



Relationships among critical thinking disposition components of Chinese undergraduates: A moderated mediating effect analysis

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ARTICLE INFO

Keywords:

Critical thinking disposition
Moderated mediation
Undergraduates
Labor Market

ABSTRACT

Critical thinking (CT), as a form of higher-order thinking, is intended to help individuals form reasonable reflection and judgment to deal with increasingly severe employment situations. As the primary workforce in the labor market, undergraduates must possess a strong critical thinking disposition (CTD) to make better use of CT. Despite extensive research on components of CTD from the perspective of educational practices, there is limited emphasis on investigating the components and their relationships of CTD in the labor market and the impact of gender differences. Therefore, this study presented an analysis of 1535 Chinese undergraduates ($M_{age} = 20.89$; $SD = 1.43$) using the Employer-Employee-Supported Critical Thinking Disposition Inventory (2ES-CTDI), aiming to explore the CTD that undergraduates should possess before entering the labor market. The relationships among the components were examined using SmartPLS4.0 in conjunction with Partial Least Squares Structural Equation Modeling (PLS-SEM). Additionally, a multigroup analysis (PLS-MGA) with a measurement invariance (MI) test was conducted to validate the moderating effects of gender. The findings indicate that (a) self-efficacy has a significant negative effect on habitual truth-digging, and boys are more affected than girls, instant judgment plays a competitive partial mediating role in this relationship; (b) self-efficacy has a significant positive effect on instant judgment, and boys are more likely to make instant judgments than girls; (c) instant judgment significantly positively affects habitual truth-digging. These findings highlight the dynamic equilibrium among the internal components of CTD in the labor market and call for increased attention from educators to the importance of gender differences in the cultivation process.

1. Introduction

Critical thinking (CT), is primarily delineated as a form of advanced cognitive processing that facilitates individuals in undertaking deliberate reflection, assisting them in concentrating on discerning what to believe or enact (Ennis, 2011). For a long time, CT has consistently been acknowledged as a key objective in higher education, representing an indispensable core competency for the 21st century (Guo & Wang, 2021). In addition to its manifestation within the higher education system, the significance of CT has increasingly come to the forefront of the labor market in recent years (Penkauskienė et al., 2019). CT has been regarded as a vital tool

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<https://doi.org/10.1016/j.ijer.2023.102306>

Received 16 August 2023; Received in revised form 13 December 2023; Accepted 27 December 2023

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for the successful accumulation and development of social capital for the future labor market (World Economic Forum, 2020). Currently, the global labor market is facing numerous challenges, such as effectively harnessing digitization and coping with the impact of multicultural environments (Indrašienė et al., 2023). CT, as a form of higher-order thinking, helps job seekers strengthen their vocational training and acquire a strong reflective attitude and core competency in lifelong learning (Apple, 2006; Brookfield, 2011; Halpern, 2013). Moreover, in an increasingly competitive labor market, employers' opinions are gaining importance. Employers believe that CT creates favorable prerequisites for individual development and organizational transformation (Yuan et al., 2021), and they urge employees to pay broader attention to CT to acquire and properly process relevant information from a rapidly changing world promptly. Faced with the constantly changing external environment, employees should effectively apply CT to seek the best solutions for their clients and organizations, highlighting the close correlation between CT and career development (Indrašienė et al., 2019). Therefore, as the primary workforce in the labor market, to confront the increasingly challenging employment landscape, undergraduates should further enhance their levels of CT to augment their overall competitiveness, thereby garnering greater favor from employers and organizations.

Researchers also consider CT as a necessary skill for future career research, particularly emphasizing its value in human-machine interactions such as artificial intelligence (AI) in the context of the new era (Indrašienė et al., 2023). However, the progress of science and technology has led to the development of AI, which, despite its benefits, also poses risks and challenges. ChatGPT, an advanced AI with the functions of answering open and close-ended questions, communicating, and exchanging ideas, shocked the world at the beginning of 2023. People were more afraid of being replaced by AI than before. To eliminate this anxiety, people must equip themselves with the competence that AI does not have, that is, to facilitate higher-order thinking competencies.

As future members of the workforce, undergraduates must possess the ability to gather extensive information, tackle intricate tasks, and engage in reflective evaluation, which means undergraduates must master the ability of reflective judgment (RJ). RJ refers to a metacognitive process in which individuals make judgments and decisions in a thoughtful and introspective manner, taking into account the principles and concepts of CT (Dwyer et al., 2015). RJ is interrelated and mutually reinforcing with CT, and both demonstrate good personal reflection and decision-making skills (Brabeck, 1983). Many scholars have even argued that RJ can be viewed as a subdimension of CT because RJ assists people in forming correct cognitive assumptions to recognize situations that require the use of CT for judgment (Baril et al., 1998; Dwyer et al., 2015; King & Kitchener, 1994). This further underscores the importance of effective judgment and decision-making in fostering a robust development of CT.

Notwithstanding, the academic community still tends to divide CT into two main sections: critical thinking skills (CTS) and critical thinking disposition (CTD). CTD can be regarded as the psychometric component of CT and is primarily used to detect a tendency to use CTS (Perkins et al., 1993). When individuals acquire CTS but exhibit a tendency to underutilize them, CT often struggles to be effectively demonstrated (Alvarez-Huerta et al., 2023). Thus, this study focuses on CTD, the activation of CTS, to conduct a comprehensive analysis and exploration of CTD required for undergraduates from the perspective of the labor market.

1.1. Critical thinking in the labor market

The deteriorating economic environment has intensified competitive pressures in the labor market, and major business organizations have had to adjust their strategies to upgrade and transform themselves to better meet the challenges of the market. Some studies have shown that organizational success depends on whether employees can react swiftly and make appropriate judgments in a changing corporate environment (Fung, 2014; Penkauskienė et al., 2019; Powley & Taylor, 2014). Elicor (2017) believes that CT can be used to help with organizational management and that employers need employees who are continually adapting to the demands of the modern market to have a degree of CT to seek timely solutions to relevant problems and thus improve the competitiveness of the organization.

Different groups in the labor market valued CT quite differently. Taking the perspectives of stakeholders such as lecturers, students, employers, and employees, Indrašienė et al. 2021 revealed the non-negligible nature of CT in the labor market and the different attitudes toward developing CT. Students and employees believed that self-regulation should be considered one of the most important CTS. However, employers and lecturers held a different view and believed that reflection and sound judgment were more important. Penkauskienė et al. (2019) shared the importance of CT in the labor market from the perspective of 189 European employers, where CT was primarily seen as an expression of sound decision-making, self-correction, and social responsibility. Another study explored and analyzed the different attitudes toward CT based on the views of employers and employees. The results showed that employees were more concerned with self-regulation, but neither group valued skepticism. In professional activities, both groups paid extra attention to flexibility and fair decision-making (Indrašienė et al., 2023).

There are also some differences between CT in higher education and the labor market. CT in higher education focuses primarily on the development of analytical and evaluative skills in an academic setting, which primarily involves questioning assumptions, analyzing evidence, and engaging in intellectual discourse to deepen understanding and develop independent thinking (Liu & Roohr, 2014), while CT in the labor market focuses on the application of these skills to real-world situations, such as problem-solving, making judgments, and adapting to changing work environments (Poštić et al., 2023). In terms of the purpose of training, CT in higher education is usually aimed at promoting intellectual growth, expanding knowledge, and developing well-rounded individuals who are prepared for future academic pursuits (Danvers, 2016; Xu & Mao, 2018), whereas CT in the labor market focuses more on an individual's critical, proactive, and positive attitudes in a professional setting, utilizing CTS to navigate one's career, and make an effective contribution to the organization (Mabić & Gašpar, 2020). Evidently, CT in the labor market places a greater emphasis on employees' abilities in decision-making and accurate judgment, focusing on the intrinsic motivation of employees to employ CT.

