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The mediation of interactivity and Tutor support in affective support in University Students

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Abstract*– The study examines the role of mediation through interactivity and tutor support in affective support, using relevance and reflective thinking as predictor variables. A non-experimental and cross-sectional approach was employed for the research. An electronic questionnaire was administered to 250 university-level students in Arequipa, Peru, achieving high-reliability levels in the instrument's application (n=20; α=0.92, ω=0.92). The analysis was enriched with construct validation techniques, factor analysis, and structural equation modelling using partial least squares. Findings revealed that interactivity and tutor support are significant mediators in online learning. Interactivity enhances affective support by fostering reflective thinking, while tutor support amplifies affective support by linking content relevance with student needs. Although interactivity exhibits a mediating effect, tutor support emerges as a more potent mediator, indicating its essential role in students' perceptions of affective support and facilitating an effective online learning environment.

Keywords*— Relevance, tutor support, interactivity, reflective thinking, affective support, COLLES, PLS-SEM.

I. Introduction

In the current digital era, the relevance of online learning has become a fundamental pillar in professional practices, highlighting its importance in developing essential competencies and skills [1]. This educational approach actively promotes reflective thinking, stimulating critical and reflective thought, a crucial aspect for adaptation and success in dynamic professional contexts. Interactivity plays a key role by enabling participation, dialogue, feedback, and effective interaction with technological resources, thus enriching the learning experience. Meanwhile, tutor support becomes an essential element in assessing the active participation of tutors or teachers in generating meaningful learning, ensuring that students not only acquire knowledge but also effectively integrate it into their practice. Finally, affective support emerges as the most critical factor, underpinning the constructivist dimension of education in online environments through sensitive and encouraging support [2].

The significance of affection and active support in educational environments significantly manifests in enhancing student interaction, motivation, and enjoyment. It has been identified that effective feedback systems make study time more enjoyable and promote learning in students with low academic performance [3]. Furthermore, the combination of educational and emotional support is directly linked to increased commitment to learning, especially in educational environments characterised by a positive emotional tone [4].

The Cognitive Affective Theory of Learning with Media (CATLM) suggests that students exhibit higher levels of happiness and motivation when learning from expressive pedagogical agents compared to neutral ones [5]. However, recent studies indicate that although these agents increase positive emotions and motivation, this does not necessarily translate into improved academic performance. This presents a scenario where, despite the positive reaction of students to the emotions of virtual instructors, the actual impact on learning outcomes requires more detailed exploration [5, 6].

The implementation of conscious affective support (effect-aware support) has significantly impacted students facing challenging tasks, making their learning experience smoother and reducing confusion [7, 8]. This approach underscores the importance of customising affective support to meet individual student needs, especially in complex learning scenarios. Critical strategies for effectively incorporating affective support in virtual education contexts include integrating intelligent virtual students capable of adequately regulating emotions and behaviours, thereby facilitating non-verbal reactions that promote effective emotional learning [9]. Developing methods for the timely recognition of students' emotional states within Educational Virtual Worlds (EVW) is crucial, allowing for precise and appropriate interventions [10]. Lastly, an integrated framework is proposed to stimulate student engagement, encompassing behavioural, cognitive, social, and affective dimensions [11].

Thus, the interaction between the mediation of interactivity and tutor-provided affective support is revealed as a critical aspect of enriching the educational experience of university students. Implementing strategies that effectively integrate affective support in virtual education could increase motivation, commitment, and academic performance. This analysis highlights the importance of future research focused on the specific impact of these strategies on learning outcomes in university contexts in Peru.

Designing characters in virtual learning environments that provide empathetic responses tailored to students' affective states significantly increases their engagement, motivation, and academic achievements. This strategy emphasises the importance of creating learning environments that stimulate cognitive and emotional resonance with students, thus

favouring a richer and more immersive educational experience [12].

Adopting approaches that foster self-awareness and self-regulation in students points to the need to focus education on developing emotional intelligence and self-care. This includes promoting social awareness and skills among students and educators to create a more effective and empathetic remote or hybrid learning environment [13]. The significance of emotional education and mentorship becomes evident in the holistic development of students, highlighting the importance of adequately managing emotions, performing cognitive reappraisal, and generating appropriate emotional responses [14].

Exploring existing systems for virtual classrooms and implementing recommendations to increase participation and interactivity in online classrooms are essential for enhancing the learning experience [15]. This improvement in participation and interactivity is supported by the effectiveness of feedback systems that make learning more enjoyable and motivating, particularly for students with low academic performance [3].

