the world's gaming capital in 2006 ([Branigan, 2011](#)). As a result of China's vision for Macao to be a 'world center of tourism and leisure' as stipulated in the Macao Tourism Industry Development Master Plan ([Macao Government Tourism Office, 2017](#), p. 10), these university students are expected not only to interact with patrons from diverse sources, but also extend their interactions from gaming parlors/halls to restaurants, hotels, shopping malls, or concert halls where patrons may enjoy their service in their stay. Such transformation has reiterated the importance of improved understanding and enhancement of such students' CT disposition in their interaction with more than 35 million patrons annually from an increased number of jurisdictions with diverse cultural backgrounds, considering Macao's role as a center of tourism and leisure.

Moreover, the emergence of such drastic transformations as technological advancements like artificial intelligence, and changes in government regulations, has enhanced the need for these university graduates to improve their CT in data analysis and evaluation ([Halpern, 2016](#)), leading to informed decisions ([Dwyer et al., 2014](#)) and enhanced innovation in the workplace ([Davies, 2006](#); [Snyder, 2003](#)).

Based on the above, assessing and understanding the CT disposition of students interested in the tourism and gaming industry has therefore become a crucial task for educators, serving as a foundational step to spearhead the development of their

CT. By analyzing such students' written essays in Traditional Chinese, this study is aimed to explore their CT disposition to help determine whether they can grasp the intricacies of different cultures and backgrounds. Such research conducted in Macao can offer important insights for jurisdictions using Traditional Chinese into the enhancement of CT in university students preparing for the challenges of the tourism and gaming industry.

1.2 Critical thinking: skills and disposition

Critical thinking (CT) is increasingly recognized as a significant skill for the challenges of the 21st century ([Trilling and Fadel, 2009](#)). It plays a key role in global competencies and is highlighted as a priority for education systems looking toward 2030 ([Howells, 2018](#)). It is difficult to provide a universal definition of CT due to its multifaceted nature. Despite this, some widely accepted descriptions of CT include reflective, reasoned thinking to evaluate beliefs or decisions ([Ennis, 2011](#)), and the ability to critically analyze information ([Lawson, 1999](#)). In education, CT is seen as a key goal, fostering skills like hypothesis generation, experimental design, and analysis ([Wiles and Bondi, 1989](#)). Regardless of the variety of perspectives, many agreed that CT is shaped by both cognitive skills (CTS), which represent the cognitive dimension of thinking and are closely related to explicit abilities and competencies ([Bravo et al., 2020](#); [Sosu, 2013](#)), and a critical thinking disposition (CTD), a type of consolidated intellectual habit ([Paul and Binker, 1990](#)) toward critical inquiry.

Both sub-dimensions, CTS and CTD, are recognized as critical components of the CT framework with research suggesting a strong connection between them. For instance, studies indicated that CTD, which reflects one's motivation and attitude toward developing CT skills, acts as the driving force that activates these skills ([Ennis, 2011](#); [Norris, 2003](#); [Perkins et al., 1993](#)). CT can only be effectively demonstrated when well-developed CTS are combined with CTD ([Álvarez-Huerta et al., 2023](#)). Despite the prevalence of research on CTS, the importance of CTD has been highlighted by empirical studies. For instance, while disposition and self-reflection were influential in predicting competence among students in Korea ([Pak, 2016](#)), cultivating CTD might enhance the emotional intelligence of undergraduates in USA ([Stedman and Andenoro, 2007](#)). Anyhow, empirical studies on CTD remain relatively limited ([Liu and Pásztor, 2022a](#)) when compared to CTS.

1.3 Components of critical thinking disposition

There are various approaches to identifying the components of CTD. For instance, [Sosu \(2013\)](#) proposed a model that categorizes CTD into two overarching components: critical openness and reflective skepticism, focusing on the reflective attitudes of students in higher education. [Bravo et al. \(2020\)](#) later refined this framework, merging the two dimensions into a single factor to create a more streamlined approach to evaluating CTD. Anyhow, the

most widely accepted framework, the California Critical Thinking Disposition Inventory (CCTDI) (Facione et al., 1994), has been established by merging the 19 domains originally outlined in the Delphi Report (Facione, 1990) into seven key attributes, including open-mindedness, systematicity, analyticity, inquisitiveness, truth-seeking, self-confidence, and maturity. Subsequently, studies have discussed the importance of these attributes in real-world scenarios. Cruz et al. (2021) indicated employers' emphasis on the "analyticity" disposition, which involves "... reasoning and the use of evidence to resolve problems, and consistently being alert to the need to intervene" (Facione et al., 1994, p. 4), and highlighted the need and ability to anticipate problems and assess situational contexts. Similarly, Bermingham (2015) noted that the "open-mindedness" disposition—defined as "being tolerant of divergent views with sensitivity to the possibility of one's own bias" (Facione et al., 1994, p. 4)—would foster self-reflection and enhance employees' performance. The CCTDI, along with the models developed from it (Yoon, 2004; Liu and Pásztor, 2022b), has been widely employed as the foundation for assessing CTD in studies in different jurisdictions like Norway (Wangensteen et al., 2010), the United Kingdom (O'Hare and McGuinness, 2015), and Japan (Kawashima and Petrini, 2004).

Although several studies on CTD have been conducted in mainland China (e.g., Wang et al., 2019; Zhai and Zhang, 2023; Liu and Pásztor, 2023; Zhao et al., 2024), there is scarcely any research on CTD in Macao. While some researchers in Macao have shown interest in CTD, their studies were conducted in mainland China (e.g., Au et al., 2023). Considering Macao's openness to the outside world for centuries and its multicultural environment, such studies in mainland China might not adequately reflect the situation in Macao. In fact, since employees need to interact with millions of visitors from diverse sources annually, it is beneficial to understand whether tourism and gaming undergraduates in Macao were substantially different from those in mainland China in terms of CTD.

To more effectively assess these students' CTD in Macao, this study has selected analyticity and open-mindedness among the seven attributes of the CCTDI due to their particular significance to the tourism and gaming industry. Apart from a willingness to be open-minded to engage with diverse perspectives, such students need to be able to analyze the intricacies of different cultures and backgrounds in their interaction with patrons. These **two** attributes not only are valuable in enhancing these students' CT in their data analysis and decision, but also critical in the establishment of positive patrons' experiences (Cruz et al., 2021) with Macao's role as a world center of tourism and leisure.

1.4 Possibility for assessing critical thinking disposition by text analysis

Although such methods as surveys and inventories have been popular in assessing CTD, they rely heavily on self-reported data, which may be susceptible to biases and limited introspection (Paulhus and Vazire, 2007). Following this, text analysis offers a novel approach by evaluating the linguistic and structural features of written or spoken communication, thereby providing a more

objective and context-sensitive alternative. In fact, some studies have assessed students' CT by analyzing the content of their writing, such as threads in online discussion forums (Al-Husban, 2020; Beckmann and Weber, 2016). Similarly, Paul et al. (2023) designed two instruments to assess CT by analyzing the content of students' essays and open-ended group discussions. In addition to creating rubrics to evaluate students' CT achievements, they suggested analyzing word frequency as an "important first step in understanding the data and knowing the kinds of topics to look out for during detailed analysis" (p. 127).