However, CT in the labor market is slightly less developed than CT in higher education. Moore (2013) argued that empirical

research on CT was still mostly focused on academic perspectives and that few attempts had been made to address these gaps in academia and the workplace. Some employers also complained that the current education system's CT training for students is not well integrated with labor market needs, causing CT development to appear fragmented (Bekbayeva et al., 2021; Gruzdev et al., 2018). While some of the studies have dealt with the embodiment of CT in the labor market, most of them focused on the theoretical level and did not provide detailed guidance on how to put it into practice (Habets et al., 2020).

The research addressing the development of labor market CT is not adequate. At the same time, existing research still focuses on describing the overall attitudes and preferences of different subjects toward CT in the labor market, with little analysis of its sub-dimensions, CTS and CTD, as well as the internal components' relationships, which are worthy of further exploration.

1.2. Critical thinking disposition and its components

CTD, the prerequisite for obtaining CTS (Liu & Pásztor, 2022; Valenzuela et al., 2011), shows its importance in the framework of CT. Nevertheless, previous studies were aimed toward researching CTS because CTS was often related to explicit skills and abilities that seem more useful for students, while CTD, largely ignored by research, was categorized as an intrinsic habit (Bravo et al., 2020; Quinn et al., 2020; Sosu, 2013).

The component development of CTD can date back to the late 20th century when the Delphi Report was published with 19 critical thinking dispositional domains (Facione, 1990). To make it more suitable for assessment, with the building of the California Critical Thinking Disposition Inventory (CCTDI; Facione et al., 1994), the fundamental components of CTD were further delineated into seven attributes, namely open-mindedness, systematicity, analyticity, inquisitiveness, truth-seeking, self-confidence, and maturity. This framework is the basis for almost all the following CTD structures, such as Critical Thinking Disposition Scale developed by Yoon (2004), with the components of objectivity, prudence, systematicity, intellectual curiosity, intellectual fairness, healthy skepticism, and self-confidence. This framework is predominantly utilized to assess the CTD of nursing students, with a specific emphasis on illuminating students' reflective habits in their daily learning and fostering the development of an independent personality. A new framework developed by Sosu (2013) was made up of two main components, critical openness and reflective skepticism. These elements are primarily utilized to gauge the critical reflective attitudes of undergraduate and graduate students in higher education during the learning process. Bravo et al. (2020) adapted Sosu's version by combining the two dimensions into a single factor, further refining the CTD framework. Quinn et al., 2020 Student-Educator Negotiated CT Dispositions Scale with reflection, attentiveness, open-mindedness, organization, perseverance, and intrinsic goal motivation. This framework took into consideration the collective perspectives of students and educators in higher education, facilitating a more comprehensive examination of students' cognitive needs, learning motivation, and flexible thinking. The above frameworks are all adaptations based on the original framework and focus on the perspectives of students, educators, and educational practices to analyze the measurement of CTD performance in higher education. Diverging from prior research, Liu and Pásztor (2022) placed a heightened emphasis on the CTD that undergraduates should possess before entering the labor market by adapting and developing the Employer-Employee-Supported Critical Thinking Disposition Inventory (2ES-CTDI), with a newly constructed component structure in terms of intelligence in the labor market.

Although the CTD frameworks and test scales proposed by the above scholars have been tested for model fitting and stability of the component frameworks, the relationships among each aspect were not thoroughly investigated. Moreover, most of these frameworks remain limited to a focus on CTD in higher education and, to some extent, ignore the development of CTD in the labor market.

1.3. CTD components and their relationships in 2ES-CTDI

The new scale 2ES-CTDI, adapted and developed by Liu and Pásztor (2022), reflects the latest framework of CTD in the labor market and mainly includes three subdimensions: self-efficacy, instant judgment, and habitual truth-digging. These subdimensions were extracted and adapted by developers from the perspectives of employers and employees in different industry domains, as well as from an Interpretative Structural Model (ISM) group composed of labor market experts (Liu & Pásztor, 2022). The objective is to address the imbalance between the cultivation of CTD in higher education and the requirements of the labor market. This framework reflects the relevant demands of employers in the labor market for the CTD qualities that employees should possess, providing an effective tool for assessing and nurturing the requisite CTD in undergraduates before they enter the labor market.

Self-efficacy reflects individuals' intrinsic motivation and self-confidence, which are connected to individual ideas about one's ability to regulate motivation, cognitive abilities, and behaviors (Bandura & Jourden, 1991). This is consistent with the motivation that employers require employees to have, that is, to encourage employees to be able to act independently, not afraid of making mistakes, free to generate ideas, make decisions, and dare to take responsibility to better create added value for the organization (King & Kitchener, 2004). Systematically incorporating changing information while maintaining open-mindedness, swiftly and accurately evaluating a statement represents the extrinsic perception in the instant judgment. Instant judgment is one of the most valued core elements for employers. Due to the unpredictability of the modern labor market, instant judgment encourages employees to respond quickly to market demands to seize opportunities and make sound decisions. It also avoids mistakes caused by overconfidence or bias. The tendency to utilize CTS to seek truth avidly and ask questions objectively, for example, to think step by step, examine with evidence, assess ideas, and so on, is the emphasis of habitual truth-digging (Facione et al., 1997). Habitual truth-digging is not only a core manifestation of CTD, but it is also viewed by employers as a pro-social collective motivation because it demonstrates an individual's continuous search for truth, as well as a strong desire to objectively help the organization to make improvements.

A preliminary exploration of the components' relationships of the three-factor CTD framework was examined by its developer (Liu & Pásztor, 2023). The results showed that the disposition of undergraduates to make instant judgments had a detrimental effect on

habitual truth-digging, whereas self-efficacy acted as a partial mediator of competition that gender moderated the link between instant judgment and self-efficacy, and that this occurred to a greater extent for boys than for girls. The gender difference results were also consistent with some other studies, in which boys had quick decision speeds under judgment stress (Lighthall et al., 2012). When confronted with a known circumstance, boys made judgments faster than girls. However, there is no difference in an unfamiliar context (Reiter, 2013). Boys appear overconfident and make judgments quickly and alone. In contrast, girls are sensitive and make decisions in groups (Minasyan & Tovmasyan, 2020). Singh et al. (2022) test of four cognitive tasks showed that boys scored higher on working memory tasks and decision-making tasks, while girls scored higher on flexibility and inhibition tasks. However, most of these manifestations of gender differences were findings from other research fields based on mean scores and have not been analyzed at a deeper level based on the CTD context in conjunction with the corresponding components' relationships, which warrants further research.

In Liu and Pásztor's (2023) study, a phenomenon was observed where, under the strong mediating effect of self-efficacy, instant judgment was found to have a negative impact on habitual truth-digging. However, according to Kahneman's (2011) dual-system theory, the human brain houses two decision-making systems: an intuitive heuristic-based rapid decision system and a rational analytical processing system. During the decision-making process, individuals often rapidly select information relevant to the current decision problem, subsequently entering the rational analytical processing phase. The rapid decision system can be considered as influencing the starting point of the rational processing system, initiating in-depth contemplation of the problem through a swift grasp of essential information about novel stimuli. The enhancement of an individual's decision-making proficiency is better achieved through the mutual interdependence and coordination of these two decision-making systems. For the current study, instant judgment is conceptualized as the rapid decision system, while habitual truth-digging is perceived as the rational analytical step. On the other hand, instant judgment reflects the open-mindedness characteristics of CTD, portraying an individual's proactive attitude towards reflection in diverse environments and continuous exploration of factual truths. Therefore, the current study posits that individuals' inclination toward instant judgment may positively influence their habitual truth-digging. It is essential to reexamine the relationships among the three subdimensions of 2ES-CTDI under varied research sample conditions.

