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Correlation between Achievement Goal Orientation and Need for Cognitive Closure among Undergraduate Engineering Students

Zain ul Abideen, Utah State University

Zain ul Abideen is a Graduate Research Assistant and Ph.D. Candidate in the Department of Engineering Education at Utah State University. He holds a Bachelor's degree in Computer Engineering and a Master's in Engineering, bringing over 12 years of teaching experience with undergraduate engineering students. He actively contributes to various technical committees and serves as a reviewer for prestigious journals and international conferences. Currently, his research focuses on his Ph.D. dissertation, where he investigates the role of cognitive and motivational factors in problem-solving and cognitive engagement among engineering students. His work aims to enhance understanding of how these factors impact student learning and success in engineering education. His dedication to advancing education, combined with his extensive academic and professional experience, establishes him as a distinguished researcher in engineering education.

Dr. Oenardi Lawanto, Utah State University

Dr. Oenardi Lawanto is a professor in the Department of Engineering Education at Utah State University, USA. He received his B.S.E.E. from Iowa State University, his M.S.E.E. from the University of Dayton, and his Ph.D. from the University of Illinois at Urbana-Champaign. Dr. Lawanto has a combination of expertise in engineering and education and has more than 30 and 15 years of experience teaching engineering and cognitive-related topics courses for his doctoral students, respectively. He also has extensive experience in working collaboratively with several universities in Asia, the World Bank Institute, and USAID to design and conduct workshops promoting active-learning and life-long learning that is sustainable and scalable. Dr. Lawanto's research interests include cognition, learning, and instruction, and online learning.

Dr. Angela Minichiello P.E., Utah State University

Angela (Angie) Minichiello, PhD is a military veteran, licensed mechanical engineer, and Associate Professor of Engineering Education at Utah State University.

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Abstract

This study aims to investigate the association between the need for cognitive closure and achievement goal orientation among engineering students and their impact on student engagement in problem-based learning. To address the diverse cognitive and motivational learning needs of the students, understanding how these two concepts interact and significantly influence students' cognitive engagement and learning outcomes is vital. The need for cognitive closure construct that reflects an individual's desire for a firm answer on a given topic, any answer, and ambiguity aversion will be examined through five facets: order, predictability, decisiveness, discomfort with ambiguity, and close-mindedness, while achievement goal orientation includes performance-driven and mastery-oriented goals. The existing literature in psychological research suggests there is a theoretical link between the need for cognitive closure and achievement goal orientation, while limited research on this relation exists in the engineering discipline. The students with high cognitive closure struggle with mastery objectives as they tend to avoid uncertain and ambiguous situations. This can limit their learning as they are more concerned with dispelling doubts than mastering the learning material.

The primary objective of this research is to explore how the five facets of the need for cognitive closure correlate with the different types of goal orientation (mastery or performance). As part of a larger mixed-methods study, this research seeks to uncover how the need for cognitive closure influences engineering students' adoption of achievement goal orientation by answering the research question: How is engineering students' need for cognitive closure associated with achievement goals in problem-based learning? Correlation and regression analysis were used to find the relationship between the five facets of the need for cognitive closure and types of achievement goal orientation. Understanding this relation has implications for designing instructional approaches to better support student learning based on their cognitive preferences and goal orientations, and provides valuable insights into learning outcomes and student engagement. This research provides the grounding for completing a more extensive study.

Keywords: need for cognitive closure, achievement goal orientation, mastery goal orientation, performance goal orientation

Introduction

The contemporary educational system aims to equip learners with the knowledge, skills, and attitudes required to navigate and contribute to diverse situations in real life. Besides imparting these skills, fostering learners' capacity and readiness to engage critically and thoughtfully with that information is another important aspect that needs attention. A significant challenge facing higher education today is designing and implementing instructional practices that effectively cultivate students' ability to apply knowledge efficiently and adaptively. Problem-based learning (PBL) is widely used to promote critical thinking, collaboration, and deep learning, but its effectiveness varies among students [1]. Individual differences in preferences, traits, and cognitive tendencies significantly influence how learners engage with PBL, with some surpassing in their inquiry-driven approach, in contrast, others benefit more from structured, teacher-led methods [2]. For educators and educational psychologists, it is essential to understand both learners' cognitive abilities and

their motivational dispositions for effective implementation of PBL-based learning environments.