Apart from analyzing the content of students' writing, text analysis has been employed to assess CT from a linguistic perspective, and several studies (e.g., McNamara et al., 2010) have indicated connections between cognitive effort, complexity of thinking, and measurable linguistic patterns like parts of speech (POS). Moreover, some linguistic features in academic writing have been observed to serve as indicators for CT or CTD assessment, like the effective use of conjunctions (often referred to as connectives, logical connectors, or cohesive devices). For instance, Jones (2011) and Sobari et al. (2024) have indicated the effective use of conjunctions is associated with more coherent, logically structured, and critically engaged discourse. This in turn demonstrates that texts that properly employ conjunctions tend to reflect stronger argumentation and higher-level reasoning, and both of which are key elements of CT.

Despite this, most empirical studies that have used text analysis to explore students' CT appear to have focused more on assessing students' CTS rather than their CTD, and were conducted in English-speaking contexts. Considering the significant differences between English and Chinese, findings from the English-based contexts may not therefore be directly applicable to the Chinese contexts. Anyhow, based upon the possible routes suggested by previous research, this study proposes analyzing these university students' written essays on the tourism and gaming industry in Macao to assess their CTD as a novel approach.

1.5 Macao's cultural and educational background on critical thinking

Given that Macao was the only Western settlement within Chinese territory for many years (Du Cros, 2009), with its mixture of Chinese and Portuguese cultural traditions since the 16th century, the coexistence of Eastern and Western practices (Silva, 2002; Vong and Ung, 2012) has existed in Macao for centuries.

China is a country that has been influenced by Confucianism with the long rule of feudalism for about 2,000 years (Li and Liu, 2006). Following this, most Chinese in Macao respect for authority and advocate conformity and harmony (Wan, 2001), thereby leading to a very "Chinese" educational system. In such a traditional culture, a teacher's role has been conceived as a knowledge transmitter and an authority, and a student's role as a knowledge receiver and an audience. In such a teacher-student hierarchical relationship, students are expected to be respectful and use formal language in communicating to their teacher because of their concerns of preserving harmony and

social face (Ting-Toomey and Kurogi, 1998; Gabrenya and Hwang, 1996). Furthermore, with the traditional culture of studying the infallible classical knowledge, some students might resort to rote memorization to achieve academic success. With the generally large class size (usually over 40) in Macao, many Macao students may be passive, uncritical, rarely asking questions or volunteering answers, and unwilling to make public critiques, as opposed to the Western culture which emphasizes student-centered, discussion-based, and interactive mode of classroom interaction (Ho et al., 2004).

Before the 21st century, many people in Macao generally thought critical thinking was very much like a formal logic course, where teachers only lectured, with few attempts to encourage student thinking and participation (McBride et al., 2002). In fact, some teachers had seldom discussed CTS and CTD in depth, and defended their exclusion by arguing that they were not included in such examinations as the GRE or GMAT.

Although students might have some knowledge of the social and cultural aspects of other jurisdictions in Macao's multicultural environment, many students had experienced some barriers in their CT education as they might be unfamiliar with some examples and contexts, not be taught in their native language, or feel shy, leading to their reduced motivation to be open-minded to analyze and think critically. Such contextual features have thus contributed to use these students' native language, the Traditional Chinese, as well as their written responses instead of oral responses, to explore their CTD, so that they might be more willing to reflect and analyze in a classroom environment without fear of losing face in public.

2 Research aims and questions

The aim of this study is to design an instrument to assess the Analyticity and Open-Mindedness attributes within the CTD framework of undergraduates taking the tourism and gaming degree programme in Macao. Situated within the Traditional Chinese cultural and linguistic context, the study employs text analysis to explore the nature of students' CTD and identify linguistic features, including the use of conjunctions in their writing, that may indicate their CTD. The findings aim to provide a foundation for further assessments and offer an improved understanding of undergraduates in this area in Macao, building a basis and possibilities for future exploration in this region and other Traditional Chinese-speaking regions.

Based on these aims, the study will address the following research questions:

RQ1: Is the designed instrument feasible and reliable for assessing the Analyticity and Open-Mindedness attributes of undergraduates in tourism and gaming within the CTD framework in Macao?

RQ2: How are the Analyticity and Open-Mindedness attributes of these undergraduates in Macao developed?

RQ3: Are there linguistic features (such as the use of conjunctions in writing) that relate to students' CTD in this context?

3 Research methods

3.1 Participants and data collection

Sixty-five full-time undergraduate Year 4 students taking a tourism and gaming degree programme at a public university in Macao participated in the study. All participants used Traditional Chinese in their studies and daily conversations. Permission to access the student population and ethical approval for the study was obtained prior to data collection. Access to the students was coordinated with the instructor of the course "Critical Thinking," and data collection took place during a prearranged class session on April 22, 2024. The date was purposely arranged considering that students had finished all their midterms and submitted their assignments and projects, with a week left for make-up classes/revision before the final examination starting at the end of April. Since the course instructor neither needed a make-up class nor much time for revision, the students might not be substantially affected by the timing of the study with significantly different motivation levels when they were concerned about their unfinished projects or imminent midterms. During the session, a fixed script was used to explain the nature of the study and the students' involvement before the assessment began. Students were allocated one hour to complete the assessment during class time.

3.2 Instrument design

The instruments used in this study were inspired by the instrument designed and proposed by Paul et al. (2023). In their research, they introduced an instrument called "Instrument 1: Essay," which provided a multi-paragraph article related to the participants' field of study (business undergraduates). Students were required to write an essay to respond to the arguments of each paragraph in a given article. The authors also developed a rubric ranging from -1 (judges incorrectly/shows poor judgment in justifying) to 3 (justifies adequately) to evaluate students' responses to each paragraph, focusing on their CTS. Additionally, they suggested analyzing word frequency in the essays to gain an initial impression of the data.

With the ideas from Paul et al. (2023) as a reference, the instrument in the present study was independently developed to align with its specific aims and objectives. This approach accounts for differences in its focus on CTD rather than CTS, the sample population, language, and research questions unique to this study.

The study utilized an article written in Traditional Chinese, relevant to the students' major—tourism and gaming—as the stimulus. The article introduces a virtual persona, Mr. A, who discusses and illustrates four statements related to the tourism and gaming industry. These statements can be summarized as follows: (1) casinos are transforming into integrated resorts; (2) the impact of technology on casinos is not necessarily negative; (3) as more activities move online, the demand for physical leisure and entertainment venues grows; and (4) gaming will not become a declining industry given the scale of current investments. The four statements were carefully designed to reflect widely

different perspectives in the industry. Specifically, they address key industry issues such as economic diversification (Statement 1), technological optimism vs. displacement of casinos (Statement 2), digital experience vs. physical experience (Statement 3), and the long-term sustainability of gaming in the post-pandemic era (Statement 4). These statements taken together cover economic, technological, social, and strategic dimensions of the field. While students may disagree with the statements, each one is grounded in arguments that may hold value in specific contexts. This design ensures that the statements are sufficiently complex, do not have definitively correct or incorrect answers, and provide students with opportunities to engage in critical thinking.

To assess students' CTD, students were challenged to critically analyze the content, rather than dismiss the statements outright without considering their broader implications. They were required to write an essay expressing their agreement or disagreement related to each of the four statements with relevant discussion. Additionally, students were asked to write a concluding paragraph discussing and summarizing whether they agreed with Mr. A's overall perspective.

