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Moderating Effects of Goal Orientations on the Relationship between Smart Learning Approach and Teaching of Critical Thinking Skills among Pre-Service Teachers

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Abstract

Teaching critical thinking skill using the smart learning approach have been treated as the essential goal of higher education in many countries, however, as the important predictors of academic performance, the effects of goal orientations on teaching critical thinking skill using the smart learning approach are still not fully clear, hence, this study tried to explore the moderating effects of goal orientations on the relationship between constructivist smart learning approach and critical thinking skills among pre-service teachers. Findings showed that there were significant moderating effects of intrinsic goal orientations on the positive relationships between smart learning approaches of student negotiation, inquiry learning, and reflective thinking and critical thinking skills, by contrast, extrinsic orientations cannot play the role. These results contribute some valuable information and knowledge for relevant theories and teaching practices, which were also further discussed in this study.

Keywords: Goal Orientations, Smart Learning Approach, Teaching Critical Thinking Skills

Introduction

learning and working in the 21st century with the highly competitive global "knowledge economy", students and employees can no longer survive by memorizing textbooks, they must learn to use "21st-century skills" to analyze, synthesize, and evaluate huge amounts of facts and information in everyday life, and solve problems effectively(Pithers & Soden, 2016). Critical thinking skills have been treated as essential skills of "21st-century skills" as well as a core goal and task of higher education in many countries(Pithers & Soden, 2016). Especially for student teachers who are future teachers in higher education, it is particularly important to cultivate and develop their critical thinking skills (Puig et al., 2020).

However, attempts to teach critical thinking skills among college students, including preservice teachers, have not been totally successful. Some previous studies have shown that college students' critical thinking skills are still in the middle level (Puig et al., 2020). Hence,

teaching these vital survival thinking skills among pre-service teachers effectively has been a major challenge to educators in the 21st century classroom (Islam et al., 2021).

Constructivist Smart Learning Approach makes the current classroom teaching more dynamic (Puig et al., 2020). It is learners-centered and emphasizes flexible, efficient, and open learning and teaching methods, and lays favorable conditions for the construction of information-based, smart and digital teaching and learning system, all of which are conducive to the development of students' critical thinking (Chang et al., 2020).

What needs to be emphasized here is that constructivist smart learning approach is different from traditional teaching methods. Teachers need to acquire and master new experience and knowledge, so as to make full use of this advance teaching approach to achieve effective teaching of critical thinking skills (Chang et al., 2020). Some studies showed that because of lacking the basic theories and knowledge , many teachers are not very capable in using the constructivist smart learning approach to service their teaching especially in teaching of critical thinking skills among pre-service teachers (Jiang et al., 2022) and they urgently needs some relevant theories and information to guide their teaching.

As the motivation for individuals to engage in achievement-related task, goal orientations are always the dynamic factors for individuals to work hard on things that they view are important and valuable (Pintrich, 2000). It is an individual belief system about the purpose of achievement activities, the significance of success and the integration of success standards, which reflects an internal cognitive orientation of achievement task (Pintrich, 2000).There are many studies have shown that goal orientations are good predictors of students' learning strategies, leaning engagement, learning self-efficacy and learning performance in different learning environment(Burke et al., 2014; Hakelind et al., 2020; Hanley, 1995; Mao et al., 2021; VanTassel-Baska et al., 2009)

Hence, the current study try to explore the moderating effects of goal orientations on the relationship between constructivist smart learning approach and critical thinking skills with expectation of contributing some effective guidance for teaching critical thinking skill among pre-service teachers.

In this sense, two research questions guide this study:

1. What is relationship between the constructivist smart learning approach and critical thinking skills among pre-service teachers?
2. To what extent do goal orientations moderator the relationship between the constructivist smart learning approach and critical thinking skills among pre-service teachers?

Literature Review and Hypotheses

Constructivist smart learning approach and critical thinking skills

Smart learning approach is based on the theory of constructivism that emphasizes the dominant position of students and the ability to guide themselves (Pérez et al., 2022). It is characterized by intelligent, situational, cooperative, interactive, flexible and ubiquitous Zhang (2021) and integrates advanced forms of educational technology to support the easy, engaged, and effective learning (3E) at anytime, anywhere, in any way and at any pace (4A) (Freigang et al., 2018).

