

Examining the relationship between instructional behaviors and critical thinking dispositions: A correlational study of general education

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Abstract

This study's objectives were to study the relationship between the critical thinking dispositions associated with instructional behaviors, examine the differences between grades in instructional behaviors and critical thinking dispositions, determine grade as a covariate variable while predicting instructional behaviors on critical thinking dispositions, and investigate the aspects of instructional behaviors predicting critical thinking dispositions. As can be known, critical thinking dispositions play an important role to contribute in critical reading. That means the more learners increase critical thinking, the more learners become critical readers. Hence, participants of 515 general knowledge students were from a general education school in Cambodia (8th graders = 143, 9th graders = 123, and 10th graders = 210), the age range was from 13 to 18 years old ($M = 1.57$, $SD = 0.50$). Some data is missing among grades that are less than 5%. Before using hierarchical multiple regression, one-way MANOVA was used to compare the differences between groups of grades. Findings revealed that both the 8th and 9th grades were different from the 10th grade. As well, grades were included through the regression model. However, grades were found to be non-significant in terms of interaction between instructional behaviors. Findings also proved that the aspects of instructional behaviors predicted two aspects of critical thinking dispositions, except that video lecture did not affect critical openness. This means the learner who suited a critical reader when teachers provided constructive feedback and support, self-determination in making decisions, sufficient video lessons, and cooperative learning. All in all, the implication of instructional behaviors might be suggested for furthermore general education.

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1. Introduction

Reading helps learners build critical thinking skills, which are vital for their growth and understanding. Reading is essential for developing these talents. Nevertheless, a significant number of students, particularly those living in underdeveloped nations, have difficulty with reading competency, which in turn has an impact on their capacity for critical thinking. The

motivation of students can be supported by effective teaching actions, which can also boost the students' attitude toward critical thinking (Em & Khampirat, 2025). Thus, this study investigates the relationship between instructional behaviors and critical thinking across a variety of grade levels within the educational system.

1.1. Background information

Active reading practice is the highest factor that allows for the enhancement of critical thinking. Learners become human assets. Naturally, this has brought attention to reading difficulties regarding several aspects of human capital to enhance the scope of their knowledge (Maughan, 1995). The ability to read is very important for facilitating advanced learning and human resource development to realize a civilized society. In addition to increasing reading ability, it is concerned with some variables related to educational study. Critical reading encompasses critical thinking (Aghajani & Gholamrezapour, 2019). The expertise that critical readers can or cannot reach relies on the level of critical thinking as well (Wilson, 2016). Unfortunately, reading proficiency has been revealed to be a major concern. Based on the PISA-D report in 2017, most 15-year-old students in developing countries only attain the basic level of reading competency. Compared to OECD countries that participated in the assessment, approximately 23% of students in developing countries reach only the lowest level of reading, whereas the average for OECD countries is 80% (Ward, 2018). Furthermore, the PISA-2022 results revealed that students in developing countries still maintain a low average (OECD, 2023).

In this context, personal actions, among various circumstances, might be justified by understanding one's disposition (Facione, 2000). Instead, schema-theory-based reading comprehension has been associated with critical thinking skills, which are known to be a major predictor (Aloqaili, 2012; Norris & Phillips, 1987). Lower reading comprehension means fewer skills for critical thinking in students (Ghorbandordinejad & Heydari, 2012; Marzban & Barati, 2016). Nevertheless, some argue that critical thinking dispositions have been measured as originally observed constructs to be enhanced with these dimensions and thus appraised through skills of thinking critically (Álvarez-Huerta et al., 2022; Cheng & Wan, 2017; Facione et al., 1995a; Kamgar & Jadidi, 2016; Norris, 2003). Hence, the thought process should reflect the tendencies of a critical thinker.

Consequently, grounded in self-determination theory, when learners are supported through effective instructional behaviors, they might improve their learning motivation (see Ruos et al., 2025). Simultaneously, this might enhance critical thinking dispositions when learners feel supported in a self-determination context (Xu & Yang, 2024). Hence, this study suggests effective instructional behaviors to address the research problem indirectly.

1.2. Research gaps

Many studies have revealed that instructional behaviors (i.e., support and feedback, cooperative support, autonomy support, video lectures) might enhance critical thinking dispositions effectively (e.g., Arslan & Demirtaş, 2016; Heng, 2014; Janse Van Rensburg & Rauscher, 2022; Pakmehr et al., 2015; Sablić et al., 2021; Xu & Yang, 2024). However, Zhang and Chen (2021) found an insufficient effect on critical thinking in nursing education. Basu Roy and McMahon (2012) also revealed that using video lectures linked with their training might decrease their level of critical thinking. Hence, different contexts might lead to different results. Moreover, all constructs were revised from different studies. Therefore, a simultaneous study might represent the gap in this research.

Importantly, the disappearance of critical thinking dispositions has been a rationale for decreasing reading literacy (Aghajani & Gholamrezapour, 2019; Aloqaili, 2012; Ghorbandordinejad & Heydari, 2012; Maughan, 1995; Wilson, 2016). Consequently, this study might enhance the level of reading comprehension among adult learners. Interestingly, counterparts, teachers, and policymakers might consider including this study in their curriculum and instruction. Theoretically, self-determination theory might demonstrate its potential in different contexts, especially in developing countries.

