Interactive Teaching Materials' Impact on Students' Perception of Teaching Quality: Mediated by Engagement

Venugopal Muthuswamy*
e-mail: fmuthuswamy@kfu.edu.sa
Associate professor, School of Business, Department of Management,
King Faisal University. Saudi Arabia.
J. Pavithra
e-mail: pavithrj1@srmist.edu.in
Assistant professor, Faculty of management, SRM Institute Of Science And Technology
SRM Nagar Kattankulathur Chengalpattu Tamil Nadu

Abstract: This study explores the impact of interactive teaching materials on students' perception of teaching quality, focusing on the mediating role of learning engagement and the moderating role of academic stress. The research aims to provide insights into how innovative educational tools and contextual factors shape teaching effectiveness in higher education.A quantitative research design was employed, using survey data from 281 college students enrolled in various programs. Validated scales were adapted from prior studies to measure interactive teaching materials, learning engagement, academic stress, and students' perception of teaching quality. The data were analyzed using Adanco software, employing structural equation modeling to test the proposed relationships and assess reliability, validity, mediation, and moderation effects.The results revealed that interactive teaching materials significantly enhance students' perception of teaching quality, with learning engagement playing a mediating role. Furthermore, academic stress moderates this relationship, reducing the effectiveness of interactive materials under high-stress conditions. These findings highlight the dual importance of engagement and stress management in maximizing the benefits of innovative teaching tools.This study advances educational theory by integrating active learning, constructivist, and stress-coping models. It offers practical recommendations for educators to enhance teaching quality by fostering engagement, leveraging interactive tools, and addressing academic stress in diverse learning environments.

Keywords: Interactive teaching materials, Learning engagement, Academic stress, Students' perception of teaching quality.

1. Introduction

The application of technology in learning has substituted the traditional teaching methods with a more energetic learning environment that provides a direct student-teacher interaction. Among the current developments in technology, interactive presentation of teaching materials is the heart of modern learning that promotes active learning and various learning styles (Lasekan et al., 2024). These are materials that

range from gamified learning tools to digital simulations that have changed the face of education from a teacher-centric paradigm to a learner-centric one (Li et al., 2024). It is also consistent with global trends in education that experience personalized and inclusive learning. Other variables like learning engagement and academic stress have also become critical determinants of the students' academic success and perceptions of teaching quality (Saleem et al., 2024). While tremendous growth has taken place, adoption and effectiveness are contingent on contextual and individual differences, so it is worthwhile to study the effects further (Doluweera et al., 2023). This study explores the intricate relationships between interactive teaching materials, learning engagement, academic stress, and students' perceptions of teaching quality, offering information on how educational practices can be optimized.

The evidence that interactive teaching material improves educational results and perceptions regarding teaching quality has supported extensive empirical work (Li & Wang, 2024). Cognitive Theory of Multimedia Learning provides a foundational basis for understanding why interactive materials will help learners memorize better if text, images, and interactivity are integrated (Javaid et al., 2024). Related studies have justified this framework to be valid. It has established that such interactive materials enhance both students' learning and engagement abilities (Skulmowski & Xu, 2022). For example, Liu et al. (2024) indicated that gamified learning platform-exposed students experienced higher levels of satisfaction with the course while also perceiving instructors as being more innovative and effective. Simulations have been shown to have a positive impact in filling this gap between conceptualization and action for complex issues and making sense of them by being more practically meaningful (Kaspar et al., 2023). There has also been much research conducted on learning engagement, and its impact consistently points to mediation of educational outcomes (Wang et al., 2023). Empirical evidence has indeed indicated that students who are engaged in active learning processes excel and provide positive evaluations concerning teaching quality (AlAli & Wardat, 2024). Emotional and behavioral engagement, for instance, is related to better motivation and satisfaction with the learning process (Yang & Geng, 2024). Conversely, academic stress is one of the most significant factors that affect students' ability to learn from interactive teaching materials. At higher levels of student stress, ability to learn often decreases, consequently affecting students' perceptions of the quality of teaching (Oladipupo & Samuel, 2024).

Despite all these research studies done on interactive teaching materials, the gap has been largely evident (Giday & Perumal, 2024). For example, even though many research studies have been done on how the materials influence the outcome of learning directly, not many researches have been done on how those same materials influence the perception of the quality of teaching in various learning environments (Almansour & Almoayad, 2024). To summarise this, there is a gap in this relationship where the mediating role of learning engagement has not been explored entirely in regards to mechanisms through which interactive materials may affect the perceptions of teaching quality (Shahzad et al., 2024). This indicates a gap in research concerning the moderating effect of academic stress, known to play an important role in determining the student response towards educational strategies (Huang et al., 2024). Another notable gap is associated with contextual variability for the effectiveness of interactive teaching materials (Akram et al., 2024). Most of the research studies are biased toward developed educational settings, where challenges and opportunities are quite different from those

of underrepresented regions (Katebi et al., 2024). Furthermore, very little attention has been given to how technology adoption and engagement levels interact with academic stress in terms of perceptions about teaching quality (Yuan, 2024). Therefore, filling in such a gap is necessary in order to be able to develop subtle understanding about the ways by which interactive teaching material can be effectively deployed within any educational context.

This study attempts to add more complexity to inquiry into interactive teaching materials, learning engagement, academic stress, and students' perception of teaching quality. That is to say, the objectives to be answered in this study are:

1. To study direct impact of the interactive teaching aids on students perception of teaching quality.
2. To investigate the mediating role of learning engagement in the relationship between interactive teaching materials and perceptions of teaching quality.
3. To evaluate the moderating effect of academic stress on the relationship between interactive teaching materials and students' perceptions of teaching quality.

The present study addresses these objectives to fill crucial gaps in literature and offer concrete insights for both educators and policymakers on optimizing the use of interactive teaching materials in different learning environments. This study will contribute to a growing body of literature on educational technology by giving an explanation for the nuanced relationship between interactive teaching materials, engagement, stress, and teaching quality perceptions. Its implications are very practical for educators who are interested in teaching better as well as for policymakers interested in programs which attempt to ensure that fair and equal access is accorded to quality education. The present study also theoretically supports a better understanding of contextual and individual factors that may determine student reaction towards new approaches of teaching.