According American Philosophy Association (1998), critical thinking should possess six basic skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation. It is generally suggested that approaches of CT interventions and strategies can be categorized into individual study(self-directed learning), dialogue (cooperative learning), authentic or situated problems and mentoring (Abrami et al., 2015). Furthermore, Ennis (2018) proposes

two CT skill teaching strategies from a wider perspective which are named Problem-based learning (PBL)and Lecture Discussion Teaching (LDT). Constructivist smart learning approach mainly involves three aspects which are cognition and metacognition, technology and content, and social and physics (Tabuenca et al., 2021). According MacLeod et al (2018) "Student Negotiation", "Inquiry Learning" and "Reflective Thinking" are the main three smart learning approaches for cognition and metacognition. Many studies have shown that the three smart learning approaches are closely associated with critical thinking skills (Lu et al., 2021; Marzano et al., 2021; Mbunge et al., 2022; Sumadyo et al., 2018).

Student negotiation enables learners to share and discuss different understandings and opinions with each other and further gain multi-dimensional and multi-perspective understanding of things that is conductive to critical thinking skills(Richards et al., 2020; Sung, 2022). Edwards et al(2020) argued that negotiation can motivate students to make higher level knowledge construction that is more important for the development of students' critical thinking Skills; Marsnik and Thompson (2013) found the negotiation in Computer-Supported Social Collaborative Learning Environment had a positive effect on the development of college students' critical thinking skills.

Inquiry learning refers to the process in which students actively explore the inconsistencies and even contradictions between their existing experiences and newly discovered phenomena or facts Ramlee et al (2019) and on this basis, reflect on and revise their experiences and understandings, and reconstruct (propose or accept) more convincing and scientific new explanations, new assumptions and new concepts (Kaiser et al., 2018). Inquiry learning is beneficial to the cultivation of students' problem solving ability, critical thinking skills. Mutlu (2020) found that Problem Based Learning in Flipped Classroom can improve students' Higher Order Thinking Skills; Wale and Bishaw(2020)conducted an descriptive quantitative true-experiment to explore the effect of Inquiry-Based Laboratory on students' Higher Order Thinking Skills, results shown that inquiry-based laboratory activities improved students' Higher Order Thinking Skills effectively.

Reflective thinking refers to the psychological activities of self- observation, analysis, evaluation, and transformation of learners' existing experiences, behavior processes, or their physical and mental structures (Akpur, 2020; Saracoglu, 2022). Reflective learning can promote learners to critically examine their own cognitive structure, learning activities , scientifically explore the problems and effectively regulate the whole learning activities to promote problem solving (Ismail et al., 2017). They assessed the associations among reflective thinking, critical thinking, self-monitoring, and academic achievement, which shown that reflective thinking predicted critical thinking positively and significantly (Yaacob et al., 2020). Greenberger (2020) conducted an experimental study which elicited the positive effects of reflective thinking-based teaching activities on pre-service teachers' critical thinking skills. Verawati et al (2021)argued that cooperative learning supported by reflective thinking activities can improve students' critical thinking skills in some degree.

Based above, we propose that the three smart learning approaches of Student Negotiation, Inquiry Learning and Reflective Thinking have positive effects on critical thinking skills among pre-service teachers. Thus, the current study hypothesize the following relationships:

Hypothesis 1_a:There is a significant positive relationship between student negotiation and critical thinking skills among Pre-Service Teachers.

Hypothesis 1_b:There is a significant positive relationship between inquiry learning and critical thinking skills among Pre-Service Teachers.

Hypothesis 1_c:There is a significant positive relationship between reflective thinking and critical thinking skills among Pre-Service Teachers.