1.3. Research objective

The objectives of this study are as follows.

1. To study the relationship between aspects of instructional behaviors and critical thinking disposition.
2. To examine the differences between grades in instructional behaviors and critical thinking dispositions.
3. To determine grade as a covariate variable while predicting instructional behaviors on critical thinking dispositions.
4. To investigate the aspects of instructional behaviors predicting critical thinking dispositions.

1.4. Research questions

To address the research problems, this study applied these questions as follows.

1. What is the relationship between measures of instructional behavior and critical thinking dispositions?
2. Are there differences between grades, instructional behaviors, and critical thinking dispositions?
3. Is grade a covariate variable while predicting instructional behaviors on critical thinking dispositions?
4. Which aspects of instructional behaviors might predict critical thinking dispositions?

2. Literature review

This section presents an overview of the theoretical and empirical foundations related to the two main variables examined in this study: instructional practices and critical thinking dispositions. Instructional behaviors have a crucial role in creating learning settings that foster critical thinking dispositions, needed for students' cognitive development and decision-making abilities. Critical thinking tendencies are vital for kids. This review aims to elucidate how various instructional strategies may affect the cultivation of critical thinking tendencies in students. This comprehension will be derived from pertinent frameworks and contemporary research.

2.1. Critical thinking disposition

According to Facione et al. (1996), critical thinking dispositions are “the consistent internal motivation to employ one’s critical thinking abilities in judging what to believe or to do in any situation.” Critical thinking dispositions refer to attitudes (habits of mind), flexibility, a tendency to look for reasons, an open mind to being knowledgeable, respect, and a willingness to pay attention to other points of view (Ennis, 1996; Facione et al., 1995b; Lai, 2011; Siegel, 1999). Facione et al. (1995) named seven criteria to assess critical thinking tendencies,

including truth-seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness, and maturity. However, Walsh et al. (2007) discovered some assessment overlaps in the California Critical Thinking Disposition Inventory instrument due to the study's lack of updates. Hence, Sosu (2013) amended the criteria for measuring critical thinking dispositions to include critical openness and reflective skepticism.

Specifically, critical openness refers to certain tendencies that are incorporated with different concepts to build original ideas and products, and to be willing to engage with these tendencies considerably—leading to organizing and refining new concepts through explicit data or evidence (Álvarez-Huerta et al., 2022; Quinn et al., 2020; Sosu, 2013). When learners gain critical openness, they enhance cognitive flexibility in thinking; as a result, they begin reducing inflexibility in critical thinking (Price et al., 2015). Learners accept all forms of feedback, including positive performance feedback and constructive criticism, with consideration. They develop new concepts by correcting the depth of their beliefs or knowledge (Álvarez-Huerta et al., 2022; Kruglanski & Boyatzi, 2012; Quinn et al., 2020). Moreover, Riggs (2010, p. abstract) emphasized that critical openness can be considered “an attitude toward oneself as a believer, rather than toward any particular belief.” By gaining attitudes of critical openness, learners are required to value epistemology, be ready to act as virtuous agents, and develop specific skills and characteristics of critical openness (Riggs, 2010).

In addition, reflective skepticism refers to the attitude of not wanting to accept something or being unwilling to believe it (Williams, 2017). It measures a tendency to treat questions with confident evidence or information, learning from past experiences (Álvarez-Huerta et al., 2022; Sosu, 2013). When learners increase reflective skepticism, they engage in challenging their understanding or ideas. They always require different, reasonable, and sufficient evidence before making judgments. They reject all evaluations based on insufficient, unclear, unverified, or unreasonable evidence and seek multiple perspectives to ensure accuracy (Álvarez-Huerta et al., 2022; Quinn et al., 2020). As Thomas and Hayes (2021) stated, these characteristics can predict cognitive and flexible thinking demands. Furthermore, as recommended by Bravo et al. (2020), this factor structure can be beneficial in measuring adolescent critical thinking dispositions.

2.2. Instructional behaviors

According to Chan et al. (2023), supportive and effective instructional behaviors in teaching for learning include learning involvement, structure, and autonomy, grounded in self-determination theory.