Engineering students encounter challenging tasks frequently, including ill-structured problems that require critical thinking and autonomy. While some students succeed in navigating these challenges, others struggle with the ambiguity and frustration that arise in the absence of clear guidance [3]. PBL, although widely implemented, does not consistently guarantee student engagement. For some, PBL provides an opportunity to explore multiple sources of information and develop a deeper understanding, while others find it confusing and overwhelming [4]. Most of the existing research on problem-solving in engineering focuses on developing technical skills and overlooks the influence of motivational and cognitive factors, which are critical in shaping problem-solving abilities. Constructs like the need for cognitive closure (NFCC**)** and achievement goal orientation **(**AGO), which reflect students' achievement goals and their preference for certainty, respectively, offer valuable insights into these overlooked dimensions. Abideen [5] elaborated how NFCC and AGO impact student engagement in problem-based learning. According to DeBacker and Crowson [6],[7], NFCC and AGO play a significant role in students' decision-making and cognitive engagement. They stated that the NFCC is theoretically connected to AGO. Despite the theoretical connection between NFCC and AGO, their relationship has not been extensively explored within the context of engineering education. While existing research has examined these constructs in broader educational and psychological settings, their specific interplay in engineering remains underexplored.

Need for Cognitive Closure

The need for closure represents an individual's desire for a clear and definite answer to a question, prioritizing certainty over confusion or ambiguity [8]. Individuals with a high NFCC often aim to make decisions quickly and prefer solutions that do not necessitate re-evaluation. Moreover, students with higher NFCC levels tend to prefer settings that offer definite answers. They are less comfortable in settings involving ambiguous or open-ended tasks, such as solving problems with multiple possible solutions [7]. While individuals with low NFCC undertake ambiguity and take time to explore multiple possibilities before making any decision. They succeed in flexible, open-ended situations and enjoy handling complex problems without rushing to a conclusion. According to Webster and Kruglanski [9], NFCC is a single underlying construct that can be expressed through five distinctive facets: Need for Order, Need for Predictability, Tolerance for Ambiguity, Closed-Mindedness, and Decisiveness. This enables a deeper exploration of how NFCC is subjectively experienced, allowing for theoretical refinement. Moreover, they improve statistical power by isolating individual variance and reducing error, enhancing the analysis of person-situation interactions [9].

Achievement Goal Orientation

Achievement goal orientation theory is widely explored in educational psychology and serves as a leading framework for understanding learning motivation [10]. Achievement goals are typically described as the purpose of driving an individual's pursuit of success [11]. Instead of emphasizing the specific objectives or standards people aim to achieve, achievement goal orientations focus on the reasons and approaches underlying their pursuit of those objectives [12]. They reflect the broader purposes of driving achievement behavior. Dweck and Leggett [11] distinguished between two types of achievement goals: mastery (or learning) goal orientation and performance goal orientation. Mastery goals focus on developing competence by acquiring new skills and knowledge. Students with mastery goal orientation value activities that enhance their understanding, view effort as a constructive path to success, and

regard mistakes as opportunities for growth [13]. While students with performance-oriented goals often view intelligence as fixed, they avoid challenging tasks to prevent negative evaluations and consider mistakes as a lack of ability. Assessing different types of achievement goal orientations can offer valuable insights into the various ways individuals engage with and perform in academic learning.

Relation between the Need for Cognitive Closure and Achievement Goal Orientation

Research on the relationship between the need for cognitive closure (NFCC) and achievement goal orientation (AGO) focused on high school and college learners, revealing interesting patterns between the facets of NFCC and different types of achievement goal orientations. According to DeBacker and Crowson [6], NFCC significantly predicts mastery goals, but it does not significantly predict performance goals. Their work utilized Webster and Kruglanski's [9] survey to examine NFCC facets and AGO, laying the groundwork for understanding these relationships in educational contexts. DeBacker and Crowson [14] further advanced this understanding by introducing a classroom-based measure of NFCC that assessed preference for structure and preference for certainty. They reported that preference for structure positively predicted both performance-approach and performance-avoidance goals, whereas preference for certainty negatively predicted mastery goals and positively predicted performance goals. Similarly, Miranda et al. [15] reported that preference for structure was related to performance-approach goals, while preference for certainty exhibited a more concerning pattern, negatively correlating with mastery goals and positively with performance-avoidance goals. Harlow et al. [16] provided further insights by demonstrating that preference for structure positively predicted all achievement goals, including mastery goals, performance-approach goals, and performance-avoidance goals. These findings collectively underscore the nuanced roles that NFCC facets play in shaping students' goal orientations and cognitive engagement. By examining these relationships, we aim to contribute to a deeper understanding of how NFCC influences motivation and engagement in engineering education, offering insights that could inform pedagogical strategies to enhance learning outcomes in this domain.