The Moderating Role of Goal Orientations

Goal orientation refers to the motivation for individuals to engage in achievement-related task which can explain individuals cognitive judgment and value judgment of achievement motivation (Malik et al., 2019). According to the two-factor theory of goal orientation, goal orientation can be divided into intrinsic goal orientations(learning goal orientation) and extrinsic goal orientations(performance goal orientations)Vandewalle & Nerstad (2019) ,intrinsic goal orientation always refers to challenge, curiosity, mastery and so on, while extrinsic goal orientation refers to grades, rewards, performance, evaluation by others, and competition. Learners with different goal orientations always show different characteristics in cognition, emotion and behavior of (Pintrich, 2000; Vandewalle & Nerstad, 2019; Weidinger et al., 2016).

Students with intrinsic goal orientations always attach importance to the development and progress of their abilities, maintain a positive emotion state in the face of difficulties and failures, make unremitting efforts and prefer choosing challenging tasks , using more deep processing strategies self-regulated learning strategies and make continuous efforts by focusing on current learning tasks(Weidinger et al., 2016); while students with extrinsic goal orientations always pay more attention to show good performance, hold negative emotions such as anxiety and shame when facing failure and more likely to choose low-effort tasks, use more superficial strategies that are easier to succeed (Vandewalle & Nerstad, 2019).There are many studies that have shown that Goal Orientations are good predictors of students' learning strategies, leaning engagement, self-efficacy by which Goal Orientations can moderate the influence of learning approach on college students' learning outcomes (He et al., 2016; Honicke et al., 2020; Kaspi-Baruch, 2019; Liu et al., 2021; Miller et al., 2021; Spinath & Steinmayr, 2012).

In a blended learning environment, college students' learning goal orientations partially moderate the relationship between task value, self-efficacy , learning engagement and learning outcomes (Honicke et al., 2020). Willey and Gardner(2014) believes that in online learning, internal learning motivation with high autonomy can effectively promote online learning engagement which further positively influence the learning outcomes; According to Weidinger et al (2016), learners' intrinsic goal orientation can positively predict the perceived usefulness in the technology-rich environment, and significantly moderate the relationship between perceived usefulness and learning outcomes, Some study found that in an online learning environment, learning goal orientations could be positively associated with students' critical thinking and creativity (Honicke et al., 2020; Islam et al., 2021; Kaspi-Baruch, 2019; Miller et al., 2021; Willey & Gardner, 2014). Additionally, scholars have found that there was a negative correlation between extrinsic motivation and learning outcomes, learning efficiency (Miller et al., 2021). Honicke et al (2020) found students' extrinsic goal orientation (i.e., grades, rewards, performance) had a negative effect on scientific creativity. Hence, this study proposed the following moderation hypotheses

Hypothesis 2_a:IGO(intrinsic goal orientation) moderators the relationship between student negotiation and critical thinking skills among Pre-Service Teachers. Such that the positive relationship is stronger when IGO is high than when it is low.

Hypothesis 2_b:IGO(intrinsic goal orientation) moderators relationship between inquiry learning and critical thinking skills among Pre-Service Teachers.Such that the positive relationship is stronger when IGO is high than when it is low.

Hypothesis 2_c:IGO(intrinsic goal orientation) moderators relationship between reflective thinking and critical thinking skills among Pre-Service Teachers.Such that the positive relationship is stronger when IGO is high than when it is low.

Hypothesis 3_a:EGO(extrinsic goal orientation) moderators the relationship between student negotiation and critical thinking skills among Pre-Service Teachers. Such that the positive relationship is weaker when EGO is high than when it is low.

Hypothesis 3_b:EGO (extrinsic goal orientation)moderators relationship between inquiry learning and critical thinking skills among Pre-Service Teachers.Such that the positive relationship is weaker when EGO is high than when it is low. Hypothesis 3_c:EGO(extrinsic goal orientation) moderators relationship between reflective thinking and critical thinking skills among Pre-Service Teachers.Such that the positive relationship is weaker when EGO is high than when it is low.