Learning structure refers to the use of explicit information that guides learners in performing tasks under the teacher's directive, to enhance the intended learning outcomes of a given course (Jang et al., 2010). Teachers who are structured in their instructional methods provide instrumental support, constructive feedback, and clear explanations regarding instructions, guidelines, and expectations to improve students' learning outcomes (Chan et al., 2023; Mouratidis et al., 2013; Ryan & Deci, 2020; Van Tassel Baska et al., 2006). In addition, Sablić et al. (2021) found that video-based instruction can enhance the proficiency of both teachers and students and improve classroom progress. Video lectures are considered a more attractive form of online instruction compared to others (Chan, 2010) and serve as a reliable instructional design to support teaching (Sablić et al., 2021). When preparing video lessons, teachers should begin with a brief and targeted learning goal, use an appropriate tone and voice in explanations, emphasize key concepts using signaling, increase engagement through a conversational and enthusiastic style, and integrate active learning components such as interactive elements,

guiding questions, or relevant homework assignments (Brame, 2016). Despite some challenges with interest assessment, teachers can record video lessons, store them, and upload them for student access (Zaneldin et al., 2019). Simultaneously, video-based learning offers clear textual and visual criteria, helping learners solidify understanding, increasing motivation, engagement, and learning satisfaction (Chen, 2012). In this sense, such constructs are used to predict learning structure, which supports pre-video lectures. Previous studies have shown that flipped classroom-based video lectures improve critical thinking dispositions (Dehghanzadeh & Jafaraghaee, 2018). Moreover, Heng (2014) found that support and feedback are key constructs for academic engagement and achievement. In this context, the quality of feedback and learner engagement are primary factors influencing reading involvement (Crook et al., 2012). Prior research also suggests that support and feedback can contribute to enhancing critical thinking dispositions (Janse Van Rensburg & Rauscher, 2022).

Autonomy support is the initial strategy used to foster internal motivation. It refers to the degree of freedom learners have in and out of classroom activities, within guided instructional frameworks and learning choices (Deci & Ryan, 1985). Rather than relying on controlling interventions, autonomy support encourages teachers to understand learners' needs in alignment with their preferences and satisfaction (Chan et al., 2023; Skinner & Belmont, 1993). Teachers are expected to offer multiple choices and rationales, allowing students to pursue options that resonate with their attitudes, perspectives, and cognitive preferences (Moon & Ke, 2020; Patall & Zambrano, 2019; Skinner & Belmont, 1993). As a result, autonomy enables learners to develop strong decision-making capabilities, encouraging them to act based on their situations and opportunities. Learners use information from the environment to inform their decisions in terms of timing and context. They become more flexible, reduce resistance, and increase intrinsic motivation, aligning with self-determination theory to manage their learning environment (Ryan & Deci, 2020). Additionally, autonomy support can enhance perceived academic competence through intrinsic motivation (Guay et al., 2001). Teachers should provide autonomy support through (1) motivational encouragement, (2) using informational rather than controlling language, and (3) helping learners understand the subjective value of tasks and learning techniques (Taboada Barber et al., 2015). Previous studies have found autonomy support to be one of the most important factors in enhancing critical thinking dispositions (Xu & Yang, 2024).

Learning involvement refers to the connection, relationships, and collaborative opportunities between learners and peers, as well as learners and teachers, within and beyond the classroom environment (Mason, 2013; Pohan, 2003). According to Pohan (2003), teachers should demonstrate care and move away from conventional methods of managing discipline and behavior. Instead, they should provide students with the necessary knowledge, skills, and dispositions. All stakeholders should place equal emphasis on students' social, emotional, ethical, and psychological growth, not just academic success. Furthermore, intentional and constructive cooperation among learners is a key factor in learning involvement (Moon & Ke, 2020). Active participation, such as discussions, interactive activities, and collaboration using social skills, is a valuable aspect of classroom engagement (Moon & Ke, 2020). Theoretically, working with students emphasizes what learners can do rather than what they must do for teachers or coursework. This approach motivates students to focus on their success and invest time and effort into the learning process (Arnold, 2014). Likewise, cooperative learning should be implemented appropriately to enhance learning involvement (Chan et al., 2023). Previous studies have shown that cooperative support can effectively improve critical thinking dispositions (Pakmehr et al., 2015).

3. Methodology

This section provides an overview of the methodological procedures that were utilized in the research project. These procedures include the research design, sampling strategy, instrumentation, data collection methodologies, and analytic methods. To investigate the connections between instructional behaviors and critical thinking dispositions among Cambodian high school students, a quantitative approach was chosen as the method of investigation. The data were obtained through the use of a self-report questionnaire, and several statistical analyses were carried out to evaluate the validity, reliability, and predictive capacity of instructional practices on the critical thinking dispositions of students.

3.1. Research design

The sample size was determined using the rule of thumb for selecting an appropriate sample size. According to Hair et al. (2017) and Tanaka (1987), a suitable sample should be ten to twenty times the number of items in the research model. In this study, 34 items were measured across nine main constructs. Therefore, an appropriate sample size for this study was 515 participants. Convenience random sampling was employed to select participants from students in the 8th, 9th, and 10th grades in high schools (8th grade = 143, 9th grade = 123, and 10th grade = 210), with an age range of 13 to 18 years ($M = 1.57$, $SD = 0.50$). Missing data accounted for less than 5%, as confirmed through data analysis.

To support this study, data were collected via a self-report questionnaire administered to high school students in Cambodia. The study was approved by the university's Board of Ethics. Permission was obtained from school principals to collaborate with the high schools. Students who voluntarily participated in the study responded to the survey questionnaire.