The theoretical basis of this study is the use of Self-Determination Theory and the Transactional Model of Stress and Coping. According to SDT, autonomy, competence, and relatedness are major elements in fostering intrinsic motivation and engagement (Singh & Meena, 2023). These principles of Interactive materials for teaching are designed in the sense that students would be achieved autonomy by self-paced learning, competence by scaffolded content, and the relatedness through the online collaboration tools. Additionally, in SDT, it is seen how learning engagement acts as a mediator that interlinks interactive materials to perceptions of teaching quality (Wang et al., 2024). A theoretical underpinning for the moderation role of academic stress is found in the Transactional Model of Stress and Coping (Jia & Cheng, 2024). This model further explains how the level of academic stress moderates the ability of individuals to participate in and profit from external stimulation, such as interactive teaching materials. High stress may negatively influence participation, whereas low stress creates a friendly atmosphere where the possibility of good learning can occur. Based on the above theories, this study is conducted to provide more knowledge regarding the impact of interactive teaching aids, engagement, and stress, as stated by its objectives, in creating perceptions about the quality of teaching among students.

2. Literature Review

In the past few years, interactive teaching resources have been popularly emphasized on improving the quality of education (Kang et al., 2024). Studies show that these materials involve multimedia presentations, digital simulations, gamified learning tools, and interactive assessments as a way to increase student interest in the educational process (Khanal, 2023). They accommodate different kinds of learning styles of students. The studies showed, for instance, how interactive materials result in a learner-centered environment by encouraging active participation and collaboration in the classroom (Arun et al., 2024). The use of interactive teaching formats instead of traditional lecturing methods comes in line with the constructivist theory of education that basically states knowledge is not passively received but actively constructed by the learner (Gellisch et al., 2023). In addition, cognitive outcomes are said to increase when technology-based teaching is adopted. Students can now better visualize concepts, interact meaningfully with dynamic content, and retain the information better (Cai et al., 2024). Such resources also allow teachers to customize learning experiences, provide prompt feedback, and address the needs of different learners for an improved perception of teaching quality (Agwu, 2023).

Besides engagement and understanding, the perception of the competence of a teacher by a student is also directly affected by interactive teaching resources (Pandita & Kiran, 2023). Research studies have shown that students associate the use of up-to-date, technology-based teaching resources with a teacher's commitment to teaching excellence (Kamran et al., 2023). This often translates to better teaching evaluations as students connect with the material better and are more motivated to learn (Zapata-Cuervo et al., 2021). In addition, interactive tools encourage two-way interactions between instructors and students, and traditional hierarchies are diminished as a collaborative atmosphere is established. This fosters not only higher student satisfaction but also student's sense of agency in learning (Luan et al., 2020). The strength of these materials, however, is highly contingent on their appropriateness to the objectives of the course and the ability of the instructor to incorporate them into the course in a non-disruptive manner (Persello, 2023). When not well-designed or not used appropriately, such tools can frustrate and hinder the intended purposes. There is thus much promise for interactive teaching materials in changing perceptions of the quality of teaching (Ortega et al., 2023). However, it is clearly very contingent upon careful design and appropriate application.

For all the foregoing research on interactive teaching materials has long pointed toward a transformative future in educational circles (Lep et al., 2023). Scholars have established that certain interactive materials; multimedia presentations, virtual labs, and digital simulation enhance the engagement of students and improve understanding (Tharapos et al., 2022). For instance, Cognitive Theory of Multimedia Learning establishes the belief that although combining text with images and interactivity may not help enhance the learning process, it is better compared to using material based on texts (Lysenko et al., 2023). This theory finds support in empirical evidence, which claims that the instructional use of technology-based materials improves student performance (Cramarenco et al., 2023). In addition, studies conducted in the higher education sector reveal that interactive tools make the entire learning process lively as well as collaborative and strong forces impact student-faculty perception of teaching

quality (Chiu, 2021). For example, Hattie (2009) proved that students feel teachers use more innovative and effective if interactive materials are integrated into the classroom. Besides, it has been established that such resources facilitate improved memory retention and problem-solving skills (Lasekan et al., 2024), all factors contributing immensely to an appreciation of the quality of teaching.

From several empirical literatures, it has been demonstrated that effectiveness in teaching increases through interactive teaching materials, and that offers a robust ground for this hypothesis (Saleem et al., 2024). Since such tools are interactive, they help in responding to the various preferences of learning. The determinant for perceiving greater quality in teaching is exceptionally founded on inclusivity (Li & Wang, 2024). For example, Skulmowski and Xu (2022) demonstrated that students who used interactive methods had greater clarity and a better feeling towards course delivery. Similar to Kaspar et al. (2023), others indicated that interactional tools facilitate immediate feedback opportunities, which are then responded to by students through rating it as better. Again, interactivity-based studies emphasize that interactivity is an essential part of contemporary education systems; indications of technology adoption signifying the educator's adaptability and commitment (AlAli & Wardat, 2024). It follows logically then that a positive relationship between interactivity-rich materials and students' perceptions of quality teaching is indicated.

H1: Interactive teaching materials significantly influences the students' perception of teaching quality.

It has also been acknowledged that learning engagement is among the most critical factors that can influence students' perceptions of the quality of teaching (Oladipupo & Samuel, 2024). Engagement represents the emotional, behavioral, and cognitive dimensions to describe how learners reflect on their experiences of learning (Almansour & Almoayad, 2024). Students are more likely to rate their instructors as effective as well as teaching methods when engaged (Huang et al., 2024). For example, Katebi et al. (2024) report a direct association between student engagement and positive comments on teaching strategies in higher education. Furthermore, an engaged learner is more responsive to course content and instructors, leading to a collaborative and cooperative learning environment. Such an environment would likely be related to quality teaching because of mutual respect and understanding between teachers and students (Singh & Meena, 2023).