Peer mentoring emerges as an effective strategy to induce positive changes in students' academic and socioemotional domains, showing improvements in both academic performance and socioemotional development [16]. Similarly, it has been observed that students with emotional and behavioural disorders who act as tutors experience significant improvements in academic, socioemotional, and behavioural aspects, benefiting both tutors and tutees [17, 18].

The importance of emotional education and student mentorship underscores the connection between emotional labour and the ability to regulate emotions effectively, which is crucial for dealing with various situations in an emotionally appropriate manner. Establishing an affective feedback system enhances the study experience, motivating students to learn and ultimately improving learning outcomes, particularly for those with low academic performance [3].

Teacher support and the teacher-student relationship play a significant role in the affective learning of students of English as a foreign language, especially in the context of learning the Chinese language. This link is crucial for student success, emphasising the importance of teacher support [19]. The combination of educational and emotional support predicts a greater intensity of commitment to learning, showing more pronounced effects in environments with a positive emotional tone [4]. This finding highlights how an environment of emotional and educational support is fundamental to fostering students' socioemotional skill development.

Tutorial action, encompassing personal and emotional aspects, is crucial for students' development, learning, and social integration. This approach underlines the potential impact of tutor support on students' emotional development [14]. Likewise, it has been observed that socioemotional educational support from teachers is positively related to students' perceived socioemotional competence, which is associated with an increase in prosocial behaviour and a decrease in behavioural problems [20].

Social and Emotional Learning (SEL) stands out for its ability to improve academic, social, and behavioural domains, suggesting the significant impact of affective support on the development of socio-emotional skills in students [21]. Emotional regulation has also been linked to prosocial behaviours in children, indicating the essential role of affective support in promoting prosocial behaviours [22].

In the context of students with learning difficulties, the importance of personalised plans and individualised support for children with disabilities is emphasised, highlighting the need for a holistic approach to development [23]. Approaches based on Social and Emotional Learning (SEL) have proven effective in improving functional, behavioural, and academic outcomes for school-aged youth, including those with disabilities [24]. Furthermore, socioemotional learning programmes based on behavioural and social learning theories have effectively improved the social skills of children and youth with learning difficulties [25].

These findings suggest that affective support and tutoring are fundamental for students' socioemotional development, especially those with learning difficulties. The implementation of individualised support strategies and social and emotional learning programmes is presented as an effective intervention to improve these students' socioemotional and academic competencies. This comprehensive approach, addressing emotional and academic needs, is essential for the holistic development of students.

The significance of tutor support in the educational context is clearly manifested in its contribution to promoting interactivity and the development of reflective thinking among students. University tutors play a crucial role in facilitating joint reflection with teachers, focusing their attention on various reflection characteristics and prioritising intervention in specific dimensions of the same [26, 27]. This specific assistance allows students to identify and analyse the factors involved in their teaching practice experiences, enhancing their understanding through analysing the dilemmas present in these situations.

Affective support, particularly the affective feedback provided by affective pedagogical tutors, significantly enhances students' self-reflection. This feedback leads to conceptual change and personal growth and improves the perception of study time and motivation to learn, underscoring the importance of the emotional component in reflective learning [3, 28].

Interactivity, facilitated by educational assistance from tutors, is essential in collective scaffolding for establishing relationships between situational and academic representations. This assistance contributes to a progressive increase in task control by students, indicating the positive impact of tutor support on developing reflective skills [29].

Moreover, emotions play a moderating role in the relationship between knowledge, cognitive skills, and reflection. This interaction underscores how emotions directly

and indirectly influence students' reflective learning, highlighting the complexity of the cognitive and emotional processes involved in learning [30].

Tutor assistance in reflective practice is fundamental for developing students' reflective capacity and understanding of teaching practice. By offering specific assistance and focusing on various characteristics of reflection, tutors positively impact students' reflective skills, demonstrating the importance of tutor support in enhancing interactivity and reflective thinking in educational settings [26, 27, 29].

Effective feedback and reflective learning are vital elements in improving education, especially when considering the impact of emotional support on these processes. A study on the affective pedagogical tutor (APT) highlights how dynamic and affective feedback significantly enhances students' self-reflection and conceptual understanding, emphasising the potential of emotional support to enrich reflective learning [28]. This finding points to the importance of incorporating affective elements into educational feedback to foster students' profound conceptual change and personal development.