3.2. Research instrument

To utilize the measures in Cambodia, all items were statistically adapted using JASP (Love et al., 2019) in conjunction with R package software for data analysis to assess the instrument's validity between instructional behaviors (i.e., support and feedback, autonomy support, video lecture, and cooperative support) and critical thinking dispositions (i.e., reflective skepticism and critical openness). The translation and back-translation method were employed to adapt all items (Behling & Law, 2006). First, the researchers adapted the English version and translated it into Khmer by experts. Then, the Khmer version was back-translated into English by other experts. Second, two bilingual Khmer and English teachers were invited to review both versions. Third, two experts were consulted to adjust the operational definitions and all items to ensure content validity. Fourth, face validity was confirmed through 50 students to assess how well the measures were understood and perceived as valid and reliable. Finally, 515 students voluntarily participated in the study to provide data for measurement validation. A self-report method was used to assess students' perceptions of all items using a 5-point Likert scale, ranging from 1 "strongly disagree" to 5 "strongly agree".

Table 1. HTMT, correlation, and validity-reliability results

Variables	SF	AS	VL	CS	RS	CO
SF	$\frac{3}{4}$	0.29**	0.18**	0.48**	0.41**	0.41**

AS	0.46	$\frac{3}{4}$	0.34**	0.23**	0.27**	0.32**
VL	0.30	0.49	$\frac{3}{4}$	0.23**	0.26**	0.25**
CS	0.71	0.28	0.28	$\frac{3}{4}$	0.61**	0.58**
RS	0.61	0.35	0.38	0.82	$\frac{3}{4}$	0.70**
CO	0.59	0.41	0.323	0.77	0.97	$\frac{3}{4}$
Mean	4.13	0.47	3.34	3.95	3.90	3.95
SD	0.392	0.66	654	0.465	0.438	0.407
Skewness	0.006	-0.307	-0.315	-0.171	-0.056	0.105
Kurtosis	0.738	0.290	0.773	0.831	1.14	0.483
AVE	0.23	0.39	0.40	0.40	0.32	0.28
$\sqrt{\text{AVE}}$	0.48	0.62	0.63	0.63	0.57	0.53
α	0.63	0.72	0.80	0.76	0.70	0.73
ω	0.65	0.71	0.80	0.77	0.70	0.72

Notes: ** $p < .01$; SF = Support and Feedback; AS = Autonomy support; VL = Video lecture; CS = Cooperative support; RS = Reflective skepticism; CO = Critical openness; SD = Standard Deviation; Skewness = Data normality of Skewness value; Kurtosis = Data normality of Kurtosis value; AVE = Average Variance Extracted; $\sqrt{\text{AVE}}$ = Square root of Average Variance Extracted; α = Cronbach's alpha internal consistency reliability; ω = McDonald Omega coefficient construct or composite reliability.

Before conducting validation through confirmatory factor analysis (CFA), skewness and kurtosis values were examined, ranging from -0.315 to 0.105 and 0.290 to 1.14, respectively. These values indicated that the assumption of data normality was met, as skewness and kurtosis values fell within the acceptable range of ± 1 and ± 2 , respectively, according to J. F. Hair et al. (2019). Furthermore, discriminant validity was assessed using Pearson's correlation and the Heterotrait-Monotrait ratio (HTMT) among different constructs. Henseler et al. (2015) and Kline (2016) asserted that intercorrelations below 0.90 or the threshold of 0.85 indicate acceptable discriminant validity. Table 1 shows the highest correlation between reflective skepticism and critical openness, ranging from 0.70 to 0.97; however, both constructs fall under the broader category of critical thinking disposition. Therefore, this correlation may still be considered acceptable. Additionally, Fornell and Larcker (1981) recommended that the square root of the AVE of each construct should be greater than or equal to the highest correlation with any other construct. Table 1 indicates that some of the highest correlations are slightly greater than the square root of the average variance extracted, indicating minimal but acceptable discriminant validity.

To ensure consistent measurement, convergent validity was also evaluated. According to Hair (2010), convergent validity is supported when standardized factor loadings are above 0.4 or

preferably 0.70, average variance extracted (AVE) values exceed 0.50, and composite reliability is above 0.70. As shown in Table 1, standardized loadings mostly range from 0.401 to 0.703, and composite reliability values range from 0.70 to 0.80. However, all AVE values are below 0.50, indicating minimal acceptable convergent validity.

Importantly, CFA was used to validate all the measures in context. Model fit was assessed using chi-square (χ^2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA), as recommended by Hair et al. (2019) and Kline (2023). For samples with more than 250 participants and over 30 observed variables, acceptable fit indices include a significant chi-square, CFI and TLI values above 0.92, $SRMR \leq 0.08$, and $RMSEA \leq 0.07$. According to Kline (2016), RMSEA values below 0.05 indicate excellent fit, while values below 0.08 suggest acceptable fit. In this study, CFA results revealed an acceptable model fit: $\chi^2(480, 515) = 773.902$, $p < .001$, CFI = 0.90, TLI = 0.89, SRMR = 0.054, and RMSEA = 0.035.