A rubric was designed to assess students' Analyticity and Open-Mindedness attributes within the CTD framework. For the Analyticity attribute, the authors analyzed each of the students' responses and discussions associated with the four statements by Mr. A in the article, using a scale from 0 to 2 (see Table 1). The rubric for Analyticity aligns with the definition outlined in the Delphi Report (Facione, 1990), which emphasizes being alert to problematic situations, anticipating possible consequences, and valuing reasoning and evidence. By focusing on students' willingness to analyze a viewpoint from multiple perspectives, the rubric reflects a key aspect of Analyticity: engaging thoughtfully with complex and challenging ideas. It is important to note that this assessment focuses on evaluating students' disposition toward analytic thinking rather than their ability to produce high-quality analysis. Thus, the rubric emphasizes students' willingness to engage in analytic thinking, rather than the correctness or quality of their viewpoints.

Another rubric was also designed to assess students' Open-Mindedness attribute. While the focus was on students' tolerance of differing ideas or opinions, their entire essay was reviewed to determine whether they had demonstrated tolerance of or respect for differing viewpoints based on the rubric (see Table 2). While the statements in the article have been widely discussed in the industry, we considered the possibility that students might genuinely agree with the statements and therefore not express disagreement. In such cases, this would not suggest a lack of critical thinking.

Students' Analyticity scores are assessed separately for each of the four statements in the article. For each response, a score from 0 to 2 is assigned based on the rubric, resulting in four distinct Analyticity scores per student with one for each statement. In contrast, Open-Mindedness is evaluated across the entire essay, resulting in a single classification for each student. The scoring process involves reviewing the essay to determine whether the student has demonstrated behaviors aligned with Class A (i.e., willingness to analyze opposing statements and acknowledge their potential value). If such behaviors are observed, the student is assigned to Class A. If not, the essay is further reviewed to identify

TABLE 1 Rubric for assessing analyticity attribute.

Score	Description
0	The student presents a viewpoint but makes no attempt to analyze it/The student does not present a viewpoint
1	The student presents a viewpoint and attempts analysis from a single perspective
2	The student presents a viewpoint and willingly engages in analysis from multiple perspectives, considering alternative viewpoints, stakeholders, or contexts

TABLE 2 Rubric for assessing open-mindedness attribute.

Class	Description
A	The student disagrees with the statements but is willing to analyze them, acknowledging that the viewpoints might hold value in certain situations or contexts.
B	The student disagrees with the statements but provides no or limited analysis that does not acknowledge their potential value in certain contexts. This indicates partial engagement with alternative viewpoints but limited open-mindedness.
C	The student does not disagree with the statements in the article, either because they genuinely agree or choose not to engage critically with opposing viewpoints.

behaviors corresponding to Class B (i.e., disagreement with the statements but providing no or limited analysis and failing to acknowledge their potential value). If such behaviors are observed, the student is assigned to Class B. If neither Class A nor B is applicable, the student is classified as "C," indicating that they did not disagree with the statements in the article. This could be due to a lack of critical engagement or genuine agreement with all the statements, but it is not possible to determine this conclusively from the available evidence.

Selected excerpts from student responses are provided below to illustrate how the rubrics for Analyticity and Open-Mindedness were applied. All responses were originally written in Traditional Chinese and have been translated into English. The examples below are partial excerpts rather than full responses.

Analyticity Example 1

The student analyzed Statement 1 from multiple perspectives, including economic, social, branding, regulatory, and risk management dimensions:

"The trend of transforming casinos into integrated resorts is a result of developments in the modern tourism and entertainment industries. [...] Traditional casino businesses face saturation and increased competition. By becoming integrated resorts, casinos can attract a broader customer base, including those who are not interested in gambling but seek other forms of leisure and entertainment. [...] The transformation also improves brand image, helping casinos shift from being seen solely as gambling venues to comprehensive leisure destinations. [...] Integrated resorts help diversify income sources and reduce risks caused by their reliance on a single business line. [...] Such a transition is also in line with economic development needs and can create employment and stimulate related industries."

This response covers multiple angles, demonstrating a high level of analytic engagement. Based on the rubric, it was assigned a score of 2 for Analyticity.

Analyticity Example 2

The student agreed with Statement 2 but did not provide any elaboration:

"I agree with this view, because casinos also need to rely on technology."

The student agrees with the statement but simply repeats its content and makes no attempt to analyze it. According to the rubric, it was assigned a score of 0 for Analyticity.

Open-Mindedness Example 1

The student disagreed with the statement but explicitly acknowledged its possible value before presenting a critical counterargument:

"Although technology brings certain convenience and improvement to the casino industry [...] I believe its negative impacts are more significant and concerning [...]"

This response reflects a willingness to consider opposing viewpoints while maintaining a clear position, which aligns with Class A in the Open-Mindedness rubric.

Open-Mindedness Example 2

The student disagreed with Statement 4 and provided a justification without engaging with alternative perspectives:

"I disagree. Investors invest not because they believe the industry isn't declining, but because of its other customer-attracting qualities [...]"

This response shows no acknowledgment of other viewpoints, corresponding to Class B.

The validity of the instrument was ensured through design and revision by the research team, comprising experts in tourism and gaming, educational assessment, and critical thinking. Each member contributed their specialized perspective to refine the setting and structure of the study. A small-scale pilot was conducted with four students to evaluate the feasibility of the instrument and confirm that the instructions and statements were clearly understood. The students demonstrated good comprehension, and no difficulties were observed. Due to the small number of participants, no statistical analysis was conducted.

3.3 Linguistic analysis

Text in Traditional Chinese, unlike that in English where words are naturally separated by spaces, requires specialized tools to segment characters into meaningful words. This process is inherently complex due to the absence of clear word boundaries as individual characters in Chinese can have multiple meanings depending on the context. Additionally, compound words often require semantic understanding to identify their structure. To address these challenges, this study employed natural language processing (NLP) tools to accurately segment the Traditional Chinese text into individual words, and perform part-of-speech (POS) tagging for further grammatical analysis.

Python programming was used to analyze the linguistic features of students' responses. While the *Jieba* library was applied for word segmentation and POS tagging, the *Pandas* library was used for data

input, output, and manipulation. Key lexical categories, including nouns, verbs, and conjunctions, were systematically extracted, quantified, and recorded for further analysis. Following automated segmentation and POS tagging using the *Jieba* library in Python, all outputs were manually reviewed by one of the authors and a trained research assistant, both native speakers of Chinese. The validation process involved checking whether conjunctions were correctly identified and tagged in context. When tagging errors were detected (e.g., a conjunction misclassified as an adverb), corrections were made based on grammatical function and sentence meaning. Any disagreements were discussed and resolved collaboratively. The review revealed that the automatic tagging was generally accurate, with only a small number of corrections needed. Thus, the manual review served as a quality control step to ensure reliability in identifying conjunction types.

3.4 Statistical analysis

All student responses were independently scored by two trained raters using the rubrics. A peer review process was used to resolve any discrepancies through discussion, which helped ensure consistency and reduce potential bias in scoring. Cronbach's alpha was calculated using SPSS to assess reliability, focusing on the scores for Analyticity, as Open-Mindedness results in a single classification. Descriptive analyses were performed in SPSS to report students' scores for Analyticity and their classifications for Open-Mindedness, providing insights into the development of these two attributes. The relationship between the two attributes was examined using independent sample *t*-tests and ANOVA.