Additionally, training focused on facilitating reflection through individual learning experiences and methods has proven effective in enhancing supervisors' capabilities in this domain. Such training significantly increases tutors' ability to promote reflective thinking among students, demonstrating the effectiveness of this training [31]. This approach not only improves tutors' competencies but also enhances the quality of the educational process by promoting more profound and more meaningful reflection.

Collaboration is presented as a fundamental pillar of meaningful learning, emphasizing peer support where affective and cognitive mediations intertwine. A research model has allowed for examining the influence of interactivity and its interpretation on peer support in class. Interestingly, it was discovered that although interactivity plays a crucial role in this support, other factors such as reflective thinking, relevance, and tutor support did not directly influence peer support within learning experiences in virtual environments. This result suggests that in contexts based on social constructivism theories, interactivity and collaboration dynamics among students have a more significant impact on mutual support than the direct intervention of tutors or the active promotion of reflective thinking [32].

These findings highlight the complexity of educational processes in virtual environments and the need for pedagogical strategies that effectively integrate emotional support, tutor training, and collaboration dynamics among students to foster reflective and meaningful learning. Based on these considerations, the following hypotheses are formulated:

H1: Interactivity significantly mediates between reflective thinking and affective support such that promoting reflective thinking through online learning increases interactivity, enhancing the affective support perceived by students.

H2: Tutor support acts as an essential mediator between the relevance of online learning and affective support in such a way that the relevance of online educational practices improves the quality of tutor support, increasing the affective support students experience in their learning process.

II. Methodology

This research is situated within the quantitative paradigm. It adopts an explanatory approach to examine the mediation of interactivity and the tutor's role in affective support for university students in engineering. A non-experimental, cross-sectional design was chosen, allowing for the observation of the variables of interest at a specific time.

The sample studied includes 250 university students from the engineering area, randomly selected to ensure representativeness. The gender distribution predominates 69.0% males and 31.0% females, with an age range of 16 to 22 years and an average age of 18.68 (SD = 1.56).

Regarding instrumentation, an adapted version of the Constructivist Online Learning Environment Survey – COLLES [33], an instrument rooted in constructivist theories applied to education, was used to measure students' perceptions of the online learning environment provided by the Blackboard Learn system. This LMS is known for facilitating collaborative learning, an essential feature for studying interactivity. The adapted instrument consists of 20 evenly distributed items among five original COLLES factors: Relevance, Reflective Thinking, Interactivity, Tutor Support, and Affective Support. The exclusion of an item from the Reflective Thinking factor in the final structural model due to inconsistencies in the model fit is noted.

The methodology selected for the assessment of responses is the 5-point Likert scale, providing a detailed gradient of students' attitudes and behavioural frequencies towards the evaluated dimensions.

The timing of the survey, conducted in December 2023, ensures the correctness’ and relevance of the data in relation to the use of digital technologies by university students.

For the data analysis, variance-based structural equation modelling (PLS-SEM), a statistical technique that identifies complex relationships and evaluates the mediation of the Interactivity and Tutor Support variables in the structural model, was employed. This analytical approach is particularly relevant for studying models that include mediating variables and allows for a deeper understanding of the underlying processes that contribute to affective support in online learning environments.

III. Results

In the exploratory factor analysis, the Kaiser-Meyer-Olkin (KMO) sampling adequacy test, an index that assesses the suitability of data for factor analysis, was initially applied. Therefore, a KMO of 0.89 indicates sufficient evidence to suggest that factor analysis is appropriate and that the item

responses are relatively well related to each factor. Each of them likely represents a distinct underlying construct. This implies that a factor analysis of these data will likely reveal significant and valuable patterns.

Table 1 presents the Exploratory Factor Analysis (EFA) – factor loads; the analysis suggests that the constructs of Relevance, Reflective Thinking, Interactivity, Tutor Support, and Affective Support are well represented by their respective items in the questionnaire. The results provide a solid quantitative basis for arguing that each of these dimensions can be effectively measured and is reflected in the responses of university engineering students to the adapted COLLES survey as a result of the analysis exploratory factor, item PR_03 was withdrawn. This establishes an empirical foundation for exploring the relationships between these variables and their impact on affective support in online learning environments. Regarding the uniqueness values presented in the table, they express the amount of variance in the responses of each item that is not explained by the factors identified in the factor analysis. Higher uniqueness values indicate that a more significant amount of an item's variance is unique or specific to that item and not due to the common factors with other items.