3.3. Instructional behaviors

Scales on instructional behaviors were adapted from prior studies (Chan et al., 2023; Heng, 2014; Long et al., 2016). Instructional behaviors were measured in terms of students' perceptions of their teachers' support and feedback (6 items, e.g., 'Your teacher offered helps to you when you had (a) problem (s) with your homework or exercise') (Heng, 2014), of their teachers' autonomy support (4 items, e.g., 'Your teacher accepted your suggestions on how to do homework or exercise that you sought') (Chan et al., 2023), of their teacher's video lecture support (6 items, e.g., The lesson were well-explained in the video lecture) (Long et al., 2016), and of their involvement in cooperative support (5 items, e.g., 'When you did group work, you discussed your ideas with other students in your group') (Chan et al., 2023). Cronbach's alpha values for support and feedback, autonomy support, video lecture, and cooperative support were 0.63, 0.72, 0.80, and 0.77, respectively, suggesting acceptable and good internal consistency.

3.4. Critical thinking dispositions

Scales on critical thinking dispositions were adapted from a previous study (Sosu, 2013). Students' critical thinking dispositions were tapped through their perceived reflective skepticism (5 items, e.g., 'You often think about your actions to see whether you could improve them.'), and perceived critical openness (7 items, e.g., 'It's important to understand other people's viewpoint.'). The Cronbach's alpha values for reflective skepticism and critical openness were 0.70 and 0.72, respectively, which indicated good internal consistency.

3.5. Data gathering procedures and ethical considerations

In support of this study, data collection was gathered through surveys from high school students in Cambodia by using a self-report questionnaire. The university's Board of Ethics ID: 136/2023 RUPP KS approved this study. A permission letter was requested to collaborate with the school principals at the high school. Volunteered students who participated in this study were treated with a survey questionnaire.

3.6. Data analysis

Data analysis with statistical processes was applied to the data to address the research questions. We studied the relationship between aspects of instructional behavior and critical

thinking disposition and examined the different instructional support and critical thinking dispositions between grades and the effects of instructional behaviors in predicting critical thinking dispositions when controlling for grades. First, intercorrelations between constructs are affirmed when their correlations are lower than 0.90 or a threshold of 0.85 (Kline, 2016). Then, the one-way MANOVA analysis was used to compare the grades between instructional behaviors and critical thinking dispositions. Box's M test was judged for homogeneity tests via Pillai's Trace and Wilks' Lambda multivariate tests between grades (Tabachnick & Fidell, 2014). Furthermore, tests between constructs effects and Levene's test were used to judge assumptions in order to determine if grades are adequate differences between groups. To specify more accuracy, multiple comparisons between groups were analyzed through heterogeneity, whether equal variance was assumed or not (Kline, 2023). Calculatedly, that might compare between groups' means if the samples' largest and smallest comparisons are lower than 1.5, respectively (Pituch & Stevens, 2016). When homogeneity of equal variance-covariance is assumed in comparing sample data between group means, Bonferroni's post-hoc multiple comparison method was used to calculate (Tabachnick & Fidell, 2014). Additionally, to ensure the model can be measured through hierarchical multiple regression, multicollinear problems were assumed when the variance inflation factor (VIF) is greater than 1.5. Lastly, hierarchical multiple regression was utilized to control grades in the model. Data analysis was performed using SPSS version 27.

4. Findings

Q1: What is the relationship between measures of instructional behavior and critical thinking dispositions?

Table 2: Multivariate tests of grade effects on instructional behaviors and critical thinking dispositions

Effect		Value	F	Hypothesis df	Error df	p.	η^2
Grades	Pillai's Trace	0.086	3.593	12.000	964.000	0.000	0.043
	Wilks' Lambda	0.915	3.620	12.000	962.000	0.000	0.043
	Hotelling's Trace	0.091	3.647	12.000	960.000	0.000	0.044
	Roy's Largest Root	0.076	6.074	6.000	482.000	0.000	0.070

Note: Box's M: (42, 528137.365) = 71.255, F = 1.665, $p < 0.05$

This study aimed to examine whether critical thinking dispositions (i.e., critical openness and reflective skepticism) are associated with instructional behavior (i.e., support and feedback, autonomy support, video lecture, and cooperative support). The satisfactory result was revealed between constructs. All subconstructs indicated the intercorrelation from low to strong (0.18 to 0.70) through Pearson's correlation (see Table 1). Moreover, the perceptions of support and feedback, autonomy support, video lecture support, and cooperative support were positively correlated with reflective skepticism and critical openness.

Q2: Are there differences between grades' instructional behaviors and critical thinking dispositions?