Purpose of the Study

The purpose of this research is to examine the correlation between the need for cognitive closure (NFCC) and achievement goal orientation (AGO). Through the quantitative data analysis approach, the study aims to explore how different facets of NFCC interact with students' mastery and performance goal orientations, providing insights into how engineering students approach learning and navigate academic challenges. The research questions that frame this study is: How does the five facets of the need for cognitive closure associated with achievement goals orientation among engineering students in problem-based learning?

Positionality

The research team comprises three individuals, all of whom hold master's degrees in engineering and are actively involved as educators and researchers in the field of engineering education. Among the members, two are tenured faculty members in the Department of Engineering Education with doctoral degrees focused on education, while the other is a senior graduate student working toward a doctoral degree in engineering education. The team members bring a wealth of experience, having taught undergraduate engineering courses, including those centered on problem-solving. This shared professional background fosters a collective commitment to exploring how various motivational and cognitive factors impact problem-solving and cognitive engagement within engineering education.

Methodology

This study employed a quantitative research design to explore the relationship between achievement goal orientation (AGO) and the need for cognitive closure (NFCC). Statistical analyses, including correlation and regression, were utilized to examine the strength and direction of relationships among variables. Grounded in Bandura's social cognitive theory [17], the methodology captures interactions between cognitive processes and their influence on motivation and behavior. Data analysis was conducted using SPSS (version 30).

Participants

A total of one hundred and three second-year engineering students participated in the quantitative data collection at a land-grant public university in the western United States during Fall 2024, comprising 64.1% men, 33% women, and 2.9% non-binary individuals. The participants were White (81.6%), Hispanic (6.8%), Asian American (8.7%), Pacific Islander (1%), and Biracial (1.9%). Participation in the study was voluntary, and IRB approved.

Measures

Demographic data was collected first, followed by data on NFCC and AGO, which was obtained through self-administered questionnaires. The Need for Cognitive Closure Scale (NFCCS) developed by Webster and Kruglanski [9], updated, and validated by Roets and Van Hiel [18] was used. NFCCS is composed of 41 Likert scale items ranging from Strongly Disagree to Strongly Agree (Slightly Disagree = 1 -> Strongly Agree = 6) divided into 5 sub-scales: need for order (10 items), need for predictability (8 items), decisiveness (6 items), avoidance of ambiguity (9 items), and closed-mindedness (8 items). There is also a reverse scale in 11 items out of 41. The 12-item Achievement Goal Questionnaire-Revised (AGQ-R), developed and validated by Elliot and Murayama [19] was used. The AGQ-R consists of four subscales measuring achievement goals: mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance. Each subscale contains three items, rated on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). All quantitative data was generated and collected using Qualtrics, an ad-hoc web-based survey tool.

Results

Data Analysis

Quantitative data collected from questionnaires (NFCS and AGQ-R) were analyzed through descriptive statistics, correlation analysis, and followed by regression analysis. Pearson correlation test was used to evaluate the associations between five facets of NFCC and AGO

Table 1. *Descriptive Statistics for All Scales*

Variable	Sub-Scales	M	SD	Cronbach's α
NFCC	Need for Order	4.38	0.88	0.86
	Need for Predictability	4.02	0.86	0.80
	Decisiveness	3.56	0.97	0.77
	Avoidance of Ambiguity	4.18	0.85	0.80
	Closed Mindedness	2.97	0.72	0.70
	Need for Cognitive Closure	3.87	0.65	0.92
AGO	Mastery Goal Orientation	4.19	0.74	0.74
	Performance Goal Orientation	3.80	0.85	0.79
	Achievement Goal Orientation	3.78	0.60	0.82

types, followed by regression analysis. The reliability of the scales measuring NFCC and AGO was assessed using Cronbach's alpha in SPSS. For the NFCS scale, Cronbach's alpha was 0.92, indicating items in the scale are highly consistent in measuring NFCC. For the AGO scale, the overall Cronbach's alpha was 0.82, which is considered good. The Cronbach's Alpha values demonstrate that the NFCC and AGO constructs have satisfactory internal consistency. The mean(M), standard deviation (SD), and reliabilities (Cronbach's α) of the sub-scales of both NFCC and AGO can be found in Table 1.