Additionally, the relationship between conjunction usage and students' Analyticity and Open-Mindedness was analyzed based on the results of the linguistic analysis. A regression model was employed to examine the predictive power of the frequency of different types of conjunctions on Analyticity scores, as Analyticity is measured as a continuous variable. In contrast, independent sample *t*-tests and ANOVA were applied to Open-Mindedness, which is classified into distinct categories (Classes A, B, and C). In addition, Levene's test was used to evaluate homogeneity of variances. Variances were equal for all outcome variables except parallel and conditional conjunction frequency, which exhibited significant heterogeneity ($p < 0.05$). Therefore, for the relevant analyses, Welch's ANOVA was used to replace the regular ANOVA. Hedges' g with 95% confidence intervals and η^2 were calculated to represent effect sizes for the independent *t*-test and ANOVA, respectively. For variables analyzed using Welch's ANOVA, η^2 was derived from the standard sums-of-squares ANOVA and should be interpreted with caution, as unequal variances may bias this estimate. It is reported here solely to facilitate comparison with other variables.

4 Results

4.1 Reliability of the designed instrument

The data collection process proceeded smoothly, with no issues arising during its implementation. Cronbach's α was calculated (α

= 0.91), demonstrating a high level of internal consistency and confirming the reliability of the instrument. These findings suggest that the newly designed instrument is both feasible and reliable for assessing CTD in this specific context.

4.2 Students' performance in terms of analyticity and open-mindedness

Table 3 presents the distribution of Analyticity scores for the four statements (labeled as Analyticity_1 through Analyticity_4). Most students scored either 1 or 2 for each statement, indicating moderate to high engagement in analytic thinking. Scores of 0, reflecting no analysis or failure to present a viewpoint, were less frequent, ranging from 6.15% to 16.92% across the statements. The sum of students' Analyticity scores across the four statements had a mean of 5.37 (SD = 2.29), indicating a reasonable level of engagement in analytic thinking.

A Chi-square test was conducted to examine whether there were significant differences in the distribution of Analyticity scores across the four statements. The result was $\chi^2 = 10.29$, $p > 0.05$, indicating no statistically significant differences in the score distribution among the four statements. As illustrated in Figure 1, this suggests that while slight differences can be

observed (e.g., stronger engagement with multiple perspectives for some statements), the scores are generally comparable across the four statements. These variations may reflect differences in the nature of the statements, as certain topics may naturally prompt stronger responses due to their content or complexity. However, the overall consistency across the four statements demonstrates that the instrument is effective in assessing students' Analyticity.

The classification results for Open-Mindedness revealed that 19 students (29.23%) were assigned to Class A (willingness to analyze opposing statements and acknowledge their potential value), 16 students (24.62%) to Class B (disagreement with the statements but providing no or limited analysis and failing to recognize their potential value), and 30 students (46.16%) to Class C (no disagreement with the statements). These results suggest that while a substantial portion of students (29.23%) demonstrated a high level of open-mindedness by thoughtfully engaging with opposing perspectives, nearly half (46.16%) either genuinely agreed with all the statements or did not critically engage with alternative viewpoints. The proportion of students in Class B (24.62%) indicates that some students provided limited analysis or outright dismissed the statements without considering their broader implications. The observed variability in Open-Mindedness highlights opportunities to further cultivate students' disposition toward critical engagement with differing perspectives.

TABLE 3 Distribution of students' four analyticity scores.

Score	0	1	2
Analyticity_1	5 (7.69%)	35 (53.85%)	25 (38.46%)
Analyticity_2	5 (7.69%)	24 (36.92%)	36 (55.38%)
Analyticity_3	4 (6.15%)	34 (52.31%)	27 (41.54%)
Analyticity_4	11 (16.92%)	28 (43.08%)	26 (40.00%)

Data are presented as N (percentage %).

4.3 Relationship between analyticity and open-mindedness

To examine the relationship between Analyticity and Open-Mindedness, two statistical methods were applied. An independent sample *t*-test was used to compare the mean Analyticity scores between Class A and Class B. This focused comparison highlights

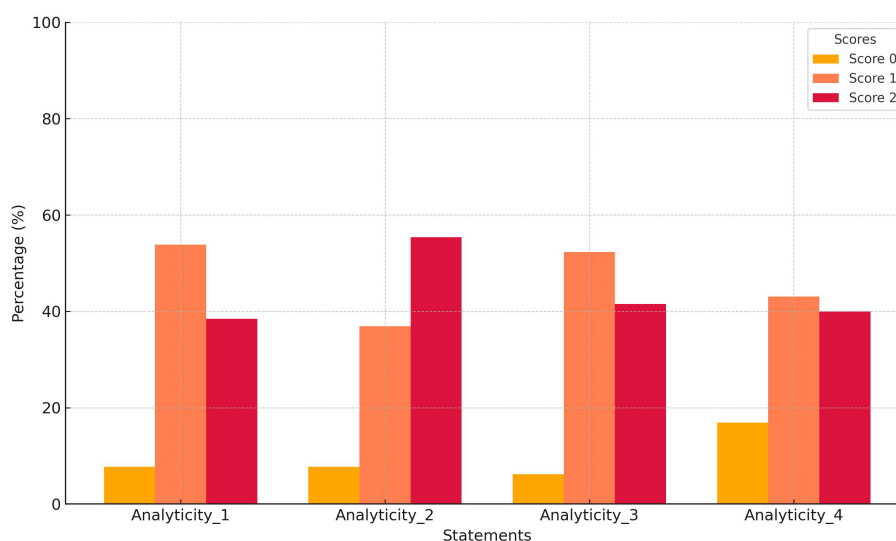


FIGURE 1
Distribution of analyticity scores across statements.

differences between students who displayed high levels of open-mindedness (Class A) and those who engaged less critically (Class B). Furthermore, a one-way ANOVA was conducted to compare Analyticity scores across all three Open-Mindedness classifications (A, B, and C). The inclusion of Class C, which represents students without disagreement with the statements, allowed for a broader analysis of the trends in Analyticity across the entire cohort. While Class C encompasses students whose responses might reflect genuine agreement or limited engagement, its inclusion provides additional context for interpreting the overall relationship between Open-Mindedness and Analyticity. The results are illustrated in Table 4.

The results demonstrated students in Class A ($M = 6.31$, $SD = 2.16$) with the highest mean Analyticity scores, followed by students in Class C ($M = 5.60$, $SD = 2.26$), while students in Class B ($M = 3.81$, $SD = 1.72$) had the lowest mean scores. The independent sample t -test for Class A and Class B revealed a statistically significant difference ($t = 3.81$, $p < 0.01$), with a large effect size [Hedges' $g = 1.24$, 95% CI (0.53, 2.00)]. This indicates that students with a higher level of open-mindedness (Class A) tended to exhibit significantly stronger engagement in analytic thinking compared to students in Class B, who displayed limited open-mindedness. The one-way ANOVA ($F_{(2,62)} = 6.41$, $p < 0.01$, $\eta^2 = 0.17$) further confirmed significant differences in Analyticity scores across all three classifications. Tukey *post-hoc* analysis indicated that students in Class A and Class C both scored significantly higher than those in Class B, with no significant difference observed between Class A and Class C.