Method

Sampling and Data Collection

In this study, population refers to students who are enrolled in a teacher preparation program and working toward teacher certification in teacher training institutions of higher education in China. The target population is located in four high education institutions in Shanxi Province in China, that have established relatively perfect facilities for smart classrooms and designed relevant curriculum training plans for their student teachers(Liu&Wu,2019).Proportional stratified sampling and multistage cluster random sampling were used to determine and select the respondents. Finally, there are 700 pre-service teachers were recruited as participants to completed the on line questionnaire survey within two weeks. By using data screen technique, we finally determine the data of 686 respondents and formed 90.9% available cases. Personnel characteristics profile of respondents in this study was shown in Table 1,

Table 1
Distribution of Personnel Characteristics Profile of Respondents

Personnel Characteristic	Demographic Variables	Frequency (n)	Percentage（%）
University	Shanxi Normal University	173	25.2
	Taiyuan Normal University	169	24.6
	Yuncheng Normal College	171	25.0
	Yuncheng College	173	25.2
Gender	Male	150	21.9
	Female	536	78.1
Grade	Freshman	223	32.6
	Sophomore	202	29.4
	Junior	140	20.4
	Senior	121	17.6
Field	Social Science	447	65.2
	Science	239	34.8

Measures

Student Negotiation, Inquiry Learning, Reflective Thinking

PI-SCLE (Preference Instrument of Smart Classroom Learning Environments) developed by (Jason & Yang, 2018). It evaluates college students' preferences in smart classroom learning environment from three aspects: cognition and metacognition, technology and content, and social and physics. Cognitive-metacognitive part was used in this study which contains three dimensions of student negotiation, inquiry learning and reflective thinking, among which, scale of Student Negotiation contains 5items(alpha =0.92), "In the smart classroom,I prefer that I can ask other students to explain their ideas" is one representative item; scale of Inquiry Learning contains 5items (alpha =0.89), "In the smart classroom,I prefer that I can conduct follow-up investigation to answer my new questions." is one representative item; scale of Reflective Thinking contains 5items (alpha = 0.91), "In the smart classroom,I prefer that I can think deeply about my own ideas" is one representative item. Additional the participants' answers to the questionnaire are based on the five-point Likert scale, from strongly disagreement (marked as 1) to strongly agreement (marked as 5).

Intrinsic Goal Orientation, Extrinsic Goal Orientation

MSLQ（Motivated Strategies for Learning Questionnaire） was developed by Pintrich et al (1991) to measure learning strategies in cognitive, metacognitive, resource management and academic motivation among college and university students. This study adopt Goal Orientation scales from MSLQ, in which Intrinsic Goal Orientation scales contains 4items (alpha =0.92), "In a class like this, I prefer course material that really challenges me so I can learn new things." is one representative item; Extrinsic Goal Orientation contains 4items (alpha =0.91),"Getting a good grade in this class is the most satisfying thing for me right now." is one representative item. Additionally, the participants' answers to the questionnaire are based on the five-point Likert scale, from strongly disagreement (marked as 1) to strongly agreement (marked as 5).

Critical Thinking Skills

4C1PA(Mobile Learning Preferences and awareness of Collaboration, Communication, Critical thinking, Problem-solving and Creativity)was developed by Hwang et al (2017),The 4C1PA includes five dimensions: collaboration, communication, problem solving skill, critical thinking skill, and creativity skill that have high reliability and validity for assessing high school (from K10 to K12)students' higher-order thinking skills in a technology-based mobile learning environment(Hwang et al ,2017). This study adopted the scales of Critical thinking skill that contains 6 items (alpha =0.89)," I consider several alternatives to a problem before I answer" is one representative item. Additionally, the participants' answers to the questionnaire are based on the five-point Likert scale, from strongly disagreement (marked as 1) to strongly agreement (marked as 5).

Result

Confirmatory Factor Analysis

To check for construct independence of all the variables (Student Negotiation, Inquiry Learning, Reflective Thinking, Intrinsic goal orientation, Extrinsic goal orientation, Critical Thinking Skills), CFA was used to test a six-factor model. The results indicated that it was appropriate to consider the six factors separately (χ^2 /*df* = 2.014, RMSEA = .0380, CFI = .998, TLI = .981).