Correlation Analysis

A Pearson correlation analysis was conducted between the Need for Cognitive Closure (NFCC) and Achievement Goal Orientation (AGO), including their respective subscales, as shown in Table 2, to examine the strength and direction of their relationships, assuming the normality of the data. The results of the analysis are illustrated in Table 2, providing a tabular representation of the associations. Our analysis showed that facets such as Need for Order and Need for Predictability exhibited a significant positive correlation with performance approach at a modest level ($p<0.05$), while Decisiveness ($p<0.01$)**,** Avoidance of Ambiguity ($p<0.01$), and Closed-Mindedness are negatively correlated with Mastery Approach. The Overall NFCC index, which aggregates all facets of cognitive closure, shows a significant positive correlation with the Performance Approach ($r = 0.25$, $p < 0.01$), suggesting that individuals with a higher overall need for closure are more likely to engage in performance-oriented goals. Conversely, the negative correlation with the Mastery Approach ($r = -0.26$, $p < 0.01$) indicates that individuals with a higher need for closure are less likely to adopt mastery goals. The correlation with Overall AGO ($r = 0.14$) is positive but weak, suggesting that NFCC has a modest relationship with achievement goal orientation in general.

Table 2.

Correlations of the Need for Closure Scale (NFCS) and Facets with Achievement Goal Orientation (AGO) and Types

Variables	Correlations		
	Performance Approach	**Mastery Approach**	**Overall AGO**
Need for Order	0.41**	0.04	0.33**
Need for Predictability	0.22*	-0.10	0.19
Decisiveness	0.10	-0.33**	-0.03
Avoidance of Ambiguity	0.06	-0.34**	0.03
Closed Mindedness	0.10	-0.39	-0.10
Low NFCC	0.20	-0.24	0.18
High NFCC	0.16	-0.12	0.00
Overall NFCC	0.25**	-0.26**	0.14

** Correlation is significant at 0.01 level(2-tailed).

* Correlation is significant at 0.05 level(2-tailed).

Regression Analysis

Based on the results of the correlation analysis, a significant relation was found between facets of NFCC and AGO types. However, this correlation does not clarify the specific nature of the relationship between the variables. Therefore, multiple regression analysis was conducted to further explore the predictive power of NFCC facets (independent variables or

predictors) on AGO types (dependent variables), providing a deeper understanding of how different aspects of NFCC influence goal-setting behaviors.
The regression model demonstrated a good fit, as indicated by a significant ANOVA result for both dependent variables of mastery goal orientation and performance goal orientation. The ANOVA results showed that independent variables (Closed-mindedness, Need for Order, Decisiveness, Need for Predictability Avoidance of Ambiguity) were significant predictors of dependent variables of performance goal orientation (F [5,97] = 5.080, $p < 0.001$) and mastery goal orientation (F [5,97] = 7.895, $p < 0.001$).

As shown in Table 3, the analysis yielded an R value of 0.456, indicating a moderate positive relationship between the independent variables and the dependent variable of performance goal orientation. The R^2 value of 0.208 suggests that approximately 20.8% of the variance in the performance goal orientation is explained by the independent variables included in the model. For mastery goal orientation, the values of R and R^2 are 0.538 and 0.289, indicating a moderate positive relationship, and the independent variables predicted 28.9% of the variance in the dependent variable of mastery goal orientation.

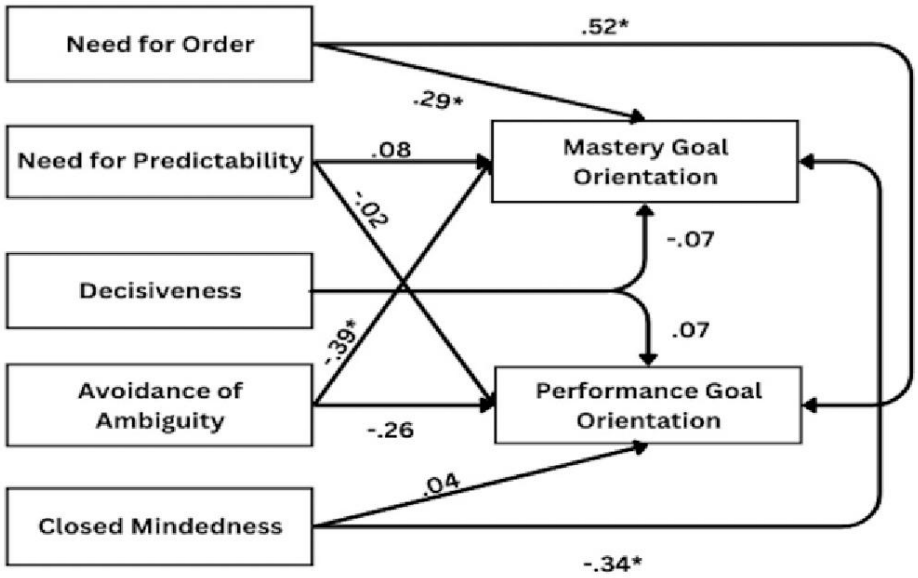
Table 3.