TABLE I
EXPLORATORY FACTOR ANALYSIS (EFA) – FACTOR LOADS

	Factor					
	1	2	3	4	5	Uniqueness
RE_01				0.49		0.65
RE_02				0.80		0.34
RE_03				0.70		0.37
RE_04				0.68		0.44
PR_01					0.60	0.46
PR_02					0.83	0.33
PR_04					0.66	0.47
INT_01			0.77			0.34
INT_02			0.86			0.33
INT_03			0.75			0.32
INT_04			0.69			0.23
AT_01	0.83					0.28
AT_02	0.85					0.30
AT_03	0.79					0.34
AT_04	0.81					0.28
AC_01		0.69				0.42
AC_02		0.89				0.18
AC_03		0.89				0.20
AC_04		0.69				0.29

Note. The 'Minimum residue' extraction method was used in combination with an 'oblimin' rotation

According to the confirmatory factor analysis (CFA), the fit indices for the structural model in this research show excellent congruence with the collected data. The Root Mean Square Error of Approximation (RMSEA) is 0.05, within a 95% confidence interval of 0.04 to 0.07, denoting a good fit and minor discrepancies between the model and the observed covariance structure. The Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI), with values of 0.96, substantially exceed the recommended threshold of 0.90, reflecting a high model-data concordance. These indices, along with the Standardized Root Mean Square Residual (SRMR) of 0.04, corroborate a model fit that is robust and well-aligned with the underlying theory, validating the proposed structure to study how interactivity and tutor support mediate affective support in engineering university students in virtual learning environments.

Table II presents the evaluation of the reflective constructs' measurement model, indicating the robust reliability and validity of the constructs under study. Affective Support (AC), Interactivity (INT), Reflective Thinking (PR), Relevance (RE), and Tutor Support (AT) exhibit Cronbach's alpha values ranging from 0.794 to 0.908, suggesting high internal consistency as all exceed the acceptable threshold of 0.7.

The composite reliability (rho_a) for each construct exceeds the acceptance criterion of 0.7, with values ranging from 0.806 to 0.912, indicating excellent composite reliability for the items of each construct. The composite reliability (rho_c) also shows outstanding results, all above the recommended threshold of 0.6, with values from 0.879 to 0.936, confirming the internal consistency and reliability of the constructs.

Convergent validity, assessed through the average variance extracted (AVE), is also satisfactory for all constructs, with values ranging from 0.645 to 0.785, exceeding the recommended minimum value of 0.5. This indicates that the constructs explain a significant proportion of the item variance and, therefore, confirm the convergent validity of the model.

TABLE II
ASSESSMENT OF THE MEASUREMENT MODEL FOR REFLECTIVE CONSTRUCTS

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Affective Support (AC)	0.908	0.912	0.936	0.785
Interactivity (INT)	0.892	0.905	0.925	0.755
Reflective Thinking (PR)	0.794	0.806	0.879	0.707
Relevance (RE)	0.816	0.834	0.879	0.645
Tutor Support (AT)	0.901	0.903	0.931	0.770

Applying the Fornell-Larcker [34] criterion confirms the discriminant validity of the measurement model used in this research, demonstrating that the constructs are distinct and unique. Observing Table III, the square roots of the average variance extracted (AVE) for each construct, located on the main diagonal, are consistently higher than the inter-construct correlations off the diagonal. For example, for the Affective Support (AC) construct, the square root of the AVE is 0.886, which exceeds the correlations of AC with Interactivity (INT), Reflective Thinking (PR), Relevance (RE), and Tutor Support (AT). This pattern is repeated across the constructs, ensuring that the items associated with each construct measure different

dimensions and do not overlap. This is a crucial indicator of reliable and precise measurement in online learning.

TABLE III
FORNELL-LARCKER CRITERION

	AC	INT	PR	RE	AT
AC	0.886				
INT	0.671	0.869			
PR	0.266	0.273	0.841		
RE	0.326	0.329	0.555	0.803	
AT	0.392	0.333	0.449	0.545	0.878

The assessment of discriminant validity using the heterotrait-monotrait (HTMT) ratio by Henseler [35] shows that all correlations between the constructs are below the conservative cutoff point of 0.85, as suggested by Franke and Sarstedt [36], indicating adequate discriminant validity in the model. Specifically, the values in Table IV reflect that constructs such as Affective Support (AC) and Interactivity (INT) have a correlation of 0.734, which is below the threshold and suggests that these constructs are distinct yet have a moderate relationship. Lower correlations, such as between Reflective Thinking (PR) and Interactivity (INT) with a value of 0.320, confirm that these constructs are different and measure distinct aspects of the student experience. Higher values, like the correlation between Relevance (RE) and Reflective Thinking (PR) of 0.686, are still below the 0.85 limit, indicating that, although they are related, they represent differentiated constructs. This HTMT analysis supports the conclusion that the constructs of the study are discriminant and, therefore, measure different facets of university students' attitudes and behaviours.