Correlation Analysis

Table2
Means, SD and Correlations of the variables

Variables	*1*	*2*	*3*	*4*	*5*	*6*
1.Student Negotiation	1					
2.Inquiry learning	0.50***	1				
3.Reflective Thinking	0.55***	0.51***	1			
4.Intrinsic goal orientation	0.45**	0.41**	0.46**	1		
5.Extrinsic goal orientation	0.24*	0.26*	0.19	0.12	1	
6.Critical Thinking Skills	0.48**	0.52**	0.58***	0.41**	0.13	1
Mean	3.38	3.27	3.34	3.10	3.54	3.29
SD	0.69	0.70	0.69	0.66	0.70	0.68

The correlation results in Table1shows that critical thinking skills is significantly positively correlated with student negotiation ($r = .48$, $p < .01$),inquiry learning($r = .52$, $p < .01$), reflective thinking($r = .58$, $p < .001$);intrinsic goal orientation is significantly positively correlated with student negotiation ($r = .45$, $p < .01$),inquiry learning($r = .41$, $p < .01$), reflective thinking($r = .46$, $p < .01$) and critical thinking skills($r = .41$, $p < .01$). These results provide preliminary support for the hypotheses.

Table 3
Regression Analysis and Hypothesis Testing

	Critical Thinking Skills			
	Model 1	Model2	Model3	Model4
Control variables				
University	0.09***	0.07***	0.06**	0.04*
Gender	0.04	-0.01	0.01	0.01
Grade	0.05*	0.03	0.03	0.06**
Field	0.26	0.01	-0.01	-0.01
Independent variables				
Student Negotiation		0.47***	0.26***	0.22***
Inquiry learning		0.51**	0.27**	0.26***
Reflective Thinking		0.53***	0.32***	0.31***
Moderator variable				
Intrinsic Goal Orientations			0.20**	0.19*
Extrinsic Goal Orientations			0.04	0.04
Interactive effect				
IGO×Student Negotiation				0.04**
EGO×Student Negotiation				0.01
IGO× Inquiry Learning				0.06**
EGO×Inquiry Learning				0.01
IGO×Reflective Thinking				0.06*
EGO×Reflective Thinking				0.01
R^2	0.22	0.26	0.32	0.36
F	83.86**	87.37***	82.86**	79.43**

Note. N = 686. Standardized regression coefficients (β) are reported Abbreviations: IGO= Intrinsic Goal Orientations; EGO=Extrinsic Goal Orientations; *p < .05;**p < .01;***p < .001
Hierarchical regression analysis was used for the hypothesis Testing, the results were shown in Table3.Model2 shows that after controlling University, Gender,Gradeand Field, student negotiation has a significant positive predictive effect on critical thinking skills(β = .47, p < .001); inquiry learning has a significant positive predictive effect on critical thinking skills(β = .51, p < .001);reflective thinking has a significant positive predictive effect on critical thinking skills(β = .53, p< .001).Thus,Hypothesis $1_{a,}$,Hypothesis $1_b$and Hypothesis 1_c were supported.

Model 3 shows that only IGO not EGO is significantly related to critical thinking skills(β = .20, p < .01).Model4shows that the interaction between IGO and student negotiation has a significant positive effect on critical thinking skills(β = .04, p < .001); The interaction between IGO and inquiry learning has a significant positive effect on critical thinking skills(β = .06, p < .001);The interaction between IGO and reflective thinking has a significant positive effect on critical thinking skills(β = .06, p < .001),thus Hypothesis $2_{a,}$,Hypothesis $2_b$and Hypothesis 3_cwere supported. by contrast, all of the interactions between IGO and student negotiation, IGO and inquiry learning and IGO and reflective thinking have not significant effect on critical thinking skills, hence, Hypothesis 3_a,Hypothesis 3_b and Hypothesis3_ccan not be supported..
Additionally, simple slope test was used to further demonstrate the specific role and characteristics of moderator effect (Aiken et al., 2013). As shown in figure1, in the high level IGO (+1 SD), student negotiation and critical thinking skills were significantly positively related (simple slope = .29, t = 2.67, p < .001); in the low level IGO (-1 SD), student negotiation and critical thinking skills were also significantly positively related (simple slope = .18, t = 2.26, p < .01),however, the slope of high-level IGO is greater than that of low-level IGO, that revealed the that the positive relationship was stronger for High IGO than Low IGO. As shown in figure2, in the high level IGO (+1 SD), inquiry learning and critical thinking skills were significantly positively related (simple slope = .28, t = 4.01, p < .001); in the low level IGO (-1 SD), inquiry learning and critical thinking skills were also significantly positively related (simple slope = .19, t = 2.41, p < .001),however, the slope of high-level IGO is greater than that of low-level IGO, that revealed the that the positive relationship was stronger for High IGO than Low IGO. As shown in figure3, in the high level IGO (+1 SD), reflective thinking and critical thinking skills were significantly positively related (simple slope = .30, t = 3.37, p < .001); in the low level IGO (-1 SD), reflective thinking and critical thinking skills were also significantly positively related (simple slope = .26, t = 2.96, p < .01),however, the slope of high-level IGO is greater than that of low-level IGO, that revealed the that the positive relationship was stronger for High IGO than Low IGO.