The connection between engagement in learning and perceived teaching quality relies on the fact that active involvement in learning makes the learning process more rewarding (Jia & Cheng, 2024). For example, Khanal (2023) found that engagement has a positive impact on academic achievement and perceived teaching quality. Moreover, students who are more engaged are also more likely to appreciate and appreciate the efforts an instructor takes to build a rich and interactive learning environment (Gellisch et al., 2023). Empirical studies reveal that if students are more engaged in the learning process, they tend to consider their teachers as effective teaching facilitators (Agwu, 2023). Further evidence that strengthens this hypothesis comes from research which reveals that engagement acts as a pathway for further understanding and positive emotional reactions towards teaching strategies that impact student ratings of teaching quality.

H2: Learning engagement significantly influences the students' perception of teaching quality.

Several studies have focused on the mediating role of learning engagement within educational contexts (Kamran et al., 2023). A number of studies have since established that although interactive teaching materials have a direct positive effect on learning outcomes, this effect is enhanced when engagement is triggered (Luan et al., 2020). For example, Ortega et al. (2023) showed that the use of interactive tools enhances levels of engagement, which in turn enhances the evaluations of teaching quality. This supports the findings by Tharapos et al. (2022), which stated that learning engagement is the bridge between innovative teaching methods and positive student outcomes. Interactive materials, inherently, require interactive participation, therefore encouraging emotional as well as intellectual investment in learning (Cramarenco et al., 2023). As such, this means that increased investment enhances students' perceptions of teachers and the broader learning environment.

The hypothesis draws empirical support from studies that recognize the inter-play between technology, engagement, and the quality of teaching (Li et al., 2024). For instance, a study by Doluweera et al. (2023) shows that gamified learning environments- that is, gamified teaching material- foster engagement, which eventually influences the perceptions of instructional quality. As Javaid et al. (2024) ascertained, interactive tools are engagement triggers that create an avenue for better evaluations of teaching. The mediating effect of engagement can be seen in the ability to link benefits of interactive materials with increased admiration for teachers. It is an essential part of this relationship.

H3: Learning engagement significantly mediates the relationship of interactive teaching materials and the students' perception of teaching quality.

Academic pressure has been reported to affect students' perception of and reaction to instructional practices (Liu et al., 2024). Higher stress levels can drown out the effectiveness of interactive teaching aids since cognitive and emotional resources are devoted to coping with stressors (Wang et al., 2023). Various studies have also pointed out that students who face high academic stress cannot enjoy the benefits of using interactive tools (Yang & Geng, 2024). Conversely, low-stress environments often allow students to embrace innovative teaching methods, resulting in positive perceptions of teaching quality (Giday & Perumal, 2024). These findings suggest that academic stress acts as a moderator, shaping the extent to which students can benefit from and value interactive teaching methods.

The moderating effect of academic stress is evident in its potential to influence students' engagement and perception of teaching quality (Shahzad et al., 2024). Empirical studies, like Akram et al. (2024), show that high levels of stress greatly reduce the ability of students to concentrate and engage with teaching materials. Interactive teaching tools would be less effective at high levels of stress because the students would not be able to participate fully in the content (Yuan, 2024). Conversely, in a low-stress environment, the interactive tools would be more effective, increasing students' ratings of teaching quality (Wang et al., 2024). This hypothesis draws on previous studies by suggesting that stress does not only impact engagement but also modifies

the perceived effects of teaching strategies, and hence it is a significant variable to understand this interaction.

H4: Academic stress significantly moderates the relationship of interactive teaching materials and the students' perception of teaching quality.

2.1. Theoretical Background

The relationships and model suggested in this research (Figure 1) are both explainable through the lenses of SDT and TMSC. SDT cites the necessity of autonomy, competence, and relatedness to foster intrinsic motivation and engagement, respectively (Kang et al., 2024). Interactive materials for teaching are aligned with these aspects as they entail autonomy, since much of the activity will involve making choices; there will be a lot of competence, as students are scaffolded through learning; and relatedness through collaborative tools (Arun et al., 2024). The Transactional Model of Stress and Coping by Folkman & Lazarus, 1984 further adds a dimension to this framework as it postulates that academic stress modifies a student's responses to educational strategies (Cai et al., 2024). Together, both theories explain an interacting effect of interactive tools, engagement, stress, and quality of teaching to lay a good basis for the proposed hypotheses.

Figure 1: Theoretical Model
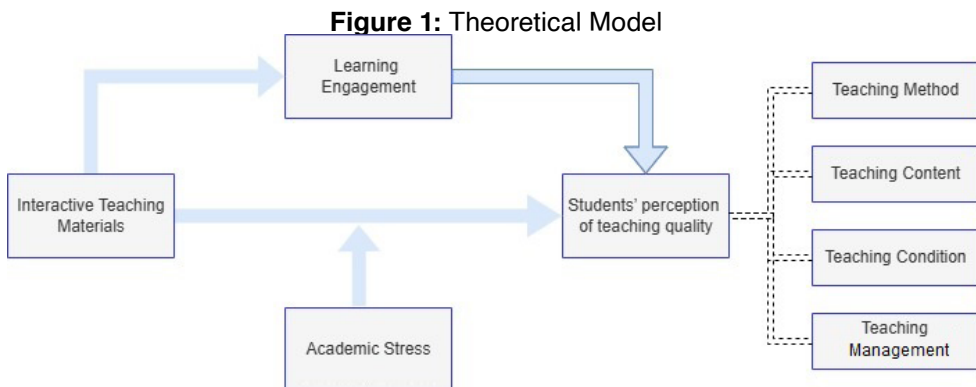
3. Methodology
3.1. Research Design

A quantitative research design was applied to investigate the relationship between interactive teaching materials, learning engagement, academic stress, and students' perception of teaching quality. Direct, mediating, and moderating effects of the variables are also examined by applying this research design with the aim of giving empirical support for the formulated hypotheses. For the purpose of collecting data, a structured survey is used. In addition, the scales from prior research studies have been validated for reliability and validity.