These findings suggest a meaningful relationship between Open-Mindedness and Analyticity. Students in Class A, who demonstrated a willingness to acknowledge the potential value of opposing perspectives, indicated the highest analytic engagement. Conversely, students in Class B, who disagreed without substantial analysis, illustrated the weakest analytic engagement. Students in Class C, who did not actively disagree with the statements, achieved moderate Analyticity scores. The reasons behind their non-disagreement are not entirely clear, suggesting their genuine agreement with the statements, limited critical engagement, or a combination of both. While their scores are higher than those in Class B and lower than those in Class A, further investigation is needed to better understand their reasoning process.

TABLE 4 Comparison of analyticity scores across open-mindedness classes.

Open-mindedness Class	Analyticity M (SD)	t -test (A and B)	ANOVA (A, B, and C)
A	6.31 (2.16)	$t = 3.81$, $p < 0.01$ Hedges' g (95% CI): 1.24 [0.53, 2.00]	$F_{(2,62)} = 6.41$, $p < 0.01$ $\eta^2 = 0.17$ <i>Post-hoc</i> : {A,C}>{B}
B	3.81 (1.72)		
C	5.60 (2.26)		

4.4 Conjunction usage and its relationship with analyticity and open-mindedness

Through text analysis using NLP with Python programming, the authors identified the word frequency in students' responses. The most frequently used words in the responses were nouns related to the provided article. For instance, the word "gaming" appeared most repeatedly with a total frequency of 704 across all students' responses, followed by "casino" (684), "entertainment" (438), and "industry" (414). Some verbs were also often used, including "provide" and "develop" with a frequency of 392.

Furthermore, conjunctions being another focus of this study can be broadly categorized into four major types depending on their functions: (i) causal conjunctions like "因為" and "因此" (meaning because), indicating cause-and-effect relationship; (ii) parallel conjunctions such as "和" and "並且" (meaning and), connecting elements of equal importance; (iii) conditional conjunctions like "如果" and "假如" (meaning if), expressing prerequisites or conditions; and (iv) adversative conjunctions such as "但是" and "然而" (meaning but), highlighting contrast or opposition. Out of a total of 3,114 conjunctions used in all students' responses, 318 were causal, 1,863 parallel, 428 conditional, and 420 adversative, collectively accounting for 97.27% of all conjunctions used and representing a predominant part of conjunction usage. These four types of conjunctions were subsequently selected for further analysis.

A regression analysis was conducted to explore the predictive power of the frequency of the four types of conjunctions on the sum score of Analyticity. The overall model was statistically significant ($F = 16.61$, $p < 0.01$), explaining 53% of the variance in Analyticity scores ($R^2 = 0.53$). The results (see Table 5) illustrated that the frequency of parallel conjunctions [$\beta = 0.45$, $p < 0.01$, 95% CI (0.14, 0.76)] and adversative conjunctions [$\beta = 0.33$, $p < 0.01$, 95% CI (0.11, 0.56)] had significant positive relationship with Analyticity scores, indicating that increased usage of these conjunction types predicted greater analytic engagement and performance. In contrast, causal conjunctions [$\beta = -0.10$, $p > 0.05$, 95% CI (-0.31, 0.10)] and conditional conjunctions [$\beta = 0.11$, $p > 0.05$, 95% CI (-0.17, 0.40)] did not reveal statistically significant predictive power.

TABLE 5 Regression analysis of conjunction types on analyticity score.

Predictor	β	95% CI	t	p
Constant	—	—	7.96	<0.01
Causal conjunctions	-0.10	[-0.31, 0.10]	-1.00	>0.05
Parallel conjunctions	0.45	[0.14, 0.76]	2.87	<0.01
Conditional conjunctions	0.11	[-0.17, 0.40]	0.79	>0.05
Adversative conjunctions	0.33	[0.11, 0.56]	2.95	<0.01
$F = 16.61$, $p < 0.01$, $R^2 = 0.53$				

TABLE 6 Mean differences in the frequency of four types of conjunctions across open-mindedness classes.

Type of conjunctions	Class	M (SD)	t-test (A and B)	ANOVA (A, B, and C)
Causal	A	6.05 (3.42)	$t = 1.97, p > 0.05$ Hedges' g (95 % CI): 0.65 [−0.02, 1.35]	$F_{(2, 62)} = 2.84, p > 0.05$ $\eta^2 = 0.08$
	B	4.00 (2.58)		
	C	4.63 (2.11)		
Parallel	A	50.32 (47.98)	$t = 3.78, p < 0.01$ Hedges' g (95 % CI): 1.15 [0.45, 1.89]	$F_{(2, 31.87)} = 12.58, p < 0.01$ $\eta^2 = 0.20$ Post-hoc: {A, C} > {B}
	B	8.38 (5.66)		
	C	25.77 (25.99)		
Conditional	A	10.47 (7.90)	$t = 4.07, p < 0.01$ Hedges' g (95 % CI): 1.25 [0.54, 2.01]	$F_{(2, 35.31)} = 12.91, p < 0.01$ $\eta^2 = 0.25$ Post-hoc: {A, C} > {B}
	B	2.75 (2.27)		
	C	6.17 (3.76)		
Adversative	A	9.95 (5.35)	$t = 3.82, p < 0.01$ Hedges' g (95 % CI): 1.26 [0.55, 2.02]	$F_{(2, 62)} = 9.30, p < 0.01$ $\eta^2 = 0.23$ Post-hoc: {A} > {B, C}
	B	4.19 (3.04)		
	C	5.47 (4.11)		

The mean differences in the frequency of the four types of conjunctions across the three Open-Mindedness classes were analyzed (see Table 6). Similar to the results illustrated in Section 4.3, an independent sample t -test was conducted between Class A and Class B, and ANOVA paired with Tukey *post-hoc* test (for causal and adversative conjunctions) and Welch's ANOVA paired with Games–Howell *post-hoc* test (for parallel and conditional conjunctions) were performed to compare Classes A, B, and C, considering the reason for Class C's non-disagreement remains unclear. The results from the t -tests and ANOVA exhibited highly consistent patterns. Students in Open-Mindedness Class A displayed a significantly higher frequency of using parallel, conditional, and adversative conjunctions compared to students in Class B. However, no significant differences were observed for causal conjunctions, as confirmed by the non-significant results in both the t -tests and ANOVA.

5 Discussion

With the rapid changes in the tourism and gaming industry, critical thinking has become increasingly important for students interested in this industry. While most studies exploring students' CTD rely on surveys and inventories, concerns remain regarding the potential biases, and limited introspection inherent in their self-reported data. To address these limitations, alternative instruments, such as those assessing students' essay writing or discussion board threads, have been developed to provide insights into their CT from a different perspective. However, when analyzing CTD through students' writing, language plays a crucial role in both instrument design and analysis methods. A well-designed instrument in one

language context may not hold the same validity, reliability, or analytical power when adapted to a different language. Despite the widely accepted importance of CTD in today's society, there has been little research on this topic in Macao, particularly for undergraduates planning to join the industry with Macao's transformation into a center of tourism and leisure beyond gambling (Sui, 2024). Additionally, studies focused on CTD within the Traditional Chinese language contexts are notably lacking. This gap has underscored the significance of the present study, and prompted a designed instrument to assess the Analyticity and Open-Mindedness attributes within the CTD framework of undergraduates in Macao by analyzing their written essays in Traditional Chinese.