1.4. Research aims and questions

According to social cognitive theory, self-efficacy reflects an individual's prediction of their capability to effectively execute specific behaviors, significantly influencing individual judgments and behavioral tendencies. Therefore, this study posits that self-efficacy will significantly impact instant judgment and habitual truth-digging. Combining the potential predictive relationship between instant judgment and habitual truth-digging, the current study takes self-efficacy as the cause, habitual truth-digging as the response, and instant judgment as a potential mediator, aiming to conduct a comprehensive investigation into the relationships among components within the 2ES-CTDI framework, thereby enhancing the exploration of the requisite CTD that undergraduates should possess before entering the labor market. Gender as a moderator was utilized to observe the effects of gender differences among these relationships. Accordingly, the research questions (RQ) were listed below:

RQ 1: What are the effects of self-efficacy on instant judgment and habitual truth-digging, and of instant judgment on habitual truth-digging?

RQ 2: What kind of mediating role does instant judgment play?

RQ 3: What kind of moderating role does gender play in each path?

2. Materials and methods

2.1. Participants

A total of 1535 undergraduates from three universities in the southwestern region of China participated anonymously and voluntarily in this assessment through convenience sampling ($M_{\text{age}} = 20.89$; $SD = 1.43$). In terms of institutional classification, one university is public, while the other two are private. Regarding the hierarchy of talent cultivation, one university is categorized as a vocational undergraduate institution (i.e., focusing on the cultivation of professional skill-oriented talents at the undergraduate level), while the other two universities are classified as general undergraduate institutions (i.e., focusing on the cultivation of academic and applied talents at the undergraduate level). Regarding gender composition, there are 397 boys (25.9 %; $M_{\text{age}} = 20.82$; $SD = 1.73$) and 1138 girls (74.1 %; $M_{\text{age}} = 20.92$; $SD = 1.30$). Participants and the university research committee both granted their assent following ethical norms (Approval committee: The Institutional Review Board of the Doctoral School of Education, University of Szeged. Approval number: 11/2021).

2.2. Instrument

As the newest and most representative CTD scale from the perspective of employers and employees, the 2ES-CTDI is primarily employed for assessing the manifestation of CTD required for undergraduate students transitioning into the labor market. The main form of the scale is a 7-point Likert scale (from strongly disagree to strongly agree), which is mainly composed of three dimensions and their respective indicators, with a total of 19 items. The three dimensions are self-efficacy (five items), instant judgment (three items), and habitual truth-digging (11 items). Two of the dimensions, self-efficacy, and instant judgment, belong to reverse measurement, and the scores of the reverse items were recoded before analyzing. The data collection and instrument usage were carried out online. Before

completing the survey, the counselors who had received training gave detailed explanations to the students on the matters needing attention. Participants only needed to scan the link or QR code to complete the scale. This process took approximately eight to ten minutes.

To ensure the appropriateness of the 2ES-CTDI framework for the present study sample, it is imperative to examine its overall internal consistency reliability. Concurrently, to ascertain the congruence of the relationships between each factor and its respective measurement items with the original framework, a confirmatory factor analysis (CFA) is warranted to conduct a structural validity analysis on the current scale framework. The findings indicate that the 2ES-CTDI framework exhibits high levels of reliability and validity within the context of this study sample (Cronbach's $\alpha_{\text{overall}} = 0.834$; $\chi^2/df = 7.36$, RMSEA = 0.064, GFI = 0.987, CFI = 0.919, IFI = 0.919, TLI = 0.907, SRMR = 0.047), thereby justifying its utilization for subsequent causal relationship analysis through PLS-SEM.

Due to the singleness of the measurement method and environment, conducting a common method variance (CMV) test is necessary. The results showed that the single-factor test could only explain 30.33 % of the total variance, which is less than the 50 % threshold, meaning that no severe problem of CMV existed (Harman, 1976).

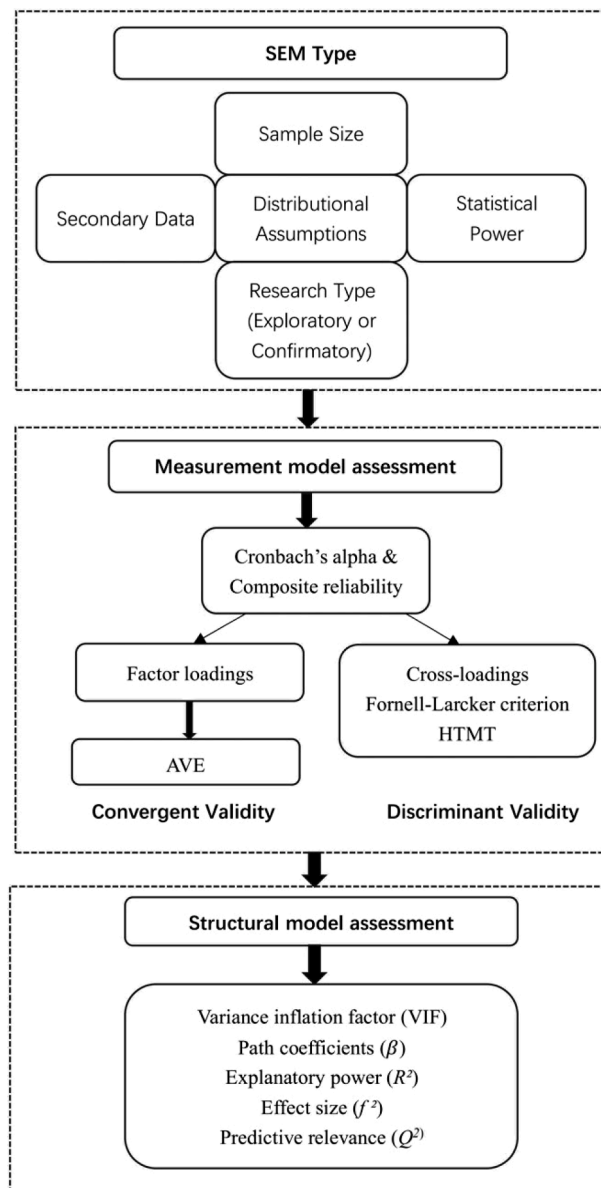


Fig. 1. The PLS-SEM analysis procedure.

2.3. Methods

2.3.1. Statistical instrument and SEM selection

For the current study, SmartPLS4.0 was used to construct the partial least squares structural equation modeling (PLS-SEM) to identify the relationships among the components of CTD and the moderated mediating effects of gender and instant judgment. Unlike covariance-based SEM (CB-SEM), PLS-SEM is considered a variance-based SEM statistical method and is mainly used for exploratory research analysis (Hair, 2017; Hair et al., 2011; Henseler et al., 2012) to show the predictive relationship between different constructs (Mehmetoglu & Venturini, 2021). Compared to CB-SEM, which always requires data normality, PLS-SEM generally does not have strict requirements. For the current study, the calculation results of SPSS 28.0 revealed that the data did not obey a normal distribution. Additionally, since PLS-SEM is suitable for different sample sizes and secondary data and has higher statistical power than CB-SEM, it is beneficial for continuous exploratory research (Hair et al., 2019; Reinartz et al., 2009).

2.3.2. Procedure of PLS-SEM analysis

The assessment of the PLS-SEM is mainly reflected in two aspects, namely, the assessment of the measurement model and the structural model. Suppose the assessment results of the measurement model are acceptable; in that case, they indicate that the model has qualified reliability and validity, and then the analysis of the structural model can be carried out. Combined with Hair's (2017) suggestions, this study follows the steps below for PLS-SEM analysis, as shown in Fig. 1.

2.3.3. Moderated mediating role of gender and instant judgment

In this study, the researchers assumed instant judgment as the mediator (Me), self-efficacy and habitual truth-digging as the independent variable (IV) and dependent variable (DV), respectively. Once a mediating effect is confirmed, gender as a moderator (Mo) can be established on the model accordingly to test whether there are significant differences between boys and girls on the three paths, as shown in Fig. 2.