Model Summary (N = 103)

				Std. Error of the	Change Statistics				
Model	**R**	**R Square**	**Adjusted R Square**	**Estimate**	**R Square Change**	**F Change**	**df1**	**df2**	**Sig. F Change**
1	0.456[a]	0.208	0.167	0.77699	0.208	5.080	5	97	<0.001
2	0.538[b]	0.289	0.253	0.64134	0.289	7.895	5	97	<0.001

a. Dependent Variable: Mean Performance Goal Orientation
b. Dependent Variable: Mean Mastery Goal Orientation
c. Predictors: (Constant), Mean Closed Mindedness, Mean Need for Order, Mean Decisiveness, Mean Need for predictability, Mean Avoidance of Ambiguity

A multiple regression analysis was conducted to assess the extent to which each independent variable predicted performance and mastery goal orientation. As shown in Figure 1, Need for order ($\beta=0.52$, $p<0.001$) was the only significant predictor of performance goal orientation. The Need for Order ($\beta=0.295$, $p<0.012$), Avoidance of Ambiguity ($\beta=0.38$, $p<0.01$), and Closed Mindedness ($\beta=0.52$, $p<0.001$) predicted mastery goal orientation. While the rest of the facets of NFCC did not predict the performance and mastery goal orientation, as shown in Figure 1.



*Significant at p<0.001

Figure 1. *Standardized Coefficients (β) Between NFCC Facets and AGO Types*

Discussion

The findings of this study contribute to a deeper understanding of the relationship between the need for cognitive closure (NFCC) and achievement goal orientations (AGO), emphasizing the role of NFCC facets in shaping engineering students' cognitive and motivational tendencies. The results showed that specific facets of NFCC are significantly correlated with different types of AGO. Particularly, for performance-approach goals, the need for order showed a strong positive and significant correlation, while the need for predictability also demonstrated a positive and significant correlation suggesting that individuals who seek structure and predictability in their learning environments are more likely to adopt goals aimed at demonstrating competence relative to others, resulting in decreased engagement. These findings are aligned with the research made by Miranda et al. [15] and Marini et al. [20] associating preference for structure (predictable and orderly) with performance goals only, while Harlow et al. [16] associated preference for structure with both performance and mastery goals. Other facets, such as decisiveness**,** avoidance of ambiguity**,** and closed-mindedness, exhibit weak positive correlations, but these are not statistically significant.

Alternatively, facets such as decisiveness, avoidance of ambiguity, and closed-mindedness were negatively correlated with mastery goals, indicating that a preference for definitive answers and discomfort with ambiguity may hinder the adoption of goals centered on learning, self-improvement, and cognitive engagement. Several studies have reported a negative relationship between preference for certainty (need for definitive answers and discomfort with ambiguity) and mastery goals. Harlow et al. [16] found that individuals with a high preference for certainty tend to have lower mastery goal orientations. Similarly, DeBacker and Crowson [14] identified a negative correlation between the need for certainty and mastery goals. This finding was further corroborated by Miranda et al. [15], who also reported a negative association between preference for certainty and mastery goals. These

consistent results highlighted the detrimental effect of a high need for certainty in the pursuit of mastery-oriented academic goals. While Marini et al. [20] reported that the need for certainty has no relationship with the motivational orientation of mastery-approach goals. Students with high NFCC struggle with the uncertainty inherent in mastery goals, often opting for quick solutions to reduce ambiguity. This tendency aligns more with performance-approach goals, where they seek external validation to minimize uncertainty. In contrast, low NFCC students, comfortable with ambiguity, are more likely to pursue mastery goals, focusing on deep learning and personal growth. These findings are aligned with the research results of DeBacker and Crowson [6].