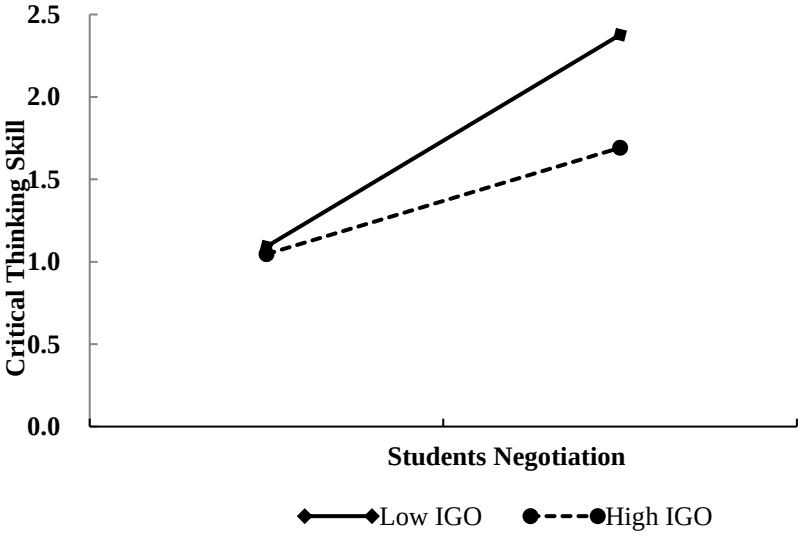

Figure1 Moderation Effect of Intrinsic Goal Orientations on relationship between student negotiation and critical thinking skills

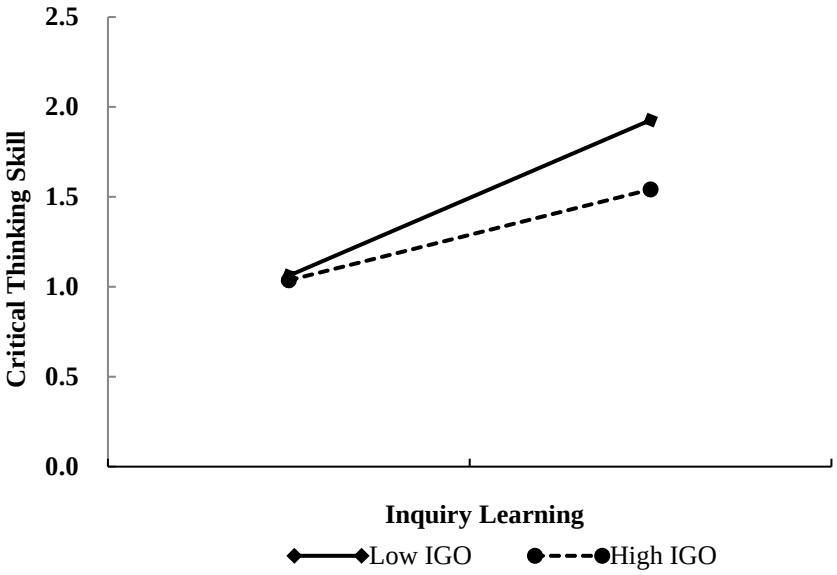

Figure2: Moderation Effect of Intrinsic Goal Orientations on relationship between inquiry learning and critical thinking skills