3.2. Sample and Participants

The target participants were college students pursuing different curricula. This sample consisted of 281 purposively selected students that ensured a healthy diversity in curriculum, level, and exposure to interactive teaching practices. The samples included both graduate and undergraduate participants, and consisted of males, females, those in their first or later years and students in other fields of specialization. This diversity formed a strong basis to generalize the findings across various educational contexts. Respondents were invited to answer the survey questionnaire willingly and under their guarantee that the responses given will be kept confidential.

3.3. Data Collection Instruments

This included surveying instruments (Table 1) that adopted previously validated constructs in the form of scales that aligned with both established theoretical and empirical frameworks to ensure the measurement of the respective constructs. Scales were scored using a five-point Likert scale that spanned 1 (strongly disagree) to 5 (strongly agree). Measured constructs were:

For example, all above scales adopted prior to have ever been tested should be reliable.

Table 1: Data Collection Instruments

Instruments	Items	Adopted from
Interactive teaching materials	Fifteen	(Pricilia et al., 2020)
Learning engagement	Three	(Sun et al., 2022)
Academic stress	Three	(Deng et al., 2022)
Students' perception of teaching quality	Sixteen	(Gao et al., 2021)

3.4. Procedure

The process of data collection entailed the survey being administered to students in class sessions or via online means so that as many students as possible could access it and participate. The survey was user-friendly and took around 10–15 minutes to fill. A total of 300 questionnaires were issued, and after removing all the incomplete and invalid responses, 281 responses were kept for analysis, resulting in a 93.7% response rate.

3.5. Data Analysis

The data collected were analyzed using Adanco, a software that is specifically designed for variance-based structural equation modeling (VB-SEM). The reason for using Adanco was because of its robust capabilities in handling reflective and formative measurement models, which makes it suitable for the complex relationships studied in this paper. The analysis was carried out in several stages:

1. Reliability and Validity Assessment: Cronbach's alpha, composite reliability, and average variance extracted (AVE) were calculated to confirm internal consistency and convergent validity of the constructs.
2. Confirmatory Factor Analysis (CFA): To validate the measurement model and ensure each construct was accurately represented by its indicators.

3. Structural Model Testing: Path coefficients were calculated to test the hypothesized relationships between the variables.
4. Mediation and Moderation Analysis: Specific tests were conducted to check the mediating role of learning engagement and moderating effect of academic stress.

The results offered robust support to the hypothesized relationships, thus providing valuable insights into the teaching and learning dynamics in higher education.

4. Results

Table 2 gives an overview of the reliability and validity of the constructs applied in this study. Dijkstra-Henseler's rho (ρA), Jöreskog's rho (ρc), Cronbach's alpha (α), and Average Variance Extracted (AVE) were used to measure internal consistency and construct validity. All constructs have high reliability with values greater than the recommended threshold of 0.7 across ρA, ρc, and α. For instance, Interactive Teaching Materials scored 0.848, 0.846, and 0.847, respectively, demonstrating strong internal consistency. Similarly, the AVE values for all constructs exceed 0.5, indicating satisfactory convergent validity.

Table 2: Variables reliability and validity

Construct	Dijkstra-Henseler's rho (ρA)	Jöreskog's rho (ρc)	Cronbach's alpha(α)	Average variance extracted (AVE)
Interactive teaching materials	0.848	0.846	0.847	0.509
Learning engagement	0.883	0.880	0.884	0.566
Academic stress	0.890	0.888	0.889	0.543
Students' perception of teaching quality	0.899	0.897	0.896	0.514