The designed instrument demonstrated good reliability and feasibility in practice, confirming that assessing students' CTD by analyzing their essays is viable with an appropriate design (thus addressing RQ1). The results indicated that students generally performed well in Analyticity, with a mean score of 5.73 (SD = 2.29) out of a total of 8. Regarding Open-Mindedness, the number of students willing to analyze opposing statements and acknowledge their potential value was slightly higher than those who disagreed with the statements but provided no or limited analysis, failing to recognize their potential value. Additionally, a group of students showed no disagreement with the statements, probably due to genuine agreement or limited critical engagement. Furthermore, the t -test and ANOVA analyses confirmed a connection between Analyticity and Open-Mindedness, suggesting that students with higher levels of Open-Mindedness were more willing to engage in analytic thinking (thus addressing RQ2). While some studies (e.g., Chen et al., 2020; Wang et al., 2019) have reported levels of Analyticity and Open-Mindedness among

university students in mainland China, these studies used different scales (e.g., CCTDI), thus making direct comparisons challenging. Interestingly, the findings from Wang et al. (2019) indicated a negative correlation between Analyticity and Open-Mindedness among students from mainland China, posing contrasts with the findings observed in this study. This suggests that although Macao is a China's special administrative region, its students may exhibit unique characteristics that may differ from those in mainland China. These findings highlight the importance of conducting explicit research in Macao to further explore its students' cultural background and psychological traits, including but not limited to CTD.

The text analysis revealed that the use of parallel and adversative conjunctions significantly predicted students' Analyticity scores, while the use of parallel, conditional, and adversative conjunctions varied significantly across Open-Mindedness classes. Students with higher levels of Open-Mindedness tended to use these conjunction types more frequently (thus addressing RQ3). Parallel conjunctions may reflect a student's ability to construct structured comparisons or build multi-faceted arguments, demonstrating the capacity to synthesize multiple points of view. Adversative conjunctions often signal contrast or refutation, and their use may indicate a student's willingness to consider opposing perspectives and engage with tensions between ideas (McNamara et al., 2014). Interestingly, causal conjunctions did not significantly predict Analyticity. This may reflect cultural or linguistic tendencies in Traditional Chinese writing, where causal logic is often implicit or embedded in context rather than explicitly marked with conjunctions. The present study provides empirical evidence that the use of conjunctions can serve as indicators of CTD in student writing in Traditional Chinese. These findings emphasize the importance of these conjunctions in constructing critical, organized, and structured arguments, suggesting a theoretical foundation for studying students' psychological traits through linguistic analysis. Beyond the theoretical contributions, these results have practical implications for psychological and educational assessments. Traditional assessment methods often face challenges related to biases (e.g., caused by self-reported data; Paulhus and Vazire, 2007) and test-taking motivation (Eklöf, 2010), which may affect reliability. An emerging trend in assessment research focuses on analyzing behavioral or linguistic patterns to reveal latent traits. For instance, to assess problem-solving, studies have analyzed students' behavioral patterns on online platforms to model their strategies and achievements objectively (e.g., Alrababah et al., 2024; Wu and Molnár, 2021). Following a similar approach, this study demonstrates the potential of assessing CTD by analyzing linguistic patterns in students' essays. While this study focuses on Macao, its implications may extend beyond the jurisdiction, thereby offering valuable insights for other Traditional Chinese-speaking contexts. The linguistic features examined in this study, along with the approach to assessing CTD, could serve as a foundation for similar research in other jurisdictions that share cultural and linguistic characteristics, enriching the understanding of CTD in diverse educational settings. Additionally, although the regression model explained a substantial portion of the variance in Analyticity scores, unobserved factors like students' prior

experience in critical thinking training, general academic ability, or topic familiarity, may also influence the scores and should be considered in future research.

By highlighting how linguistic features can reflect tourism and gaming undergraduates' CTD, this study contributes to an improved understanding of their CTD. To better cultivate Open-Mindedness and Analyticity in Macao tourism and gaming students, teachers may consider building a culture of enquiry by engaging in a visual practice like displaying an intriguing or ambiguous work of art, followed by moments of silent looking (Verducci, 2019). With Macao large class size, teachers may facilitate but do not lead the discussion among students grouped into sizes of 3 to 5, leading to multiple enquiries from these groups without expecting a single black-or-white truth. The teachers may need some professional training in their flexibility and adaptability in managing student interaction in a truth-seeking spirit, as well as maintaining the dialogue alive when students have a bottleneck situation. Such training on easing the classroom environment and motivating students to be open-minded is crucial as it may help students analyze the consequences of their choices, be alert to what happens next, prepare them for changes in the dynamic industry and be inventive in addressing emerging issues.

On the other hand, given that many CT instruments are imported from the West considering its origin from ancient Greek philosophy, universities and teachers may consider translating and adapting such imported instruments with testing and pilot assessment to minimize the language barrier, as well as developing local texts and instruments to suit target students' cultural practice and understanding.

Although the current study indicates that assessing undergraduates' CTD through analysis of their written essays is viable with the designed instrument for contexts using Traditional Chinese, this requires the support of educators, curriculum developers, and policymakers for improved objectivity, reliability and efficiency. By incorporating linguistic analysis and CTD assessment into educational practices, teachers may determine whether students have the required level of CTD to grasp the intricacies of diverse cultures and backgrounds associated with patrons from different sources in the gaming and tourism industry. Furthermore, despite the relatively small sample size, the designed instrument may be used to determine whether students in less popular majors have the required CTD to join the industry as a result of the transferability of many skills in the 21st century. Consequently, this context-specific research is particularly significant to help the industry development by providing university students with improved disposition as a result of the joint efforts of the industry, government, and academia.

Finally, beyond the context of this study, although the conjunction—CTD framework was demonstrated using tourism essays, the approach might be adapted to other educational settings. For instance, in STEM reports and essays, contrastive and causal connectives may signal hypothesis-testing discourse whilst in teacher-training reflection journals, thereby tracking shifts in evaluative stance. Such extension would provide a broader evidence base for using linguistic markers as unobtrusive indicators of CTD.

6 Limitations and future study

This study is limited by its relatively small sample size. As Macao is a small jurisdiction, the population of our target group (undergraduates taking the tourism and gaming programme) is limited, which may have influenced the results, led to reduced statistical power, and enhanced susceptibility to sampling errors. Although ANOVA and regression analyses were conducted with methodological care, the modest sample size ($n = 65$) may limit the statistical power and generalizability of the findings, particularly in the regression model involving multiple predictors. Future research with larger sample size, potentially through collaboration with other institutions in Macao or in regions where Traditional Chinese is used, is needed to validate the findings to ensure their generalizability. Another limitation lies in the interpretation of Open-Mindedness. Some students did not express disagreement with the statements, which could mean they genuinely agreed, or it might suggest a lack of critical engagement, where they accepted the statements without deeper analysis. Our current classification system might not fully capture students who agreed with certain points whilst still engaging critically. Future research may consider introducing an additional category to recognize such nuanced critical responses. Moreover, such qualitative methods as in-depth interviews may help uncover whether these students are critically engaged in their reasoning. Furthermore, future work may also adopt a longitudinal design that reassesses the same cohort after critical-thinking modules to explore their changes in CTD. Such studies may provide a clearer picture of the relationship between Open-Mindedness and Analyticity, especially in cases where no explicit disagreement is observed.