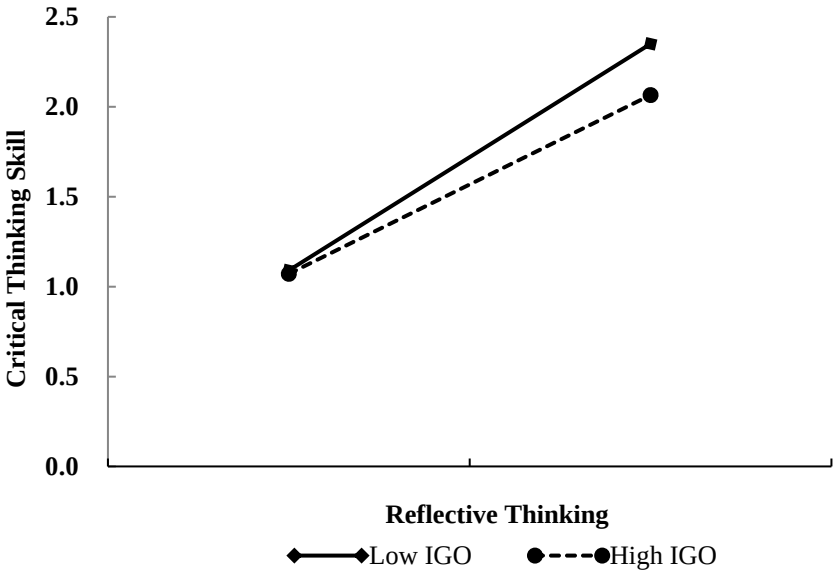

Figure3: Moderation Effect of Intrinsic Goal Orientations on relationship between reflective thinking and critical thinking skills

Discussion

The purpose of this study is to explore the specific relationship between constructivist smart learning approach and critical thinking skills and the moderating effects of goal orientations on the relationship. The findings shown that smart learning approaches of student negotiation, inquiry learning and reflective thinking, critical thinking skills can significantly positively predict critical thinking skills, and interactions between intrinsic goal orientations and student negotiation, intrinsic goal orientations and inquiry learning and intrinsic goal orientations and reflective thinking have significant positive effects on critical thinking skills. The positive relationships between smart learning approaches of student negotiation, inquiry learning and reflective thinking and critical thinking skills were stronger for high-level intrinsic

goal orientations than low-level intrinsic goal orientations. By contrast, all of the interactions between extrinsic goal orientations and student negotiation, extrinsic goal orientation, and inquiry learning and extrinsic goal orientation and reflective thinking have not significant effect on critical thinking skills. There were no moderating effects of extrinsic goal orientations on the positive relationships between smart learning approaches of student negotiation, inquiry learning and reflective thinking and critical thinking skills. These results provide valuable information and knowledge for relevant theories and teaching practice that were discussed in following section.

Theoretical Contributions

This study used Gibson (1986)'s affordance theory of ecological psychology to frame the research content. According Gibson (1986), affordances refers the possibilities and opportunities that the environments afford organism to make some related achievements Oliver (2005), which always has positive effects on organism's developments. however, Gibson argued that the organism's action intention and goal will influence affordances' positive effects on their development (Oliver, 2005). Based on the affordance theory, this study explored the effects of smart learning approaches that were viewed as the affordance form smart learning environments Johnson et al (2016) on development of learners' critical thinking skills, and the influence of learners' goal orientations on the association between affordance form smart learning environments and learners' critical thinking skills. Hence this study added new information and knowledge to the affordance theory, expands and enriches the content of affordance theory to some degree.