For the mediating effect analysis, Preacher and Hayes (2004) proposed a new method called bootstrapping, which produces a higher level of statistical power. Bootstrapping does not make assumptions about the shape distribution of data, which is highly in line with the requirements of PLS-SEM. In this study, bootstrap replications were set at 5000 to test for mediating effect. The mediating effect (i.e., indirect effect) is considered significant if the 95 % confidence interval (CI) does not include a 0 value.

To better represent the mediating effect, it is also necessary to determine the type of mediation. Traditional mediation-type tests primarily employed the analysis method of Baron and Kenny (1986), but recent research indicated certain limitations in this approach (Hayes & Scharkow, 2013). Therefore, Hair (2017) combined the views of Zhao et al. (2010), based on previous research on mediating effect analysis to make a synthesis, types of mediation were reclassified. The mediation-type analysis should be carried out in strict steps, as shown in Fig. 3.

After exploring the mediating model, we tested whether gender as a moderator can affect the mediating model-related effect. Gender is a categorical variable, which is different from a continuous variable. This study mainly adopted two genders, boys, and girls.

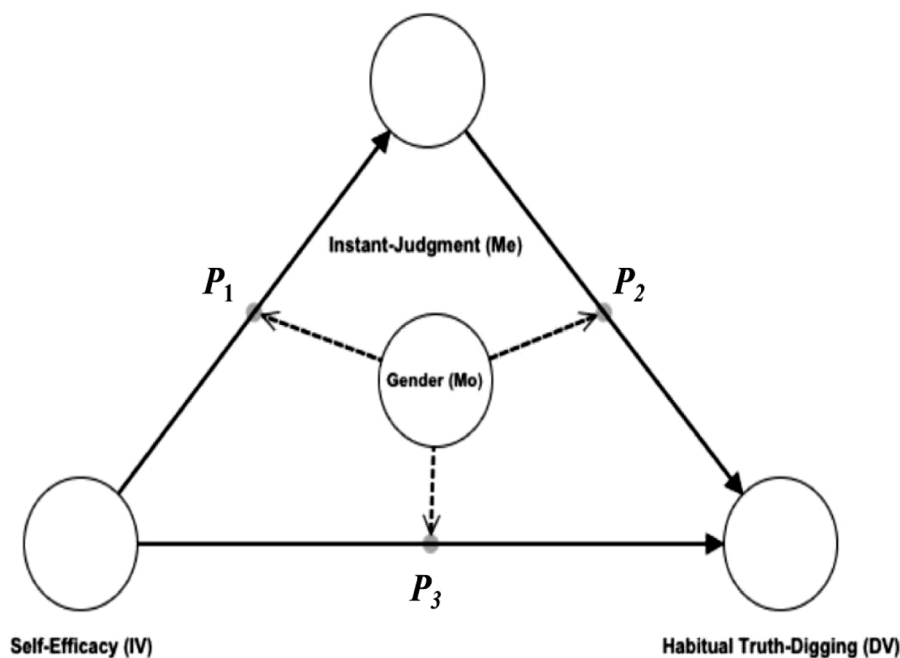


Fig. 2. The moderated mediating model.

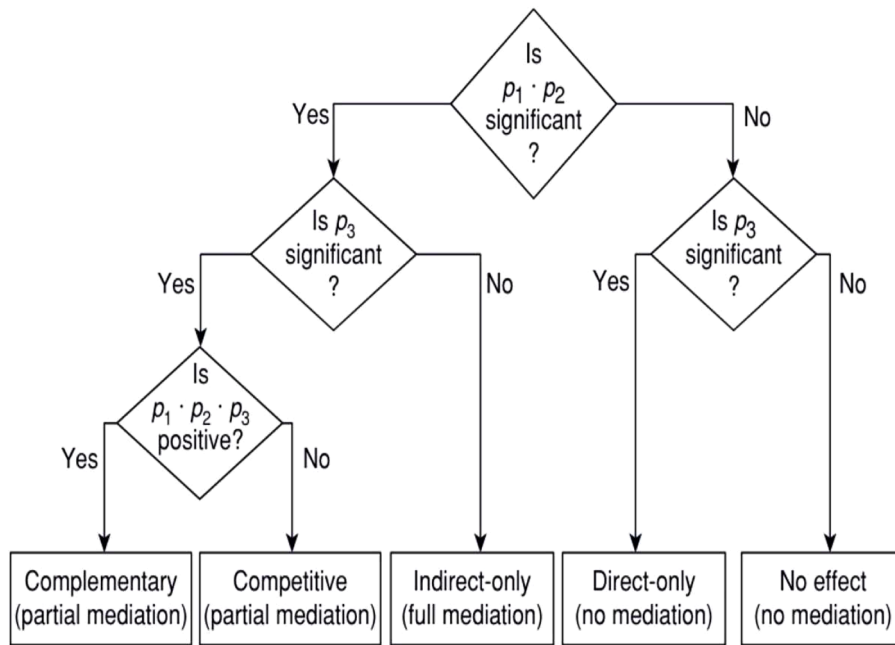


Fig. 3. Mediation analysis procedure (Hair, 2017; reprinted with permission from sage publications).

The traditional method is to conduct subgroup analysis to test whether there are significant differences in the paths of different groups. The current study utilized multigroup analysis (PLS-MGA). Another issue that needs more attention is that most previous studies have neglected to test for measurement invariance (MI) has led to skepticism as to whether the results of the study are due to measurement differences or group differences (Liu & Pásztor, 2023). Therefore, in this study, the measurement invariance of composite models (MICOM) procedure developed specifically for PLS-SEM was used to examine MI before performing PLS-MGA. This process consists of three main steps: configural invariance (Step I), compositional invariance (Step II), and equal means and variances for different groups (Step III), as shown in Fig. 4. Comparisons of standardized path coefficients between different groups are only warranted when partial measurement invariance is achieved.

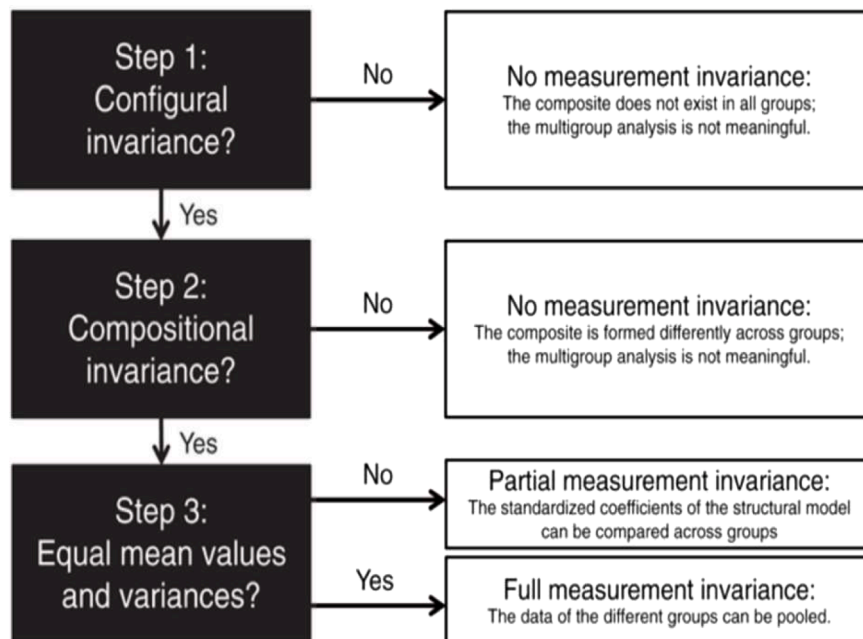


Fig. 4. The MICOM procedure (Henseler et al., 2016; Reprinted with permission from Emerald Insight).