Learning Engagement reported an AVE of 0.566, suggesting that the latent construct adequately explains the variance in the observed variables. Academic Stress and Students' Perception of Teaching Quality also exhibit healthy reliability and validity metrics, including Cronbach's alpha values as 0.889 and 0.896, respectively that confirm the measurement consistency. Summary of CFA results indicates that it is an apt model for capturing latent constructs: The CFA validated the item loading on appropriate factors, putting emphasis on a robust model in place. High standardized loadings across all constructs indicate that the observed variables are reliable indicators of the underlying constructs. For instance, factor loadings for interactive teaching materials and learning engagement are always above 0.6, which means that the theoretical expectations are strongly aligned. Fit indices such as RMSEA, CFI, and TLI further support the appropriateness of the model (Figure 2), thus making it applicable in interpreting relationships among variables.
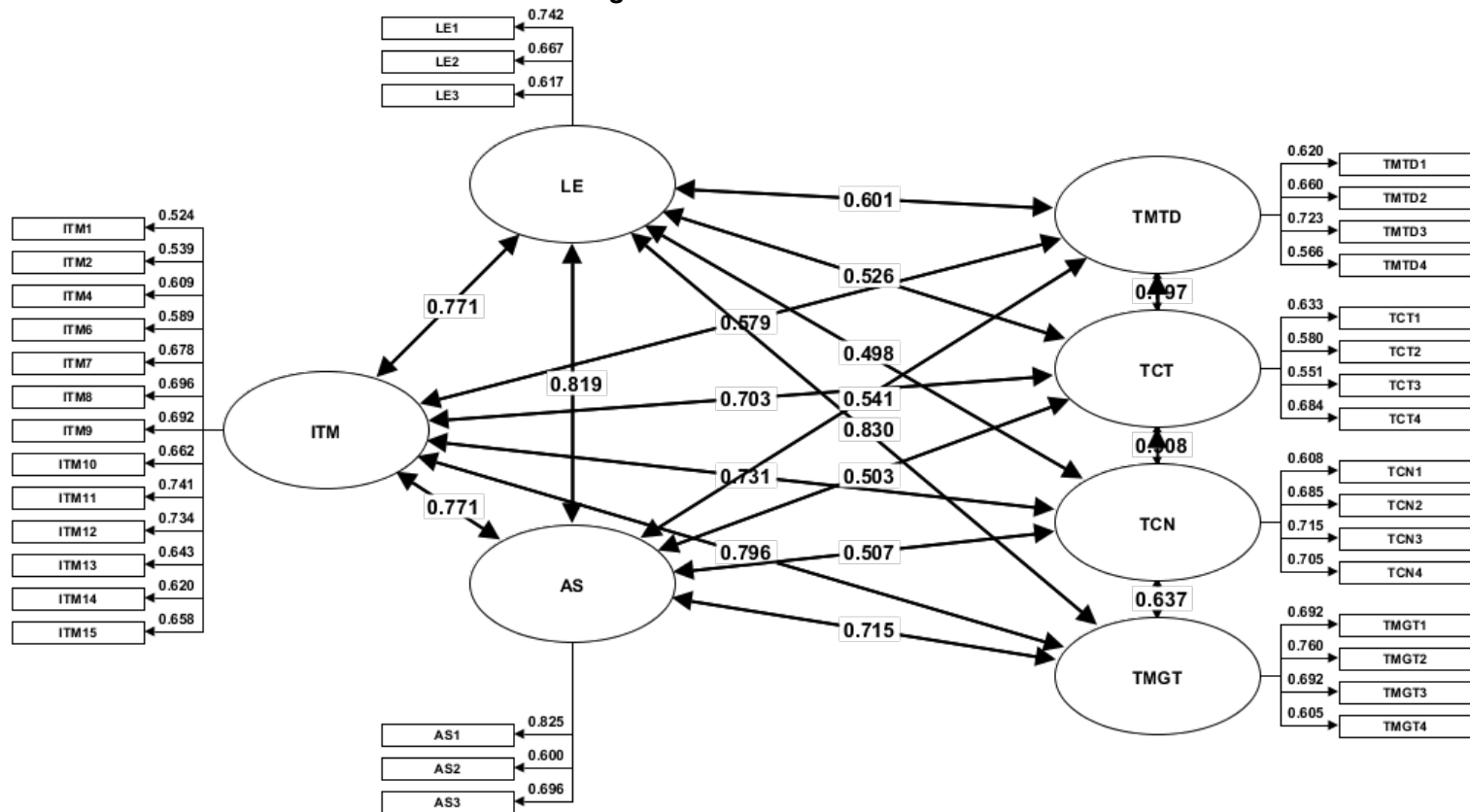
Figure 2: Estimated Model

Table 3 shows the fitness statistics of individual measurement items. Indicators across constructs have satisfactory factor loadings, where most values are above the threshold of 0.6. For Interactive Teaching Materials, TMTD3 had the highest loading at 0.723, which proves its relevance as a robust indicator. Similarly, Learning Engagement items such as ITM12 and ITM11 have strong loadings of 0.734 and 0.741, respectively, which confirm their alignment with the construct. Academic Stress item AS1 recorded the highest loading (0.825), highlighting its significance in capturing the construct. These results validate the fitness of the measurement items, ensuring their appropriateness for inclusion in the structural model.

Table 3: Measurement Items Fitness Statistics

Indicator	Interactive teaching materials	Learning engagement	Academic stress	Students' perception of teaching quality
TMTD1	0.620			
TMTD2	0.660			
TMTD3	0.723			
TMTD4	0.566			
TCT1	0.663			
TCT2	0.580			
TCT3	0.551			
TCT4	0.684			
TCN1	0.608			
TCN2	0.685			
TCN3	0.715			
TCN4	0.705			
TMGT1	0.692			
TMGT2	0.760			
TMGT3	0.692			
TMGT4	0.605			
ITM1		0.524		
ITM2		0.539		
ITM4		0.609		
ITM6		0.589		
ITM7		0.678		
ITM8		0.696		
ITM9		0.692		
ITM10		0.662		
ITM11		0.741		
ITM12		0.734		
ITM13		0.643		
ITM14		0.620		
ITM15		0.658		
LE1			0.742	
LE2			0.667	
LE3			0.617	
AS1				0.825
AS2				0.600
AS3				0.696

Table 4 measures the discriminant validity between constructs by showing HTMT values. The outcome suggests that all values are below the threshold of 0.85, meaning acceptable levels of correlation. As shown below, the correlation between Interactive Teaching Materials and Learning Engagement is 0.688, establishing discriminant validity. Likewise, the association between Academic Stress and Students' Perception

of Teaching Quality of 0.539 is well within acceptable limits. These outcomes ensure that each construct is empirically distinct and therefore enhances the robustness of the interpretation of the model.

Table 4: Heterotrait-Monotrait Ratio of Correlations (HTMT)

Construct	1	2	3
Interactive teaching materials			
Learning engagement	0.688		
Academic stress	0.635	0.808	
Students' perception of teaching quality	0.470	0.486	0.539

As presented in Table 5, Fornell-Larcker Criterion results support discriminant validity. Diagonal values, being the square root of AVE, are greater than off-diagonal correlations. For example, the diagonal value for Learning Engagement (0.646) is higher than its correlation with Interactive Teaching Materials (0.716), which confirms that the constructs share more variance with their indicators than with other constructs. The findings are similar to HTMT results, thereby confirming the theoretical and empirical distinctiveness of the constructs.

Table 5: Fornell-Larcker Criterion

| Construct	1	2	3	4
Interactive teaching materials	0.693			
Learning engagement	0.716	0.646		
Academic stress	0.816	0.838	0.758	
Students' perception of teaching quality	0.815	0.706	0.785	0.753

Table 6 presents the R-squared values for the model's explanatory power. Learning Engagement has an R^2 of 0.671, which means that the predictors explain 67.1% of its variance. Similarly, Students' Perception of Teaching Quality has an R^2 of 0.542, showing a good amount of explanatory power. Adjusted R^2 values further confirm the stability of these results. Predictive relevance is confirmed when Q^2predict values are positive, and the Learning Engagement yielded a Q^2predict of 0.520. The adequacy of the model is shown by low values of RMSE and MAE, which allows for reliable prediction and interpretation.