Data Availability

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Centre for Gaming and Tourism Studies, Macao Polytechnic University. The

studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

CS: Conceptualization, Investigation, Methodology, Project administration, Resources, Validation, Writing – original draft, Writing – review & editing. YL: Methodology, Validation, Writing – review & editing. YZ: Data curation, Software, Writing – review & editing. HW: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing.

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References

- Al-Husban, N. A. (2020). Critical thinking skills in asynchronous discussion forums: a case study. *Int. J. Technol. Educ.* 3, 82–91. doi: 10.46328/ijte.v3i2.22
- Alrababah, S. A., Wu, H., and Molnár, G. (2024). A pilot study for measuring complex problem-solving in Jordan: feasibility, construct validity, and behavior pattern analyses. *SAGE Open* 14:21582440241249884. doi: 10.1177/21582440241249884
- Álvarez-Huerta, P., Muela, A., and Larrea, I. (2023). Disposition towards critical thinking and student engagement in higher education. *Innov. High. Educ.* 48, 239–256. doi: 10.1007/s10755-022-09614-9
- Au, M. L., Li, Y. Y., Tong, L. K., Wang, S. C., and Ng, W. I. (2023). Chinese version of yoon critical thinking disposition instrument: validation using classical test theory and Rasch analysis. *BMC Nurs.* 22:362. doi: 10.1186/s12912-023-01519-y
- Beckmann, J., and Weber, P. (2016). Cognitive presence in virtual collaborative learning: assessing and improving critical thinking in online discussion forums. *Interact. Technol. Smart Educ.* 13, 52–70. doi: 10.1108/ITSE-12-2015-0034
- Belhassen, Y., and Caton, K. (2011). On the need for critical pedagogy in tourism education. *Tour. Manag.* 32, 1389–1396. doi: 10.1016/j.tourman.2011.01.014
- Bermingham, M. (2015). Clearing up “critical thinking”: its four formidable features. *Creat. Educ.* 6, 421–427. doi: 10.4236/ce.2015.64042
- Bhabha, H. K. (2012). *The Location of Culture*. London: Routledge.
- Boluk, K. A., Cavaliere, C. T., and Higgins-Desbiolles, F. (2019). A critical framework for interrogating the United Nations sustainable development goals 2030 Agenda in tourism. *J. Sustain. Tour.* 27, 847–864. doi: 10.1080/09669582.2019.1619748
- Branigan, T. (2011). *Macao – gaming capital of the world*. The Guardian, May 11, 2011. Retrieved from: <https://www.theguardian.com/travel/2011/may/11/macau-gambling-capital-of-world> (accessed 27 April 2025).
- Bravo, M. J., Galiana, L., Rodrigo, M. F., Navarro-Perez, J. J., and Oliver, A. (2020). An adaptation of the critical thinking disposition scale in Spanish youth. *Think. Skills Creat.* 38:100748. doi: 10.1016/j.tsc.2020.100748