3. Results

3.1. Assessment of the measurement model

Following the steps shown in Fig. 1, we first assessed the measurement model to ensure its reliability and validity. According to Hair (2017), Cronbach's alpha and Composite reliability (CR) values in the interval of 0.70 and 0.90 can be considered satisfactory. Table 1 shows that all factors of the model have good internal consistency reliability and can be used for further analysis.

When the indicator loadings ≥ 0.70 ($p < .05$) and average variance extracted (AVE) ≥ 0.50 , the model is considered to have good convergent validity. For the current study, all loadings are significant, and the loadings of most indicators in the three factors are qualified (see Table 1). However, the loadings of some indicators are lower than 0.70. According to Hulland (1999) when using the newly developed scale, there are usually several indicators in the predictive model with loadings below 0.70. Hair et al. (1998) advised that loadings above 0.40 could have practical significance. Table 1 also shows that the AVE of habitual truth-digging is less than 0.50, Fornell and Larcker (1981) believed that when the CR value of a factor is above 0.60, an AVE of 0.36–0.50 is also acceptable for exploratory research.

Table 2 shows that the outer loading of each indicator on its construct is greater than its cross-loading with other constructs. Table 3 reflects the test for Heterotrait-Monotrait ratio (HTMT), which meets the standard of less than 0.85 (Henseler et al., 2015). In addition, Table 3 also shows that the square root of the AVE (\sqrt{AVE}) of each construct is greater than its highest correlation with other constructs. The above items met the relevant criteria for testing discriminant validity (Hair et al., 2019; Henseler et al., 2015). The above tests all reflect that this model has good reliability and validity and can be used for subsequent analysis.

3.2. Assessment of the structural model

According to the suggestion of Hair (2017), if the variance inflation factor (VIF) value of each construct is below 5.0, there is no severe multicollinearity problem. As shown in Table 4, the VIF values for this study are within acceptable range. Table 4 also reveals that the path coefficients (β) in this study are all significant, demonstrating the existence of internal relationships among the three factors. Specifically, instant judgment significantly positively affects habitual truth-digging ($\beta = 0.281$, $p < .001$) while self-efficacy has a significant negative effect on habitual truth-digging ($\beta = -0.159$, $p < .01$). Additionally, self-efficacy has a significant positive impact on instant judgment ($\beta = 0.427$, $p < .001$).

The coefficient of determination (R^2) is regarded as the core part of PLS-SEM; it measures the variance explained in the endogenous constructs and thus represents the explanatory power of the model. Table 5 shows that the R^2 for instant judgment and habitual truth-digging are 0.182 and 0.065, respectively, indicating that 18.2 % of the variance in instant judgment could be explained by self-efficacy. In comparison, self-efficacy and instant judgment could explain 6.5 % of the variance in habitual truth-digging.

f^2 represents the effect size of one factor on another in one path, which is also used to reflect the predictive power (Hair, 2017; Hair et al., 2019; Shmueli et al., 2019). According to Cohen (1977), values higher than 0.02, 0.15, and 0.35 can be considered small, medium, and large effect size levels, respectively. Table 5 indicates that instant judgment has a small effect on habitual truth-digging ($f^2 = 0.069$). Self-efficacy also has a small effect on habitual truth-digging ($f^2 = 0.022$). Additionally, the data shows that self-efficacy has a medium effect on instant judgment ($f^2 = 0.223$).

Table 1
Descriptive statistics, reliability, and convergent validity of factors.

Factors	Indicators	$M \pm SD$	Original sample loading(O)	95 % Confidence Interval (CI)		Cronbach's alpha	CR	AVE
				Lower	Upper			
Self-Efficacy	A1	3.55 \pm 1.56	.583***	.527	.631	.757	.768	.510
	A2	4.18 \pm 1.63	.779***	.754	.801			
	A3	3.89 \pm 1.61	.746***	.710	.776			
	A4	3.68 \pm 1.61	.728***	.689	.761			
	A5	4.03 \pm 1.59	.719***	.684	.750			
Instant Judgment	B1	5.64 \pm 1.50	.865***	.846	.883	.820	.828	.735
	B2	5.48 \pm 1.58	.844***	.815	.868			
	B3	5.84 \pm 1.50	.862***	.835	.885			
Habitual Truth-Digging	C1	5.69 \pm 1.23	.836***	.775	.871	.906	.917	.453
	C2	5.02 \pm 1.33	.674***	.559	.732			
	C3	4.89 \pm 1.37	.584***	.429	.670			
	C4	5.27 \pm 1.25	.742***	.639	.790			
	C5	5.24 \pm 1.33	.664***	.595	.713			
	C6	4.79 \pm 1.35	.534***	.356	.635			
	C7	5.00 \pm 1.33	.615***	.478	.691			
	C8	4.71 \pm 1.30	.457***	.276	.562			
	C9	5.20 \pm 1.27	.706***	.602	.758			
	C10	5.11 \pm 1.24	.707***	.617	.753			
	C11	5.46 \pm 1.15	.789***	.733	.822			

Note: *** $p < .001$, M = Mean, SD = Standard Deviation.

Table 2
Cross-loading analysis.

Factors	Indicators	Habitual Truth-Digging	Instant Judgment	Self-Efficacy
Self-Efficacy	A1	−0.093	.258	.583
	A2	.017	.367	.779
	A3	−0.010	.294	.746
	A4	−0.081	.257	.728
	A5	.002	.328	.719
Instant Judgment	B1	.179	.865	.421
	B2	.170	.844	.342
	B3	.200	.862	.324
Habitual Truth-Digging	C1	.836	.242	−0.056
	C2	.674	.063	.011
	C3	.584	.048	.072
	C4	.742	.131	.037
	C5	.664	.132	−0.026
	C6	.534	.022	.087
	C7	.615	.065	.035
	C8	.457	−0.034	.024
	C9	.706	.109	.020
	C10	.707	.103	−0.007
	C11	.789	.142	−0.075

Note: The bold font indicates the factor loading of each indicator on its construct.

Table 3
HTMT and Fornell-Larcker analyses.

Factors	HTMT criterion			Fornell-Larcker criterion		
	Habitual Truth-Digging	Instant Judgment	Self-Efficacy	Habitual Truth-Digging	Instant Judgment	Self-Efficacy
Habitual Truth-Digging				.673		
Instant Judgment	.161			.213	.857	
Self-Efficacy	.110	.530		−0.039	.427	.714

Note: The bold font indicates the square root of each construct's AVE (\sqrt{AVE}).

Table 4
VIF and path coefficients analyses.

Path	VIF	Path coefficients (β)	95 % Confidence Interval (CI)	
			Lower	Upper
Instant Judgment \rightarrow Habitual Truth-Digging	1.223	.281***	.243	.330
Self-Efficacy \rightarrow Habitual Truth-Digging	1.223	−0.159**	−0.248	−0.050
Self-Efficacy \rightarrow Instant Judgment	1.000	.427***	.382	.472

Note: *** $p < .001$, ** $p < .01$, calculated by PLS-SEM algorithm and bootstrapping.

Table 5
 R^2 , f^2 and Q^2 analysis of factors.

Factors	Habitual Truth-Digging	Instant-Judgment	Self-Efficacy	R^2	R^2_{adjusted}	Q^2
Self-Efficacy	.022	.223				
Instant Judgment	.069			.182	.182	.131
Habitual Truth-Digging				.066	.065	.009

Note: Calculation by PLS-SEM algorithm and blindfolding.

Stone-Geisser's Q^2 value is an important indicator to test the predictive relevance of each construct within the structural model and generally requires a value greater than 0 (Zheng & Li, 2020). Table 5 reflects the satisfactory predictive relevance of the structural model in this study ($Q^2_{\text{Instant Judgment}} = 0.131$, $Q^2_{\text{Habitual Truth-Digging}} = 0.009$).