Table 6: R-square statistics Model Goodness of Fit Statistics

Construct	Coefficient of determination (R2)	Adjusted R2	Q²predict	RMSE	MAE
Learning engagement	0.671	0.687	0.520	0.055	0.078
Students' perception of teaching quality	0.542	0.594			

Table 7 shows that all hypotheses are supported with p-values below 0.001 and significant coefficients (Figure 3). Interactive Teaching Materials had a strong effect on Students' Perception of Teaching Quality ($\beta = 0.491$, $t = 6.505$), thus illustrating the direct influence of technological tools on perceived teaching effectiveness. Learning Engagement also has a strong influence on Students' Perception of Teaching Quality ($\beta = 0.430$, $t = 6.277$), and therefore is the pivotal influence in the perception process.

Figure 3: Structural Model for Path Analysis
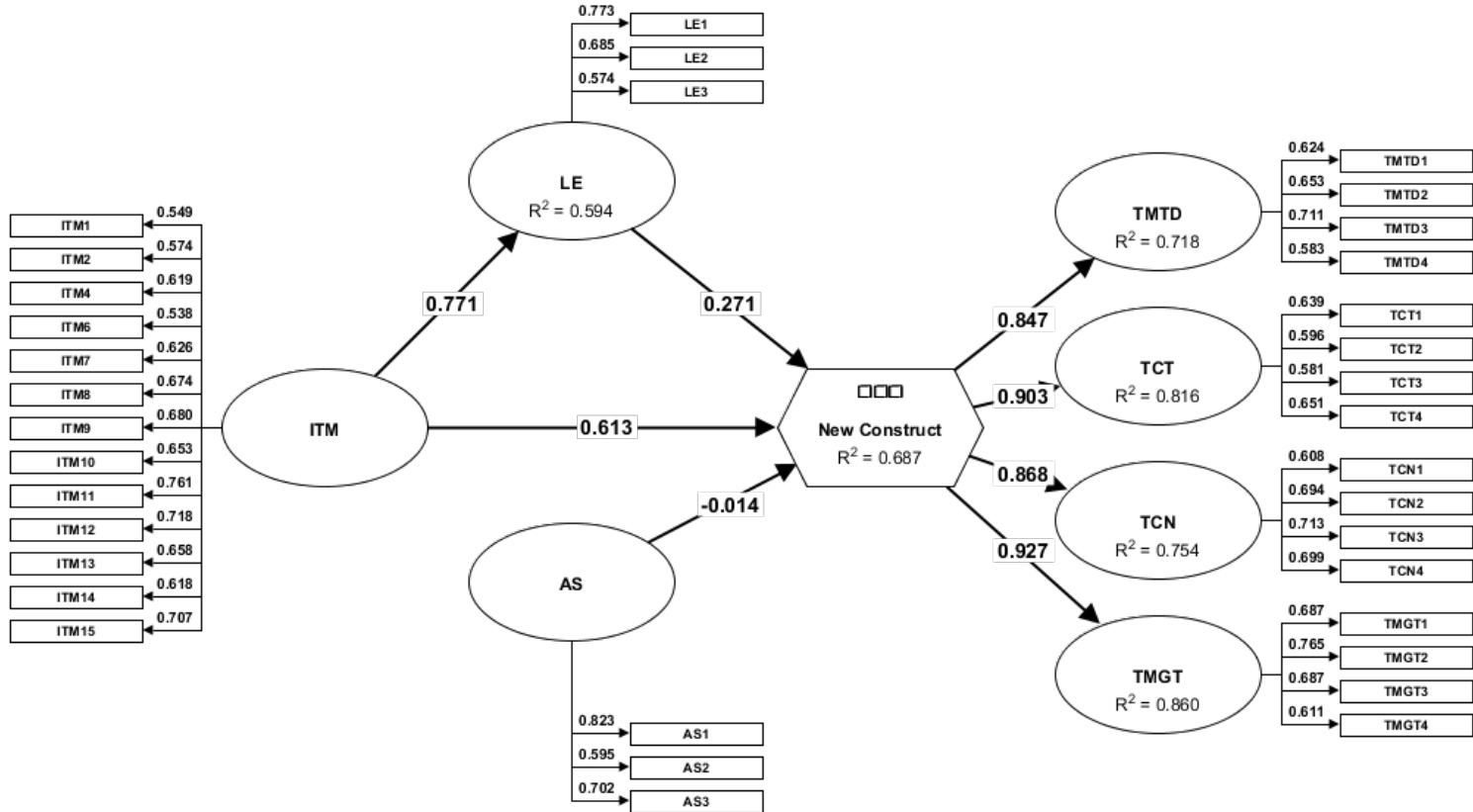
This reveals that Learning Engagement indeed has a mediating effect (β = 0.352, t = 5.530) on how the interactive materials transform into teaching quality perceptions. Lastly, Academic Stress highly moderates the relationship between Interactive Teaching Materials and Students' Perception of Teaching Quality (β = 0.282, t = 5.074). This indicates that the stress levels determine the benefit derived from or the perception created by the use of interactive tools.

Table 7: Path Analysis

Hypothesis	Coefficients	Standard Errors	t values	p values
Interactive teaching materials significantly influences the students' perception of teaching quality.	0.491	0.069	6.505	<0.001
Learning engagement significantly influences the students' perception of teaching quality.	0.430	0.062	6.277	<0.001
Learning engagement significantly mediates the relationship of interactive teaching materials and the students' perception of teaching quality.	0.352	0.058	5.530	<0.001
Academic stress significantly moderates the relationship of interactive teaching materials and the students' perception of teaching quality.	0.282	0.051	5.074	<0.001

5. Discussion

The integration of innovative teaching strategies and tools has become the pivot in modern education, improving learning outcomes while enhancing students' perception of teaching quality. The research highlights intricate relationships between interactive teaching materials, learning engagement, academic stress, and students' perception of teaching quality. Accepting all the proposed hypotheses, the study underlines the multifaceted impact of these factors in educational settings. This chapter discusses these results in the context of previous literature, focusing on their relevance to educators and policymakers.