Multiple studies confirmed NFCC as the antecedent of AGO and their impact on cognitive engagement [6],[14],[15],[16],[20]. This research has shown that NFCC significantly predicted both mastery and performance goals, in contrast to Harlow et al. [16]. Need for order emerged as a significant predictor of performance goal orientation, reinforcing the idea that a structured and orderly environment encourages performance-driven motivation, and, in turn, engagement is decreased. This result is aligned with the findings of Harlow et al. [16] that preference for structure predicted both mastery and performance goal orientation. Mastery goal orientation, in contrast, was predicted by a combination of the need for order, closed-mindedness, and avoidance of ambiguity, indicating that while a need for order may support mastery goals, other facets of NFCC, such as discomfort with ambiguity and rigid thinking, might impede them.

Conclusion

This research explored the relationship between five facets of the need for cognitive closure and achievement goal orientation (AGO) types of mastery and performance orientation. The findings revealed that there was a significant association between the facets of NFCC and AGO types, highlighting the complexities of cognitive closure in shaping goal-setting behaviors.

For mastery goal orientation, the facets of decisiveness and avoidance of ambiguity were negatively and significantly correlated with mastery goals, indicating that students who preferred urgency during decision-making and discomfort with ambiguity may be less inclined to adopt learning-oriented goals. A negative association implied that fostering a learning environment emphasizing mastery goals might require strategies to reduce cognitive closure tendencies, such as encouraging openness to uncertainty, patience in problem-solving, and rewarding exploration over immediate results. There was also a moderate negative correlation between mastery goals and closed-mindedness, but that was not significant. There may be a chance that students who were unwilling to be confronted by alternative opinions are less likely to adopt mastery goals. Interestingly, the need for order did not show a correlation with mastery goals, but in regression, it was predicting the mastery goals when controlling for other facets of NFCC. This highlighted the importance of considering these factors simultaneously rather than in isolation.

In case of performance goal orientation, the need for order and the need for predictability were positively and significantly correlated with performance goals, suggesting that students with a higher preference for structure and stable knowledge were more likely to be engaged in performance-driven behaviors. However, decisiveness, avoidance of ambiguity, and closed-mindedness showed a weak and non-significant relation with performance goals, indicating that urgency for decision-making or avoidance of confusion does not strongly influence performance-oriented goal setting of students. However, in the regression model, only the need for order remained a positively significant predictor of performance goal

orientation, while need for predictability did not. This trend suggested that students who desire structured and orderly environments were more inclined towards performance-based goal settings, whereas the desire for predictability and stability alone may not be a unique determinant in situations when other facets of NFCC were controlled.

Another interesting result was a significant association between overall NFCC and types of AGO, i.e., mastery and performance goal orientation. This indicated a meaningful relationship between individuals' cognitive preferences and their approach to goal setting. A positive association of NFCC with performance goal orientation emphasizes demonstrating competence relative to others, which implies that individuals with high NFCC may seek clear benchmarks or competitive settings to minimize ambiguity, whereas those with low NFCC may place less emphasis on external validation. Conversely, high NFCC individuals might succeed in more structured and predictable learning environments where mastery goals are aligned with clear and achievable outcomes. This study reveals a weak positive relationship between overall Achievement Goal Orientation (AGO) and overall Need for Cognitive Closure (NFCC) and its facets, suggesting that the influence of cognitive closure on goal orientation may be nuanced and not uniformly strong across all dimensions. Although NFCC facets are significant predictors of performance and mastery goal orientation. These associations may reflect the multifaceted nature of motivation, which may be influenced by a combination of cognitive, personality, and environmental factors. Furthermore, the association between NFCC and AGO is confirmed by the regression analysis, showing that NFCC is the predictor of AGO. This research emphasizes the need for further investigation, as it reveals that while NFCC plays a significant role, it is not the sole determinant of motivational orientations. Therefore, additional exploration into other contributing factors is necessary. These results emphasize the importance of examining constructs at a sub-scale level, as nuanced relationships may be present that are not evident when only broad constructs are considered. Longitudinal and cross-cultural studies can provide insights into how NFCC influences AGO across contexts.

Implications

Understanding the in-depth relationship between NFCC and AGO has important implications for engineering educators to support engineering students. Engineering students often face complex and ill-structured problems that require critical thinking and persistence. High NFCC students may struggle with such kinds of problems as they prefer structured problems. This preference can significantly affect their learning experiences and problem-solving skills. Instead of understanding the problem, they may memorize the procedures and struggle with the concepts. Instructors can use scaffolded learning approaches that initially provide structured guidance for students with high NFCC so that they can gradually navigate toward mastery-oriented learning. By strategically designing differentiated instructional methods for low as well as high NFCC students, educators can help develop confidence, strength, and problem-solving skills, making them prepared for situations where uncertainty is inevitable.

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