3.3. Assessment of the moderated mediating effects

The mediation-type test shown in Fig. 5 indicates that all the path coefficients are significant. Meanwhile, the path from self-

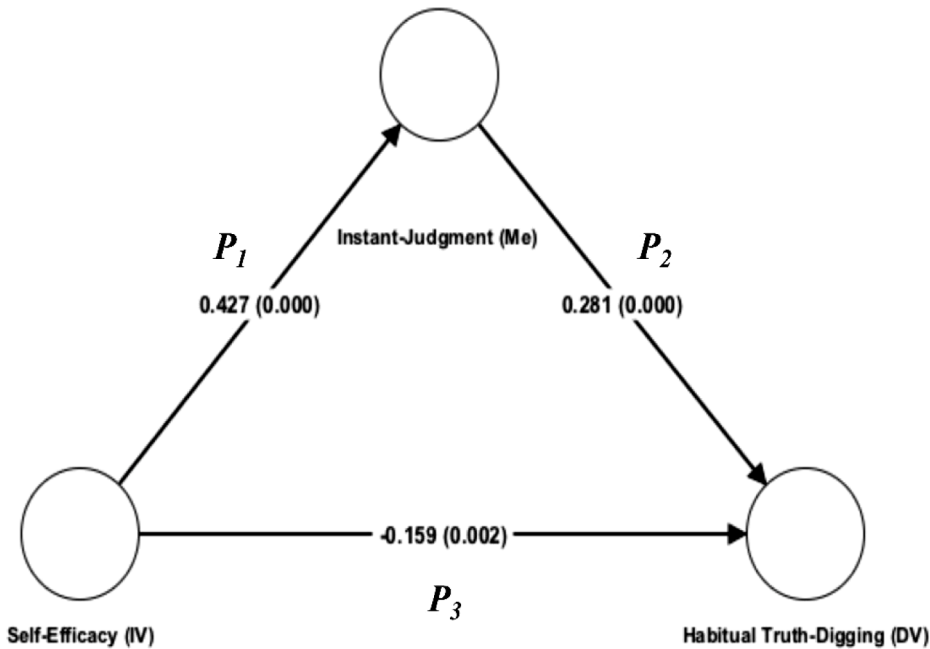


Fig. 5. Mediation-type test.

efficacy to habitual truth-digging is negative, which means that $p_1 \cdot p_2 \cdot p_3$ will also be negative. Table 6 shows that the mediating effect of this model is significant (95 % CI = [.100; 0.147], which does not include a 0 value), so the competitive partial mediating role of instant judgment can be determined. According to Table 6, the partial mediating effect size is 0.12, which can be considered medium (Hair, 2017). The value of RIT, is 3.077, meaning that approximately 307.7 % of the effect of self-efficacy on habitual truth-digging is mediated by instant judgment, and through the value of RID, we can infer that the mediating effect is approximately 0.756 times as large as the direct effect of self-efficacy on habitual truth-digging.

Prior to the multigroup analysis for verification of the moderating effects of gender, an MI test was performed. Since the measurement metrics and the algorithmic criteria are the same, the first step of configuration invariance can generally be considered as automatic matching. Then, if the original correlation is greater than the 5 % quantile or the permutation P value is insignificant, compositional invariance is established (Cheah & Thurasamy, 2020). Finally, if both the means and variances of the original differences fall within the 95 % CI, full invariance can be established (Henseler et al., 2016). Combining the results of Fig. 4 and Table 7, this study was only consistent with partial measurement invariance, thus allowing for a comparison of path coefficients across boys and girls.

Table 8 shows that in the path from self-efficacy to instant judgment, the effect of boys is significantly higher than that of girls (Difference_{boy-girl} = 0.233, $p < .001$), which means that at a higher level of self-efficacy, boys will be more prone to make instant judgments than girls. The simple slope analysis in Fig. 6 also reflects a similar performance. The slope of boys is steeper than that of girls, which indicates that the function's slope changes greatly and faster in this interval (Chowdury, 2012). That is, the function's rate of change is very high. Therefore, it can also be inferred that boys' change on this path is stronger than that of girls.

Table 8 also shows that with the improvement in self-efficacy, the level of habitual truth-digging of both boys and girls has decreased to a certain extent, but the decrease is significantly greater for boys than girls (Difference_{boy-girl} = -0.159, $p < .05$). Fig. 7 also proves the corresponding conclusion. Another path from instant judgment to habitual truth-digging shows that the difference is insignificant, so we do not consider it.

Table 6

Test of indirect effect.

Path	Indirect Effect	95 % Confidence Interval (CI)		Direct Effect	Total Effect	RIT	RID
		Lower	Upper				
Self-Efficacy -> Instant Judgment -> Habitual Truth-Digging	.120***	.100	.147	-0.159	-0.039	3.077	.756

Note: *** $p < .001$, RIT = Ratio of the indirect and total effect, RID = Ratio of indirect and direct effect, RIT and RID are based on absolute value calculations.

Table 7

Results of the MI test.

Factors	Configural Invariance (Step I)	Compositional Invariance (Step II)		Equal Means Assessment (Step III)		Equal Variances Assessment (Step III)	
		Original Correlation	5.0 %	Original Differences	95 %Confidence Interval (CI)	Original Differences	95 %Confidence Interval (CI)
Self-Efficacy	Yes	.998	.995	.101	[−0.118; 0.113]	.379	[−0.174; 0.168]
Instant Judgment	Yes	.999	.998	−0.582	[−0.111; 0.109]	.472	[−0.212; 0.197]
Habitual Truth-Digging	Yes	.985	.839	−0.293	[−0.111; 0.110]	.724	[−0.260; 0.221]

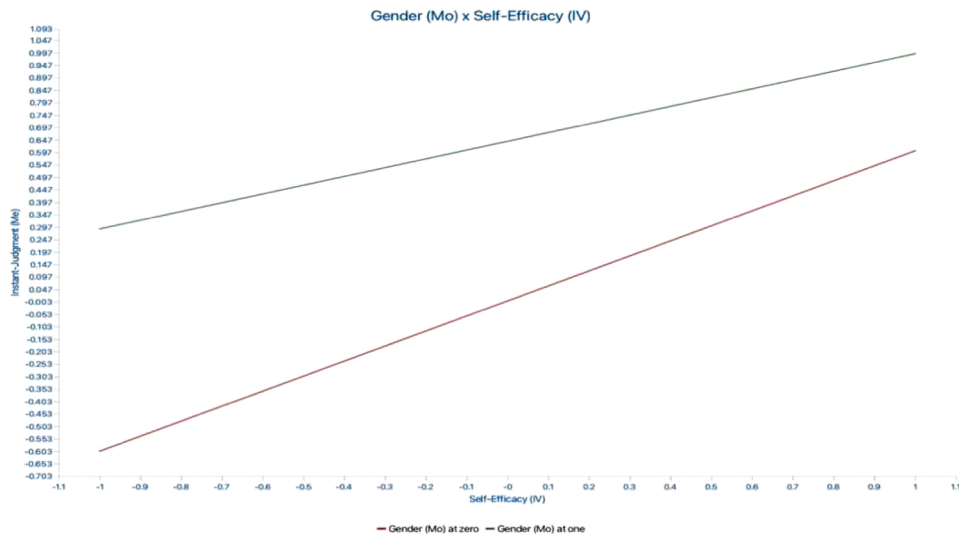
Note: Step I was automatically established, and the permutation P value of Step II is higher than 0.05.

Table 8

Moderating effects of gender among components of CTD.

Path	Global	Boy	Girl	Difference (Boy - Girl)	P value
Self-Efficacy -> Instant Judgment	.427	.607	.375	.233	.000
Self-Efficacy -> Habitual Truth-Digging	−0.159	−0.301	−0.027	−0.274	.030
Instant Judgment -> Habitual Truth-Digging	.281	.237	.251	−0.014	.791

Note: Henseler's PLS-MGA was used, CI = 95 %.