Firstly, in the constructivist smart learning environment, student negotiation is a cooperative dialogue that enable knowledge to be shared through different viewpoints Page & Mukherjee (2007) and generate many cognitive differences and opinion collisions, that is an opportunity but also a challenge for learners to learn from each other so as to promote the development of individuals ' critical thinking skills (Wahyuni & Kurniawati, 2021). Students with intrinsic goal orientations who are eager to learn and master more information and knowledge would deeply analyze and question others ' views, put forward open questions worthy of discussion, or respond to others ' questions with arguments and explanations to supplement others ' views Telaumbanua et al (2019) so as to construct and create high-level cognitive structure to develop their critical thinking skills .By contrast, students with extrinsic goal orientations always attach great importance to the high level of feedback and evaluation from their peers, in order to avoid performance failures, they will respond negatively to student negotiation by remaining silent which would make them miss some chances to stimulate them to think deeply (Sengupta et al., 2022).

Secondly, inquiry learning is the process of problem-based situations in which learners are driven by tasks and goal to solve some complex problems, which requires students to discover problems, collect information, solve problems and. construct higher-order knowledge (Lu et al., 2022). It always attract students' attention and stimulate their interest, emphasizes the development of students' self-confidence and encourages them to solve problems independently (Qin et al., 2022). In the process of inquiry learning, students with intrinsic goal orientations driven by the goal of developing their own abilities, always make their best efforts to identify problems, collect multiple materials and information, refine possible hypotheses and try various solutions to problems so as to construct higher-order knowledge and develop critical thinking skills ,while students with extrinsic goal orientations will view inquiry learning as a very difficult task, and they will feel anxious and even unwilling to put

much effort into completing it (Meece & Anderman, 2019), thus losing the opportunity to develop critical thinking skills .

Thirdly, reflection in a constructivist learning environment always require learners to creatively anticipate the learning activities to be carried out, effectively monitor and regulate the learning process, and evaluate and summarize the learning outcomes, thus promoting learners' self-development (Afifah & Azizah, 2021). In the process of reflection, students with intrinsic goal orientations who prefer challenging them self always l make more rational and scientific explanations for the attributions of success or failure, and thus reevaluate themselves and obtain higher levels of self-worth experiences and evaluations, which can further enhance their critical thinking skills (Yu et al., 2022),while students with extrinsic goal orientations always satisfied with their high scores and high evaluations from others, and seldom choose to do further reflection and make multi-level self-evaluation, thus losing the opportunity to develop critical thinking skills.

Contextual Contribution

The findings of this study provides practice implications for teaching of critical thinking skills in smart learning environments. Teacher should make full use of the advantages of student negotiation, inquiry learning and reflective thinking to help students develop their critical thinking skills. Specifically, in smart classroom contexts, learners' critical thinking skills should be developed in the context of high order learning activities that involve some complex problems.

Firstly, teachers should encourage students to choose student negotiation and inquiry learning to engage in the complex problems solving and guide them to clearly divide the work and supervise each other, require them to reflect and summarize after completing the tasks, and establish a feedback mechanism of self-assessment, other assessment and teacher assessment, so as to improve learners' critical thinking skills.

Secondly, teachers should develop and enhance pre-service teachers' intrinsic goal orientations. In the smart classroom, the teaching tasks design should emphasize "experiential" and "in-depth" that can encourage students to go through a series of cognitive processes, such as information gathering, material observation, and production of results, so as to gradually stimulate students' curiosity and thirst for knowledge.

Thirdly, teachers should design diversified evaluation criteria, emphasize openness and flexibility in the evaluation of students' learning process and learning results, encourage students to be bold in innovation and dare to question, and actively adopt diversified problem-solving strategies to enhance students' self-confidence and intrinsic motivation.

Limitations and Future Research Direction

This study only focused on pre-service teachers in high education training institutions, the representation of this sample group is limited. It is recommended that future research should expand the sample to a more general group of college students with the aim of providing a broader range of services for teaching higher-order thinking skills among college students. The data collected through cross-sectional survey in this study limited the explanation of causality and effect. Therefore, it is suggested to use another thorough and rigorous method to repeat the current efforts, such as the longitudinal method, in order to obtain more comprehensive findings and provide another insight on causal reasoning. Additionally, this study failed to explore more other smart learning approaches’ effect on critical thinking skills.

Future research could examine the relationship between some other smart learning approaches and critical thinking skills as well as the mediating factors under the relationship.

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