- Byram, M. (2020). Teaching and assessing intercultural communicative competence: revisited. *Multiling. Matt.* doi: 10.2307/jj.22730614
- Chen, Q., Liu, D., Zhou, C., and Tang, S. (2020). Relationship between critical thinking disposition and research competence among clinical nurses: a cross-sectional study. *J. Clin. Nurs.* 29, 1332–1340. doi: 10.1111/jocn.15201
- Cheng, C. M. B. (1999). *Macau: A Cultural Janus* (Vol. 1). Hong Kong: Hong Kong University Press.
- Cruz, G., Payan-Carreira, R., Dominguez, C., Silva, H., and Morais, F. (2021). What critical thinking skills and dispositions do new graduates need for professional life? Views from Portuguese employers in different fields. *High. Educ. Res. Dev.* 40, 721–737. doi: 10.1080/07294360.2020.1785401
- Davies, T. (2006). Creative teaching and learning in Europe: promoting a new paradigm. *Curric. J.* 17, 37–57. doi: 10.1080/09585170600682574
- Dredge, D., Benckendorff, P., Day, M., Gross, M. J., Walo, M., Weeks, P., et al. (2012). The philosophic practitioner and the curriculum space. *Ann. Tour. Res.* 39, 2154–2176. doi: 10.1016/j.annals.2012.07.017
- Du Cros, H. (2009). Emerging issues for cultural tourism in Macau. *J. Curr. Chin. Aff.* 38, 73–99. doi: 10.1177/186810260903800105
- Dunne, G. (2015). Beyond critical thinking to critical being: criticality in higher education and life. *Int. J. Educ. Res.* 71, 86–99. doi: 10.1016/j.ijer.2015.03.003
- Dwyer, C. P., Hogan, M. J., and Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Think. Skills Creat.* 12, 43–52. doi: 10.1016/j.tsc.2013.12.004
- Eklöf, H. (2010). Skill and will: test-taking motivation and assessment quality. *Assess. Educ. Princ. Policy Pract.* 17, 345–356. doi: 10.1080/0969594X.2010.516569
- Ennis, R. (2011). Critical thinking: reflection and perspective Part II. *Inq. Crit. Think. Across Discip.* 26, 5–19. doi: 10.5840/inquiryctnews201126215
- Facione, N. C., Facione, P. A., and Sanchez, C. A. (1994). Critical thinking disposition as a measure of competent clinical judgment: the development of the California critical thinking disposition inventory. *J. Nurs. Educ.* 33, 345–350. doi: 10.3928/0148-4834-19941001-05
- Facione, P. (1990). *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction (The delphi report)*. Millbrae, CA: California Academic Press.
- Gabrenya, Jr, W. K., and Hwang, K. K. (1996). “Chinese social interaction: harmony and hierarchy on the good earth,” in *The Handbook of Chinese Psychology*, ed. M. H. Bond (Hong Kong: Oxford University Press), 309–321.
- Halpern, D. F. (2014). *Critical Thinking Across the Curriculum: A Brief Edition of Thought and Knowledge*. New York: Routledge.
- Halpern, D. F. (2016). *Teaching and Assessing CT: Helping University Students Become Better Thinkers*. Clemson, South Carolina: Workshop Presented at Clemson University. Available online at: <https://louisville.edu/ideaaction/-/files/featured/halpern/critical-thinking.pdf> (accessed on October 1, 2024).
- Ho, E., Holmes, P., and Cooper, J. (2004). *Review and Evaluation of International Literature on Managing Cultural Diversity in the Classroom*. Prepared for the Ministry of Education and Education New Zealand. Hamilton: University of Waikato.
- Howells, K. (2018). *The Future of Education and Skills: Education 2030: The Future We Want*. Paris: OECD.
- Jones, J. (2011). Using metadiscourse to improve coherence in academic writing. *Lang. Educ. Asia* 2, 1–14. doi: 10.5746/LEIA/11/V2/11/A01/JFJones
- Kawashima, A., and Petrini, M. A. (2004). Study of critical thinking skills in nursing students and nurses in Japan. *Nurse Educ. Today*, 24, 286–292. doi: 10.1016/j.nedt.2004.02.001
- Lawson, T. J. (1999). Using psychological critical thinking as a learning outcome for psychology majors. *Teach. Psychol.* 26, 207–209.
- Li, J. F., and Liu, G. Z. (2006). 论批判性思维训练的途径及其问题[On the training of critical thinking]. *J. Northwest Norm. Univ. (Social Sciences)* 43, 63–67.
- Liu, Y., and Pásztor, A. (2022a). Effects of problem-based learning instructional intervention on critical thinking in higher education: a meta-analysis. *Think. Skills Creat.* 45:101069. doi: 10.1016/j.tsc.2022.101069
- Liu, Y., and Pásztor, A. (2022b). Design and validate the employer-employee-supported critical thinking disposition inventory (2ES-CTDI) for undergraduates. *Think. Skills Creat.* 46:101169. doi: 10.1016/j.tsc.2022.101169
- Liu, Y., and Pásztor, A. (2023). Moderated mediating effects of gender among the components of critical thinking disposition in undergraduate students. *Heliyon* 9: e14664. doi: 10.1016/j.heliyon.2023.e14664
- Macao Government Tourism Office (2017). *Macao Tourism Industry Development Master Plan 2017*. Retrieved from https://masterplan.macaotourism.gov.mo/2021/index_en.html (accessed April 27, 2025).
- McBride, R. E., Xiang, P., Wittenburg, D., and Shen, J. (2002). An analysis of preservice teachers' dispositions toward critical thinking: a cross-cultural perspective. *Asia-Pacific J. Teach. Educ.* 30, 131–140. doi: 10.1080/13598660220135649
- McNamara, D. S., Crossley, S. A., and McCarthy, P. M. (2010). Linguistic features of writing quality. *Writt. Commun.* 27, 57–86. doi: 10.1177/0741088309351547
- McNamara, D. S., Graesser, A. C., McCarthy, P. M., and Cai, Z. (2014). *Automated Evaluation of Text and Discourse With Coh-Metrix*. New York, NY: Cambridge University Press.
- Norris, S. P. (2003). “The meaning of critical thinking test performance: the effects of abilities and dispositions on scores,” in *Critical Thinking and Reasoning: Current Research, Theory, and Practice*, ed. D. J. Fasko (New York, NY: Hampton Press, Inc.), 315–329.
- O'Hare, L., and McGuinness, C. (2015). The validity of critical thinking tests for predicting degree performance: a longitudinal study. *Int. J. Educ. Res.* 72, 162–172. doi: 10.1016/j.ijer.2015.06.004
- Pak, S. Y. (2016). Relationship between self-reflection, critical thinking disposition, multi cultural experience and cultural competence in nursing students. *J. Digit. Converg.* 14, 345–355. doi: 10.14400/JDC.2016.14.12.345
- Paul, J. A., Sinha, M., and Cochran, J. D. (2023). Instruments to assess students' critical thinking—A qualitative approach. *Decis. Sci. J. Innov. Educ.* 21, 123–143. doi: 10.1111/dsji.12295
- Paul, R. W., and Binker, A. (1990). *Critical Thinking: What Every Person Needs to Survive in a Rapidly Changing World*. Rohnert Park: Center for Critical Thinking and Moral Critique, Sonoma State University.
- Paulhus, D. L., and Vazire, S. (2007). “The self-report method,” in *Handbook of Research Methods in Personality Psychology*, eds. R. W. Robins, R. C. Fraley, & R. F. Krueger (The Guilford Press), 224–239.
- Perkins, D. N., Jay, E., and Tishman, S. (1993). Beyond abilities—a dispositional theory of thinking. *Merrill-Palmer Quart. J. Dev. Psychol.* 39, 1–21.
- Silva, R. (2002). *Save the uniqueness of Macao: The melting pot of East and West*. Paper read at the Conservation of Urban Heritage. Macau Vision International Conference, Macao.
- Snyder, K. D. (2003). Ropes, poles, and space: active learning in business education. *Act. Learn. High. Educ.* 4, 159–167. doi: 10.1177/1469787403004002004
- Sobari, T., Mulyadi, Y., Wikanengsih, W., and Mustika, I. (2024). Role of conjunctions and students' cognitive characteristics in argumentative essay writing. *Int. J. Learn. Teach. Educ. Res.* 23, 111–130. doi: 10.26803/ijlter.23.3.6
- Sosu, E. M. (2013). The development and psychometric validation of a critical thinking disposition scale. *Think. Skills Creat.* 9, 107–119. doi: 10.1016/j.tsc.2012.09.002
- Stedman, N. L., and Andenoro, A. C. (2007). Identification of relationships between emotional intelligence skill and critical thinking disposition in undergraduate leadership students. *J. Leaders. Educ.* 6, 190–208. doi: 10.12806/V6/I1/RF10
- Sui, C. (2024). Can Macao — the “Las Vegas of the East” — move beyond gambling? *Marketplace*. Available online at: <https://www.marketplace.org/2024/05/08/can-macao-the-las-vegas-of-the-east-move-beyond-gambling/> (accessed December 19, 2024).
- Ting-Toomey, S., and Kurogi, A. (1998). Facework competence in intercultural conflict: an updated face-negotiation theory. *Int. J. Intercult. Relat.* 22, 187–225. doi: 10.1016/S0147-1767(98)00004-2
- Tribe, J. (2002). The philosophic practitioner. *Ann. Tour. Res.* 29, 338–357. doi: 10.1016/S0160-7383(01)00038-X
- Trilling, B., and Fadel, C. (2009). *21st Century Skills: Learning for Life in Our Times*. San Francisco, CA: John Wiley and Sons.
- Verducci, S. (2019). Critical thinking and open-mindedness in polarized times. *Encount. Theory History Educ.* 20, 6–23. doi: 10.24908/encounters.v20i1.13446
- Vong, L. T., and Ung, A. (2012). Exploring critical factors of Macau's heritage tourism: what heritage tourists are looking for when visiting the city's iconic heritage sites? *Asia Pac. J. Tour. Res.* 17, 231–245. doi: 10.1080/10941665.2011.625431
- Wan, G. (2001). The learning experience of Chinese students in American universities: a cross-cultural perspective. *Coll. Stud. J.* 35, 28–44.
- Wang, X., Sun, X., Huang, T., He, R., Hao, W., and Zhang, L. (2019). Development and validation of the critical thinking disposition inventory for Chinese medical college students (CTDI-M). *BMC Med. Educ.* 19, 1–14. doi: 10.1186/s12909-019-1593-z
- Wangenstein, S., Johansson, I. S., Bjørkstrøm, M. E., and Nordström, G. (2010). Critical thinking dispositions among newly graduated nurses. *J. Adv. Nurs.* 66, 2170–2181. doi: 10.1111/j.1365-2648.2010.05282.x
- Wiles, J., and Bondi, J. (1989). *Curriculum Development: A Guide to Practice* (3rd Edn.). New York, NY: Macmillan Publishing Company.
- Wu, H., and Molnár, G. (2021). Logfile analyses of successful and unsuccessful strategy use in complex problem-solving: a cross-national comparison study. *Eur. J. Psychol. Educ.* 36, 1009–1032. doi: 10.1007/s10212-020-00516-y
- Yoon, J. (2004). *Development of an instrument for the measurement of critical thinking disposition in nursing* [Dissertation, The Catholic University of Education]. Seoul, Korea.
- Zhai, J., and Zhang, H. (2023). Critical thinking disposition of medical students in Anhui Province, China: a cross-sectional investigation. *BMC Med. Educ.* 23:652. doi: 10.1186/s12909-023-04646-x
- Zhao, Y., Liu, Y., and Wu, H. (2024). Relationships among critical thinking disposition components of Chinese undergraduates: a moderated mediating effect analysis. *Int. J. Educ. Res.* 124:102306. doi: 10.1016/j.ijer.2023.102306