**Fig. 6.** Simple slope analysis of Path 1

Note: Gender at zero = Boy, Gender at one = Girl, Path 1 = Self-Efficacy -> Instant Judgment.

4. Discussion

4.1. Discussion on the positive effects of self-efficacy on instant judgment

Some researchers have demonstrated that self-efficacy positively affects employees' audit judgments (Iskandar & Sanusi, 2011; Sanusi et al., 2018; Muhsin, 2023). Bidokia et al.'s (2023) study also showed that self-efficacy plays a complementary mediating role between auditors' goal orientation and judgment performance. These studies are consistent with our research and are mainly focused on the financial field, which also highlighted the importance of self-efficacy and judgment in the labor market. When employees have a high sense of self-efficacy, they tend to have a more positive view of their abilities and skills and a full belief in their ability to solve problems (Fraile et al., 2023; Orakci, 2023). This positive self-perception will boost employees' confidence, making them more likely to make appropriate decisions in real work situations that require instant judgment.

This phenomenon can also be partly explained from the perspective of attribution theory. Attribution theory holds that individuals' interpretations and attributions of events can affect their behavior and emotional responses (Martinko & Mackey, 2019). When employees have high self-efficacy, they are more inclined to attribute success to internal factors, such as their own abilities and efforts

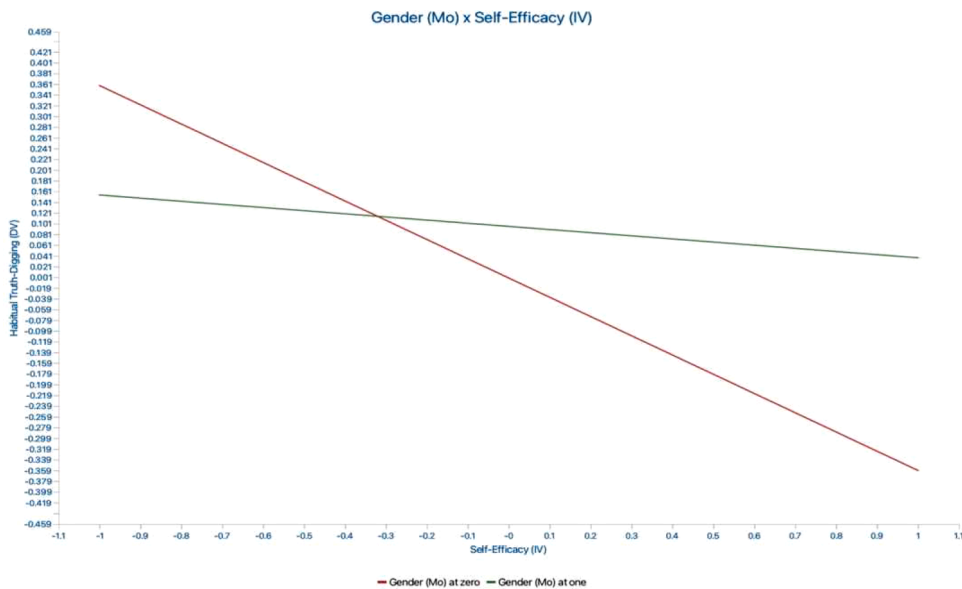


Fig. 7. Simple slope analysis of Path 2

Note: Gender at zero = Boy, Gender at one = Girl, Path 2 = Self-Efficacy \rightarrow Habitual Truth-Digging.

(Schwarzer, 2014). This tendency toward internal attribution makes employees more likely to develop positive emotions and beliefs in the face of challenges and stress. In situations that require instant judgment, employees are more confident in their ability and resources to respond, and they are more inclined to actively participate in the decision-making process rather than passively watching or procrastinating. This observation highlights the significant role of self-efficacy in the holistic cultivation process of CTD in the labor market, serving as a crucial factor in providing intrinsic motivation and psychological encouragement.

The instant judgment employed in this study is intended to encourage employees to engage in quick reflection on problems. In real-life environments, especially in the labor market, employees must be fast, accurate, and precise in using their synthetic thinking skills to make decisions that are better for the organization. Maintaining sensitivity to events, preserving an open mindset, and making accurate judgments are also core elements of the foundational framework of CT (Ennis, 2011). However, it should be noted that instant judgment is not the same as reckless judgment and still must be based on logical thinking; it should be regarded more as a disposition to react immediately, to quickly think about the viewpoints and positions that should be adopted when solving practical problems and to make correct decisions.

4.2. Discussion on the positive effects of instant judgment on habitual truth-digging

In this study, instant judgment was found to have a positive impact on habitual truth-digging, which is a significant discovery, as it contradicts Liu and Pásztor's (2023) findings. Previous study has shown a negative influence of instant judgment on habitual truth-digging, primarily due to its potential to exacerbate impulsive and reckless behavior in employees. However, this is highly likely attributed to the strong mediating effect of self-efficacy as observed in previous research. In addition, fast thinking and slow thinking are generally seen as opposites (Lawson et al., 2020). This study adopts a cautious stance toward such claims, and we suggest that instant judgment and habitual truth-digging should not be viewed as mutually exclusive but rather as encouraging students to continuously enhance their truth-seeking dispositions through self-judgment. From the perspectives of psychological flexibility and adaptability, employees who frequently engage in instant judgment may demonstrate heightened agility in addressing various problems, leading to better adaptation to changes and challenges (Kashdan & Rottenberg, 2010), and ultimately fostering habitual truth-digging. The results of this study further corroborated such a conclusion. Undergraduates, through sustained and effective self-judgment and reflection, along with maintaining receptivity and openness to novel experiences, engage in the exploration of the intrinsic logical connections between themselves and external entities. Consequently, their inclination toward truth-digging can experience a corresponding elevation.

Habitual truth-digging refers to the formation of a habitual thinking mode and judgment standard through long-term observation and practice, which are used to judge the authenticity and reliability of things. However, habitual truth-digging also has its limitations, as it is based on past experiences and observations and may not be able to adapt to new situations and changes. Instant judgment emphasizes making judgments and decisions quickly based on current information and situations and can help individuals better cope with change and uncertainty. Therefore, instant judgment can reveal and correct the bias and error of habitual truth-digging promptly, thereby improving the accuracy and reliability of judgment. At the same time, habitual truth-digging can also provide a basis and reference for instant judgment so that we do not completely ignore past experiences and observations while making quick judgments. This further substantiates the mutually supportive roles of the dual systems in human decision-making, as postulated by Kahneman

(2011). The rapid system enhances decision flexibility through the immediate and accurate apprehension of critical information points, while the rational system provides essential logical and experiential safeguards, ensuring the precision and accuracy of decision-making. In summary, instant judgment and habitual truth-digging are not in conflict, but in fact, can promote and enhance each other.

4.3. Discussion on the negative effects of self-efficacy on habitual truth-digging

It was found in this study that self-efficacy has a significant negative impact on habitual truth-digging. Habitual truth-digging can be considered a core component of CTD and is crucial for reflecting CT. Some researchers have found a significant positive effect of self-efficacy on CTD (Aydin Gürler, 2021; Vachova et al., 2023). One possible reason for the negative relationship in this study is that the individuals may be overly confident in their ability to discover the truth, lacking the motivation for critical or skeptical thinking, which contradicts the concept of CT which encourages open-mindedness and questioning for effective reflection (Lipman, 1987; Siegel, 1999).