TABLE IV
HETEROTRAIT CRITERION - MONOTRAIT –HTMT

	AC	INT	PR	RE	AT
AC					
INT	0.734				
PR	0.307	0.320			
RE	0.369	0.376	0.686		
AT	0.430	0.365	0.528	0.628	

The coefficient of determination R^2 is a statistical measure that indicates the proportion of the variance in the dependent variable that is predictable from the independent variables in a regression model. In the context of this research, the R^2 values are interpreted as follows:

Interactivity (INT): With an R^2 of 0.074, approximately 7.4% of the variation in affective support can be explained by interactivity. This implies that other factors not included in the model contribute to most of the variability in affective support, as interactivity has a relatively low impact.

Tutor Support (AT): An R^2 of 0.297 indicates that 29.7% of the variation in affective support can be explained by tutor support. This suggests that tutor support has a moderate influence on affective support, being a more significant factor than interactivity.

Affective Support (AC): The highest R^2, at 0.483, suggests that nearly 48.3% of the variation in affective support is explained by the model. This shows that the model has a reasonable capacity to explain affective support. However, there is still more than half of the variability attributable to factors not included in the model.

These R^2 values indicate that while tutor support is a stronger predictor of affective support compared to interactivity, there is still a considerable margin of affective support variability not captured by the modelled constructs. This suggests the need to explore other potential factors that may influence students' affective support. See Figure 1.

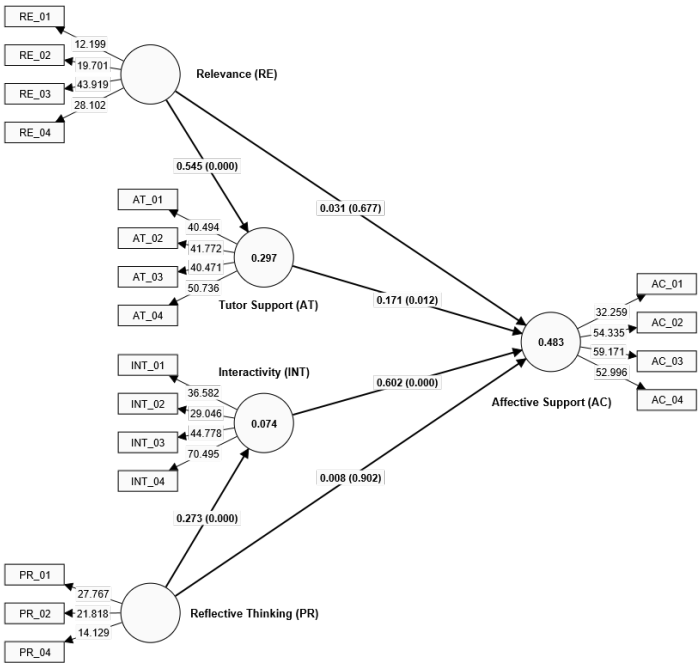

Figure 1 Model R^2 – Mediating effect - SmartPLS.

Table V displays the results of the analysis of relationships between different constructs in an online learning model, using the original sample, sample mean, standard deviation, T statistics, and p-values.

Interactivity (INT) -> Affective Support (AC): There is a solid and significant relationship (coefficient of 0.602) with a T statistic well above the significance threshold (11.000), indicating that interactivity positively predicts affective support, with a p-value of 0.000, confirming statistical significance.

Reflective Thinking (PR) -> Affective Support (AC): The relationship is fragile (coefficient of 0.008) and not significant, with a T statistic of 0.123 and a p-value of 0.902, indicating that reflective thinking does not have a significant predictive effect on affective support.

Reflective Thinking (PR) -> Interactivity (INT): There is a moderate and significant relationship (coefficient of 0.273)

with a T statistic of 3.791 and a p-value of 0.000, suggesting that reflective thinking does have a significant impact on interactivity.