Table 3. Levene's Test for Equality of Error Variances by Grade

Variables	Levene Statistic	df1	df2	p.
Support and feedback	0.429	2	486	0.651
Autonomy support	1.960	2	486	0.142
Video lecture	1.493	2	486	0.226
Cooperative support	0.627	2	486	0.535
Reflective skepticism	9.511	2	486	0.000
Critical openness	2.248	2	486	0.107

To determine whether grades show ample differences, one-way MANOVA analysis was used to compare the grades between instructional behaviors (i.e., support and feedback, autonomy support, video lecture, and cooperative support) and critical thinking dispositions (i.e., critical openness and reflective skepticism). Box's M test was used to judge homogeneity tests via Pillai's Trace and Wilks' Lambda multivariate tests between grades. Table 2 shows Box's M test: $(42, 528137.365) = 71.255$, $F = 1.665$, $p < .05$, as well as, via Pillai's Trace and Wilks' Lambda multivariate tests between grades were significant (Tabachnick & Fidell, 2014). Furthermore, tests between constructs effects and Levene's test were used to judge assumptions in order to determine if grades show a significant difference between groups. As can be seen, Table 3 revealed Levene's test of quality of error variances was non-significant and the test between-subject effects between grades was significant, affirming that equal variance was assumed. Not only this, but to modify how different levels among grades, post-hoc comparison between groups was utilized. Table 5 showed that grade 8 and grade 9 had no significant difference between instructional behaviors and critical thinking dispositions. Notably, both grades 8 and 9 were significantly different compared to grade 10.

Table 4: Between-Subjects Effects of Grade on Instructional Behaviors and Critical Thinking Dispositions

Source	Dependent Variable	SS	df	MS	F	p.	η^2
Grade	Support and feedback	1.864	2	0.932	5.457	0.005	0.022
	Autonomy support	5.191	2	2.596	5.965	0.003	0.024
	Video lecture	8.599	2	4.299	10.414	0.000	0.041
	Cooperative support	3.401	2	1.700	8.218	0.000	0.033
	Reflective skepticism	3.474	2	1.737	9.711	0.000	0.038

	Critical openness	1.902	2	0.951	5.915	0.003	0.024
Error	Support and feedback	83.023	486	0.171	n/a	n/a	n/a
	Autonomy support	211.474	486	0.435	n/a	n/a	n/a
	Video lecture	200.632	486	0.413	n/a	n/a	n/a
	Cooperative support	100.554	486	0.207	n/a	n/a	n/a
	Reflective skepticism	86.924	486	0.179	n/a	n/a	n/a
	Critical openness	78.120	486	0.161	n/a	n/a	n/a

Note: SS = Type III Sum of Squares; MS = Mean Square; η^2 = Partial Eta Squared

Q3: Is grade a covariate variable when predicting instructional behaviors on critical thinking dispositions?

As can be seen in Table 5, the comparison between grades might be considered a covariate variable. This means the distinction between grades might impact predictive analysis. However, Table 6 shows that grades are not ought to be judged as a covariate variable. Lack of significance in terms of interaction between the grades and instructional behaviors (i.e., support and feedback, autonomy support, video lecture, and cooperative support) during regressing critical thinking dispositions (i.e., critical openness and reflective skepticism). Hence, grades might not be a covariate in predictive analysis through a multiple regression study.

Table 5. Post-hoc Grade Comparisons on Instructional Behaviors and Critical Thinking Dispositions

Variables	Grades comparison	MD	SE	95% Confidence Interval	
				Low	High
Support and feedback	Grade 8 vs. Grade 9	0.0216	0.04976	-0.1006	0.1438
	Grade 8 vs. Grade 10	-0.1137*	0.04406	-0.2219	-0.0055
	Grade 9 vs. Grade 10	0.1353*	0.04642	0.0214	0.2493
Autonomy support	Grade 8 vs. Grade 9	-0.1071	0.07942	-0.3021	0.0879
	Grade 8 vs. Grade 10	-0.2405*	0.07031	-0.4131	-0.0678
	Grade 9 vs. Grade 10	-0.1333	0.07408	-0.3152	0.0486
Video lecture	Grade 8 vs. Grade 9	0.0782	0.07736	-0.1117	0.2682

Cooperative support	Grade 8 vs. Grade 10	-0.2253*	0.06849	-0.3935	-0.0572
	Grade 9 vs. Grade 10	0.3036*	0.07216	0.1264	0.4808
	Grade 8 vs. Grade 9	-0.0292	-0.0292	-0.0292	-0.0292
	Grade 8 vs. Grade 10	-0.1802*	-0.1802*	-0.2993	-0.0612
	Grade 9 vs. Grade 10	-0.1511*	-0.1511*	-0.2765	-0.0256
Reflective skepticism	Grade 8 vs. Grade 9	0.0046	0.05092	-0.1204	0.1296
	Grade 8 vs. Grade 10	-0.1680*	0.04508	-0.2787	-0.0574
	Grade 9 vs. Grade 10	-0.1726*	0.04750	-0.2893	-0.0560
Critical openness	Grade 8 vs. Grade 9	-0.0513	0.05002	-0.1715	0.0689
	Grade 8 vs. Grade 10	-0.1432*	0.04226	-0.2446	-0.0418
	Grade 9 vs. Grade 10	-0.0919	0.04592	-0.2022	0.0185

Note: * $p < 0.05$ MD = Mean Difference; SE = Standardized Error

Q4: Which aspects of instructional behaviors might predict critical thinking dispositions?