Additionally, potential causes can be explained by cognitive closure. Individuals with high self-efficacy may tend to exhibit cognitive closure (i.e., manifesting an impulsive behavior driven by the eagerness to seek pertinent answers quickly to satisfy cognitive needs). Some individuals may even exhibit defensive avoidance (i.e., avoiding truths that contradict their existing views), and may fear that the revelation of the truth will threaten their self-confidence. In response to these situations, the mediating role of instant judgment should be valued more because it encourages individuals to think out of the box, actively participate in reflective judgment, and face challenges head-on. Certainly, this phenomenon does not apply universally to individuals with high self-efficacy. Some individuals exhibit elevated self-efficacy while concurrently maintaining a tendency to explore and question truths, necessitating further scrutiny of individual differences.

Defining and accurately cultivating one's self-efficacy is complex, sometimes it is no better to wrongly overestimate a person's abilities than to underestimate one's abilities; this requires us to carefully balance the process of self-efficacy development. However, in general, the contribution of self-efficacy to fostering students' confidence in CTD is significant. The partial competitive mediating role of instant judgment has been demonstrated, indicating that while self-efficacy may lead to a decrease in habitual truth-digging, this negative impact can be mediated and gradually balanced through continuous training in instant judgment. As internal components of CTD, the three factors mutually constrain and complement each other, and the absence of any aspect may hinder students' effective development of CTD.

4.4. Discussion on the moderating effects of gender among components in 2ES-CTDI

Previous research on gender differences in the internal components of CTD has predominantly relied on comparisons of mean scores between different gender groups (Du et al., 2013; Fitriani et al., 2018). However, these studies have not delved into the relationships among the components with gender as a factor for further analysis. While such approaches yield differential results, they fall short of facilitating effective improvements by not considering the interplay among the components. Additionally, some results indicated the absence of significant gender differences within CTD components (Ding, 2016; Whitney et al., 2016). Addressing these issues, gender differences were integrated into the exploration of relationships among internal components of CTD in the labor market, and simultaneous tests of MI between different groups were conducted to ensure validity. Consequently, this study effectively filled the research gap in this area.

For the current study, the results indicated that when the level of self-efficacy remains higher, boys may be more likely to make instant judgments compared to girls. According to the gender differences theory, due to cognitive disparities between boys and girls, boys may have advantages in spatial perception and reaction speed, which could facilitate their propensity for quick judgments, while girls may be better at linguistic and relational assessment (Hyde, 2014). Some previous studies have also substantiated similar conclusions (Byrnes et al., 1999; Cross et al., 2011; Lizárraga et al., 2007). This difference highlights the need for future research to integrate the study of boys' and girls' brain cognitive mechanisms with CTD development. Gender socialization and cultural factors may also contribute to disparities in instant judgment between boys and girls. In certain cultures, boys are encouraged to display traits of confidence and decisiveness, while girls are often encouraged to emphasize introversion and tranquility (Furente et al., 2023).

In another set of relationship, the moderating effect of gender was also identified. As self-efficacy levels increase, the habitual truth-digging propensity in boys tends to decrease more than in girls, suggesting that boys with higher self-efficacy might be less inclined to engage in deep reflection. Similar viewpoints were reached in the study by Pajares (2004), where boys and girls tended to adopt different stances in response to self-efficacy. Boys often lean towards self-congratulation, while girls frequently maintain a humble attitude, contemplating their next steps (Berliner & Calfee, 2004). Due to differences in societal role expectations, boys may exhibit greater confidence and a tendency to trust their decisions, explaining why the positive impact of self-efficacy on instant judgment is more pronounced in boys. In contrast, girls may lean towards composure, introspection, and thoughtful consideration. Considering the gender differences observed in this study, educators are called upon to set higher standards in the cultivation of CTD. Educators should aim to maintain undergraduates' self-efficacy at a moderate level, providing timely encouragement and adjusting their states during the educational process. Simultaneously, considering gender and individual differences, efforts should be made to sustain a balanced development of CTD.

5. Limitations, educational implications and future recommendations

5.1. Limitations

First, the study employed convenience sampling to determine the sample, which, although cost-effective and quick in identifying groups that can participate in the research, can lead to bias, as the selected sample carries a greater degree of randomness and instability. This bias can make it difficult to represent the defined population accurately (Fraenkel et al., 2023). Simultaneously, it is essential to note that the sample for this study comprised only undergraduates from China, thus limiting the generalizability of the research findings. It remains unclear whether similar patterns would apply to undergraduates in other countries. Second, the measurement instrument still exhibits some instability. The data in this study indicate relatively low loadings for certain items, such as C8 (0.457). The convergent validity of habitual truth-digging in this study is also imperfect. Finally, as this study took a new perspective to analyze the internal components' relationships of CTD, there is less literature that can be referred to, the study is still mainly focused on the discovery of the problem as well as the description of the phenomenon, which must be carried out for a deeper level of endogenous attribution in future research.

5.2. Educational implications

The main theoretical contribution of this study lies in its departure from traditional perspective of educational practices, instead focusing on the demands of employers and the labor market and discussing the CTD that undergraduates must possess to better meet employment requirements. In a society where competition for employment is increasingly intense, undergraduates must enhance their sensitivity to relevant information and make instant and accurate judgments; this also has implications for higher education. Teachers should integrate the cultivation of students' CT with the demands of the labor market. By analyzing the relationships among the internal components of CTD as examined in this study, it is possible to help teachers further optimize their teaching focus, considering the interplay among self-efficacy, instant judgment, and habitual truth-digging as three factors. Additionally, the manifestation of gender differences also requires attention. In the process of CTD cultivation with an employment orientation, different teaching strategies or interventions can be adopted for boys and girls, considering their personality differences, and striving to find a balance.

5.3. Future recommendations

Regarding sample representativeness and diversity, we recommend that future research utilize different sampling methods to select research samples. Additionally, it is important to broaden the scope of the demographic investigation, such as including undergraduates from other countries, different regions in China, different age groups, and different majors, to examine the similarities and differences of CTD in the labor market. Furthermore, in the measurement process, it is advised that future studies further enhance the measurement reliability and validity. Last, future studies should continue to explore the differences among CTD components attributed to gender from a deeper and multifaceted perspective, considering factors such as the cognitive mechanisms of the brain and the developmental potential of psychological awareness.

6. Conclusion

This study, grounded in the perspective of the labor market, employed the 2ES-CTDI framework to investigate the relationships among components of CTD of Chinese undergraduates. The framework delineates the dynamic equilibrium of CTD development within the labor market context, offering practical applicability for cultivating CTD in undergraduates. The findings suggest that educators, in the process of fostering CTD in undergraduates, should pay heightened attention to the demands of the labor market. Simultaneously, emphasis should be placed on the coordination of individual components and the influence of gender differences. Educators are encouraged to integrate relevant recommendations from labor market experts, making timely adjustments based on the demonstrated CTD of undergraduates. This approach facilitates more effective cultivation of CTD, enabling undergraduates to possess the critical capacities and advanced cognitive qualities essential for future employment.

Ethical approval

Participants and the university research committee both gave their consent by ethical standards. Approval Committee: The Institutional Review Board (IRB) of the Doctoral School of Education, University of Szeged. Approval number: 11/2021.

Data availability statement

Data will be made available on request.

CRedit authorship contribution statement

Yangyintao Zhao: Data curation, Formal analysis, Methodology, Software, Validation, Visualization, Writing – original draft.
Yong Liu: Conceptualization, Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing – review &

editing. **Hao Wu:** Funding acquisition, Resources, Writing – review & editing.

Declaration of Competing Interest

Declarations of interest: none.

Acknowledgment

This is to acknowledge that this work is supported by China Scholarship Council (Grant No: 202008500108), Tempus Public Foundation of Hungary government for Stipendium Hungaricum Scholarship (Grant Number: SHE-16610-004/2020), Excellence PhD Scholarship of University of Szeged, and University of Szeged for Open Access (Grant Number: 6675).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.ijer.2023.102306](https://doi.org/10.1016/j.ijer.2023.102306).

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