Relevance (RE) -> Affective Support (AC): The relationship is weak and not significant (coefficient of 0.031), with a low T statistic (0.417) and a p-value of 0.677, suggesting that relevance is not a significant predictor of affective support.

Relevance (RE) -> Tutor Support (AT): There is a strong and significant relationship (coefficient of 0.545) with a high T statistic (10.560) and a p-value of 0.000, indicating that relevance has a significant influence on tutor support.

Tutor Support (AT) -> Affective Support (AC): The relationship is moderately strong and significant (coefficient of 0.171) with a T statistic of 2.509 and a p-value of 0.012, showing that tutor support has a significant positive effect on affective support.

TABLE V
BOOTSTRAPPING TEST RESULTS – MODEL PATH COEFFICIENTS

Path coefficients	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	p-value
(INT) -> (AC)	0.602	0.602	0.055	11.000	0.000
(PR) -> (AC)	0.008	0.009	0.065	0.123	0.902
(PR) -> (INT)	0.273	0.277	0.072	3.791	0.000
(RE) -> (AC)	0.031	0.032	0.074	0.417	0.677
(RE) -> (AT)	0.545	0.548	0.052	10.560	0.000
(AT) -> (AC)	0.171	0.170	0.068	2.509	0.012

Table VI presents the results of the bootstrap tests for the proposed hypotheses as follows:

H1: The indirect path from Reflective Thinking (PR) to Interactivity (INT) to Affective Support (AC) has an original sample coefficient of 0.164, with a sample mean of 0.167 and a standard deviation of 0.046. The T statistic is 3.538 with a p-value of 0.000. This indicates significant mediation by interactivity between reflective thinking and affective support, confirming hypothesis H1. Reflective thinking significantly increases interactivity, which in turn enhances the affective support perceived by students.

H2: The indirect path from Relevance (RE) to Tutor Support (AT) to Affective Support (AC) has an original sample coefficient of 0.093, with a sample mean of 0.094 and a standard deviation of 0.040. The T statistic is 2.342, with a p-value of 0.019. These results indicate that tutor support is a significant mediator between the relevance of online learning and affective support, validating hypothesis H2. The relevance of online educational practices significantly improves the quality of tutor support, increasing the affective support that students experience in their learning process.

Both results support the theory that both interactivity and tutor support are critical mechanisms through which online learning components can positively influence university students' affective support. Therefore, hypotheses H1 and H2 are accepted according to the significance level $p < 0.05$.

TABLE VI
BOOTSTRAPPING TEST RESULTS – SPECIFIC INDIRECT - MODEL PATH COEFFICIENTS

Hypothesis	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	p-value
H1. Reflective Thinking (PR) -> Interactivity (INT) -> Affective Support (AC)	0.164	0.167	0.046	3.538	0.000
H2. Relevance (RE) -> Tutor Support (AT) -> Affective Support (AC)	0.093	0.094	0.040	2.342	0.019

IV. CONCLUSIONS

Based on the analyzed and obtained results, the following conclusions can be formulated: Interactivity within the online learning environment plays a significant role in students' perception of affective support, mediating between reflective thinking and affective support. With an R^2 of 0.074 for interactivity and a significant direct relationship with affective support ($p=0.000$), it is concluded that, although its effect is modest, interactivity is an essential factor contributing to how students perceive affective support in the context of online education. The significant mediation confirmed by a high T statistics value reinforces the hypothesis that fostering an interactive environment can enhance students' emotional experience. However, it also suggests that other significant factors contribute to affective support not captured by this model.

Tutor support is a robust mediator between the relevance of educational content and the affective support students receive. With an R^2 of 0.297 for tutor support and a direct and significant influence on affective support ($p=0.012$), it is evident that the quality of tutor support has a moderate but significant influence on affective support. The relevance of educational content significantly improves the quality of tutor support, increasing the affective support students experience. This finding underscores the importance of considering the quality of tutor support as a critical component in the design and implementation of online learning programs to enhance the positive affective experience of students.

These findings highlight the importance of interactivity and tutor support as mediating elements in online education. While interactivity needs to be reinforced by other elements to have a more profound impact, tutor support is a more immediate and direct factor in enhancing affective support, which is essential for an effective and enriching online learning environment.

Future research could focus on identifying additional variables that impact affective support, such as student autonomy or content quality, and consider how individual differences influence the effectiveness of interactivity and tutor support. Longitudinal studies could elucidate how these effects evolve, thus optimizing online educational strategies.

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