The acceptance of hypothesis one points to the importance that interactive teaching materials play in altering the perception that students have toward teaching quality. This is in accord with previous research studies, as the resources for improvement include understanding through online platforms, game-based material, and multi-media materials which not only help in achieving improved understanding but also perceived instructor performance (Pandita & Kiran, 2023). The interactive learning resource provides for the interactive as well as an interactive learning environment meeting the demands of today's learner who grew up in technology-intensive settings. Data from this study indicate that students evaluate instructors who use such tools as more innovative, organized, and responsive. This is consistent with theories of active learning where the students are active participants instead of passive recipients in the learning process, thus having a better assessment of teaching quality.

The second hypothesis focuses on the importance of learning engagement in students' perceptions of teaching quality. The results indicate that the higher the behavioral, emotional, and cognitive engagement, the more positive attitudes toward teachers are. This would be aligned with previous findings that students appreciate the efforts used in teaching and instruction better where they are more engaged (Zapata-

Cuervo et al., 2021). The paper examines the combined relationship of engagement and perceptions, helping to understand how engagement and emotional involvement increase appreciation in students for teachers' efforts as they learn within a learning setting. Furthermore, engaged students are more likely to pay attention and appreciate the teaching methods and support strategies adopted by instructors. This further reinforces the value of encouraging engagement in learning environments.

The third hypothesis explains the mediating role of learning engagement, therefore detailing the mechanism by which interactive teaching material influences the students' perception of teaching quality. While instrumental, it shows that impact is amplified by active engagement. This aligns well with constructivist theories, wherein knowledge construction grows through active involvement and meaningful engagement with the content (Lep et al., 2023). The interactive materials also give a much more connected relationship between the students and the process of learning, which ultimately gives way to better perceptions about the quality of teaching. This mediating function draws on the aspect that interactive teaching tools must be created to keep active learners interested and involved through collaborative activities, solving of problems, and real-time feedback.

The fourth hypothesis provides insight into the moderating effect of academic stress. This effect has a two-way influence on the interactive teaching materials and students' perception of teaching quality. Data analysis reveals that although interactive materials tend to improve teaching quality perceptions, the effect is dampened when there is high stress. This finding is in congruence with the Transactional Model of Stress and Coping, which holds that stress affects the cognitive processing as well as the emotional resilience of people (Lysenko et al., 2023). Under conditions of high stress, students might not totally focus and thus acquire the benefits derived from interactive resources and eventually reduce the perception of teaching quality. Conversely, positive effects of interactive materials are exaggerated in low-stress environments; thus, this points out the significance of handling stressors within the educational setup.

The study focuses on the interactive relationship between learning engagement, interactive teaching materials, and academic stress that shape the students' perception of teaching quality. The findings not only validate the transformative potential of interactive materials but also emphasize the critical roles of engagement and stress management in optimizing their effectiveness. By fostering engagement and creating supportive, low-stress learning environments, educators can leverage these tools to their full potential, enhancing the overall educational experience. These results offer valuable guidance for future research and practical interventions aimed at improving teaching practices and student outcomes.

6. Implications of the study

By combining insight from active learning, constructivist theory, and the transactional model of stress and coping together to explain interactions between interactive teaching materials, student learning engagement, academic stressors, and students' perception of quality teaching, the study makes crucial contributions to theory in education. The results will also confirm several important assumptions from the active learning view, and these are that student activation in the process of teaching and learning contributes to better educational results. The gap between the theoretical constructs and their practical

application is bridged by establishing that interactive teaching materials promote more learning engagement, which subsequently enhances students' perceptions of teaching quality. Besides this, learning engagement mediates a new conceptual development into theory so as to recommend that engagement not only becomes a by-product of teaching but rather the vital medium whereby instructional intervention may realize full potential. Secondly, how the aspect is researched and considered within academic stress, possibly a moderator variable, will go to explain and provide an answer to this question on deeper level complexity relating such environmental elements and perception over learning. The conditions where interactive teaching material is most useful are identified to advance the transactional model of stress and coping, and its role in degrading or even enhancing the potential effectiveness of interventions in education. These findings provide a theoretical basis for future research to explore the boundaries of stress, engagement, and technology integration in education, encouraging scholars to develop more holistic models that account for diverse contextual factors in learning environments.

This research offers actionable insights for educators, administrators, and policymakers seeking to improve teaching quality through innovative methods. This research provides empirical support for incorporating digital tools, gamification, and multimedia resources into curricula since it validates the effectiveness of interactive teaching materials. In this respect, the use of such tools can add lessons to the lesson plan with interesting and lively materials that are able to upgrade students' perceptions about teaching quality. A high priority for teaching materials should guarantee active participation with respect to learners' needs. Through this, material usage will prove effective in combining traditional and new teaching methods and techniques. As such, research also emphasizes on the need to create a tension-free, interaction-rich learning culture. Institutions should use these studies to develop trainings and trainings programs within workshops that involve educators in designing ways to decrease classroom stress that can lead towards student engagement. Pragmatic approaches to include mindfulness exercises, giving immediate feedback, and collaborative learning environment can be a way to alleviate the negative effects of academic stress. The following factors addressed, educational institutions will be able to create an environment that enhances the benefits of interactive teaching materials while optimizing learning.