This study aimed to examine whether critical thinking dispositions (i.e., critical openness and reflective skepticism) are associated with instructional behaviour (i.e., support and feedback, autonomy support, video lecture, and cooperative support). The result revealed the satisfaction with the measurement model. As can be seen, the result exposed instructional behaviors explained the variance with 39% of critical openness ($R^2 = 0.39$, $\Delta R^2 = 0.003$, $F(4, 515) = 38.530$, $P < 0.001$) and 41% of reflective skepticism (41% of variance) ($R^2 = 0.41$, $\Delta R^2 = 0.005$, $F(4, 515) = 83.934$, $P < 0.001$). Also, variance inflation factors (VIF) ranged from 1.204 to 1.460, a value of 1.5, confirming the multicollinear problem in the measurement model. Interestingly, critical openness was associated with support and feedback ($\beta = 0.12$, $p < 0.05$), autonomy support ($\beta = 0.15$, $p < 0.01$), and cooperative support ($\beta = 0.48$, $p < 0.01$) significantly. Simultaneously, reflective skepticism was associated with support and feedback ($\beta = 0.13$, $p < 0.05$), autonomy support ($\beta = 0.07$, $p < 0.05$), video lecture ($\beta = 0.09$, $p < 0.05$), and cooperative support ($\beta = 0.51$, $p < 0.01$), significantly.

Table 6. Hierarchical multiple regression analysis

Constructs	Critical openness					Reflective skepticism				
	β	F-value	R^2	ΔR^2	VIF	β	F-value	R^2	ΔR^2	VIF
Model 1										
Support and feedback	0.109*	76.755**	0.3860	0.3861	1.4070	0.121*	83.934**	0.4060	0.4061	1.411
Autonomy support	0.161**				1.2790	0.077*				1.279

Video lecture	0.060	1.2040.094*	1.211
Cooperative support	0.474**	1.3390.510**	1.342
Model 2			
Support and feedback	0.116* 38.530**0.3890.0031.4540.127* 42.462**0.4100.005		1.460
Autonomy support	0.153**	1.3430.074*	1.346
Video lecture	0.059	1.2190.092*	1.228
Cooperative support	0.475**	1.3410.509**	1.344
Support and feedback x Grade	0.006	1.4370.067	1.424
Autonomy support x Grade	-0.039	1.3350.003	1.329
Video lecture x Grade	-0.024	1.244-0.008	1.241
Cooperative support x Grade	0.029	1.315-0.067	1.303

Note: *p > 0.05, **p > 0.01

5. Discussion

This study aimed to examine whether critical thinking dispositions (i.e., critical openness and reflective skepticism) are associated with instructional behaviors (i.e., support and feedback, autonomy support, video lecture, and cooperative support). As researchers reviewed, these instructional supports were used to study with some levels of students; however, they were rarely studied with critical thinking dispositions. So, this design expressed a preferent result. A similar level of study between grades might lead to different results. Interestingly, most instructional behaviour can predict critical dispositions. Critical openness was associated with support and feedback, autonomy support, and cooperative support. This is more likely the learners' perceived specific trends in different concepts to generate a new idea on their own when they encounter them through adequate instruction, such as constructive feedback, encouragement, and instant and structured support, as well as an autonomous learning style in their responsibility. Furthermore, allowing cooperative support in their collaborative group was a more accurate study through peer teaching and peer responsibility during the group discussion in terms of academic education. In this sense, it might be reliable and matched to previous studies (e.g., Chan et al., 2023; Moon & Ke, 2020; Pakmehr et al., 2015; Xu & Yang, 2024)

On the other hand, reflective skepticism was also associated with all instructional behaviors. This is more likely learners might perceive their willingness to treat the questioning through confident evidence or information to be learnt from past experiences when they are familiar with ample instructional behaviors through teachers, like support and constructive feedback, freedom of learning in and out of the class through their own decisions with learning tasks, groups, or peers, well-supported through video lectures in different places, flexible support

linking their interests and learning tasks, as well as cooperative support via group study in terms of academic study in-and-out of the learning courses. Hence, findings revealed in confirming and matching through previous studies (e.g., Chan et al., 2023; Dehghanzadeh & Jafaraghaee, 2018; Janse Van Rensburg & Rauscher, 2022; Moon & Ke, 2020; Pakmehr et al., 2015; Xu & Yang, 2024).

6. Conclusion and recommendation

This research study was very impressive in seeking new supports for the educational sector with three layers: academic level, educational policy level, and theoretical and practical level. As well, researchers suggest and recommend the following:

A can be proposed through this study: (1) to study the relationship between instructional behaviours, learning motivations, and critical thinking dispositions, and (2) to examine the effects of instructional behaviors and learning motivations on critical thinking dispositions. After surveying among secondary and high school students in the amount of 515, the findings indicated the need for practitioners or teachers to improve their teaching in general knowledge, and lead to improving the feasibility of education to reach world competition and be honorable for Cambodian education. To promote the critical thinking dispositions, researcher recommend that teachers should (1) be concerned with learning choice with tasks (i.e., homework, exercise, peer-work, and group-work) that can build their interest to concentrate on learning process, (2) support with sufficient learning structure that teachers require to offer clear support, such video lecture with clear explanation, linking with homework or exercise in the textbooks, being available for free-time and free-places through learning courses, as well as adequate support and feedback (i.e., constructive and timely feedback, encouraging to ask the question) on what they do with learning, especially reading course (3) provide an involvement with them that teachers permit them to get an opportunity to build group learning cooperatively (i.e., cooperative learning, peer support such as peer-constructive feedback, peer-teaching, and peer-assistance) that deals with their thinking styles as critical thinking dispositions (i.e., self-evaluation, reasoning thinking, optimal cognition, mind-understanding, and evidence-based decision) during the academic year in general knowledge educations to enhance the efficient and effective instructions to fulfill national and international goals to promote human's critical thinking, especially teenagers who are over 15 years old.

As can be revealed above, this study aims to examine the effects of instructional behaviors on critical thinking dispositions. As we have exhibited in the views of this study that revealed instructional behaviors grounded by self-determination theory were suited to the contextual study. Among indicators of instructional behaviors that should be promoted through educational curriculum and instruction by increasing teaching training courses or seminars. Likewise, this research study was taken as part of innovation in the educational sector in Cambodia. Policymakers and stakeholders, and MoEYS, who would like to improve pedagogical knowledge for teachers' training, should make decisions through each indicator to adapt training to them. When they study this finding, they will set up their teaching at a public school to make a huge change in students' learning in general knowledge. They might be attracted to most of the students in high school to pursue their studies. Not only that, it can lessen the student's drop-out rates and promote enormous human resources for Cambodia. Hence, it can lead Cambodia's students to be caught up in various opportunities to learn many skills that are appropriate with the latest changes in the world and the Sustainable Development Goals.

Seriously, a theoretical study was contemplated as the main product of the research study. Little is known about how self-determination theory can be supported in educational context. After research, studies should increase specific indicators among subscales of each main construct. To keen specific evidence and create new correlations out of instructional behaviors critical thinking dispositions.

6.1. Limitations and suggestions for future research

Similar to most studies, this correlation design with this model was limited to the general educational level. However, we have seen that some effects of constructs were shown to be insufficient to promote, so researchers should try to develop this study instrument that can ensure the reliability and validity of measurement with participants. Moreover, researchers suggest that future research should apply this model to different students' levels. Otherwise, if the next study would like to replicate this study, they should adapt the research instrument with teachers in secondary school and high school to ensure the logic of measurement of the instrument. On the other hand, the next study should use a mixed-methods study to clarify some effects that did not appear in this study. Last, but not least, get a dominant benefit from this study to develop the teaching style for all teachers at the same level of study that can make sure numerous high school students can receive real education in Cambodia to be appropriate with the Sustainable Development Goals.

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Declaration of AI usage

The authors used Grammarly to polish the language in some parts of the article. However, they declared that the content of the article is totally theirs.

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Appendix

Instructional behaviors	
Support and Feedback	Items
	Your teacher enabled students of different abilities to answer the questions.
	Your teacher offered to help you when you had (a) problem(s) with your homework or exercise.
	Your teacher praised you when you did well on your homework or exercise.
	Your teacher checked your homework.
	Your teacher checked if you had learned the material well before going on to new material.
	Your teacher gave you good feedback that helped improve your understanding.
	Your teacher gave you feedback on your homework or exercise.
Autonomy support	Items
	Your teacher decided with you who you would learn from or do group work with.
	Your teacher lets you choose between homework and an exercise that matches your interests.
	Your teacher accepted your suggestions on how to do homework or exercise that you sought.

Your teacher accepted your suggestions on who you prefer to do group work with.

**Video
lecture**

Items

You like viewing pre-class videos better than reading text materials

The videos were helpful because you could do them on your own time.

You think video lecture learning is easy to learn from the lesson.

The lessons were well-explained in the video lecture.

The video lecture helped complete the homework or exercise.

The video lectures were more helpful for completing the in-class activities.

**Cooperative
support**

Items

When you did group work, you discussed your ideas with other students in your group.

When you did group work, you tried to understand other students' ideas in your group.

When you did group work, you taught or helped other students in your group when they encountered problems at some point in the group work.

When you did group work, you got constructive feedback from other students in your group.

When you did group work, you collaborated with other students in your group to prepare the group work.

Critical thinking dispositions

**Critical
openness**

Items

You always think about the bigger picture during a discussion.

You always use new ideas to shape (modify) the way you do things.

You always seek for new ideas from different source (reading book, searching on internet, asking others, searching in library....)

You are always on the lookout for new ideas.

	You sometimes find a good argument that challenges some of your firmly held beliefs.
	It's important to understand other people's viewpoints.
	You think it is important to justify your understanding or the choices you make.
Reflective skepticism	Items
	You always re-evaluate your experiences.
	You always re-evaluate your experiences to learn from them.
	You always check the source of information, whether it is credible, before making judgments or believing.
	You always think about the wider implications of a decision before taking action.
	You often think about your actions to see whether you could improve them.