7. Limitations and Future Research Directions

Despite its value, there are several limitations to this study. First, the study focused on a particular population and educational context so that the findings may have limited generalizability. Further research into different populations and settings-different age groups, cultures, and education systems-is warranted to generalize and extend the findings. Also, this study's cross-sectional design limits drawing a casual relationship between the variables involved. Longitudinal studies would have the ability to depict a more profound understanding of how interactive teaching materials and engagement change over time and their long-term effects on perceptions of teaching quality. Data can be somewhat biased because it is self-reported and may be colored by social desirability or subjective perceptions. Future studies using a mixed methods approach, where qualitative insight may be combined with analyses in the form of numerical values, may provide a better understanding of the variables involved. Additionally,

exploring other potential mediators and moderators, such as technological self-efficacy, cultural influence, or institutional support, could give more content to the theoretical and practical implications of the research study. These paths can lead to even more robust and contextually nuanced models of teaching and learning dynamics.

8. Conclusion

In summary, this study highlights the transformative potential of interactive teaching materials in enhancing students' perception of teaching quality, mediated by learning engagement and moderated by academic stress. The findings highlight the critical importance of integrating technology into education in a manner that promotes engagement and minimizes stress. Focusing on the dynamic interplay between these factors, this work provides theoretical and practical insights for improvement in educational practices and outcomes. With changing education systems across the globe that must suffice to current digital demands, these research findings have been very helpful in guiding educators and policymakers who work with education systems. Interactively teaching materials create engagement and minimize stressors among stakeholders, ensuring that learning environments resonate with students' needs and expectations. Efforts will both improve teaching quality and prepare the students for greater success in this increasingly complex, technology-driven world.

Acknowledgement:

References

Agwu, U. D., & Nmadu, J. . (2023). Students' interactive engagement, academic achievement and self concept in chemistry: an evaluation of cooperative learning pedagogy. *Chemistry Education Research and Practice*, *24*(2), 688-705. https://doi.org/10.1039/d2rp00148a

Akram, M. A., Mohannad Faisel Bashir, E., & Abdullah Mahfoud Salem, B. (2024). The Effect of Perceived Quality, Student Life Social Identification on Student Satisfaction with Moderator Role of Organizational Identification. *International Research Journal on Advanced Engineering Hub (IRJAEH)*, *2*(04), 1075-1086. https://doi.org/10.47392/irjaeh.2024.0149

AlAli, R., & Wardat, Y. (2024). Low PISA Performance Students: Factors, Perceptions, and Improvement Strategies. *International Journal of Religion*, *5*(9), 334-348. https://doi.org/10.61707/nve8gj33

Almansour, M., & Almoayad, F. (2024). Exploring challenges and perceptions in the learning environment: an online qualitative study of medical students. *BMC medical education*, *24*(1), 147-147. https://doi.org/10.1186/s12909-024-05116-8

Arun, R., Natarajan, S., Sampath, K., Thoti, K. K., Mahalakshmi, R., & Sivaperumal, K. (2024). The Influence of Online Education on the Behavioral Patterns of Uni-

versity Students in India. In *Advancements in Communication and Systems* (pp. 335-348): Soft Computing Research Society. http://dx.doi.org/10.56155/978-81-955020-7-3-29

Cai, Y., Zeng, T., Gao, R., Guo, Y., Wang, Y., & Ding, D. (2024). A Cross-lagged Longitudinal Study of Bidirectional Associations between Meaning in Life and Academic Engagement: The Mediation of Hope. *Applied Research in Quality of Life*, *19*(5), 2665-2684. https://doi.org/10.1007/s11482-024-10348-3

Chiu, T. K. F. (2021). Student engagement in K-12 online learning amid COVID-19: A qualitative approach from a self-determination theory perspective. *Interactive Learning Environments*, *31*(6), 3326-3339. https://doi.org/10.1080/10494820.2021.1926289

Cramarenco, R. E., Burcă-Voicu, M. I., & Dabija, D.-C. (2023). Student Perceptions of Online Education and Digital Technologies during the COVID-19 Pandemic: A Systematic Review. *Electronics*, *12*(2), 319. https://doi.org/10.3390/electronics12020319

Deng, Y., Cherian, J., Khan, N. U. N., Kumari, K., Sial, M. S., Comite, U., Gavurova, B., & Popp, J. (2022). Family and Academic Stress and Their Impact on Students' Depression Level and Academic Performance. *Frontiers in psychiatry*, *13*, 869337-869337. https://doi.org/10.3389/fpsyt.2022.869337

Doluweera, M., Kirihene, K. D. H. K., Indika, N. L. R., Sirisena, C. N., Jatunarachchi, A. H., Chandrasena, U., Dharmadasa, S. G., Samaranayake, A., Devendra, V. G., Edirisinghe, V. N., Sugandhika Suresh, T., Jayasena, S., Yu, G. F. B., Pastor, C. J., & Thoradeniya, T. (2023). Students' perceptions of online education: A session at the FAOBMB–IUBMB–CBSL virtual education symposium 2021. *Biochemistry and Molecular Biology Education*, *52*(2), 228-236. https://doi.org/10.1002/bmb.21807

Gao, S., Zhuang, J., & Chang, Y. (2021). Influencing Factors of Student Satisfaction With the Teaching Quality of Fundamentals of Entrepreneurship Course Under the Background of Innovation and Entrepreneurship. *Frontiers in Education*, *6*. https://doi.org/10.3389/feduc.2021.730616

Gellisch, M., Morosan-Puopolo, G., Wolf, O. T., Moser, D. A., Zaehres, H., & Brand-Saberi, B. (2023). Interactive teaching enhances students' physiological arousal during online learning. *Annals of Anatomy - Anatomischer Anzeiger*, *247*, 152050. https://doi.org/10.1016/j.aanat.2023.152050

Giday, D. G., & Perumal, E. (2024). Students' perception of attending online learning sessions post-pandemic. *Social Sciences & Humanities Open*, *9*, 100755. https://doi.org/10.1016/j.ssaho.2023.100755

Hattie, J. (2009). The black box of tertiary assessment: An impending revolution. In L. D. Meyer, S.; Anderson, H.; Fletcher, R.; Johnston, P.; Rees, M. (Ed.), *Tertiary Assessment and Higher Education Student Outcomes: Policy, Practice and Research* (1st ed.). Ako Aotearoa. https://www.researchgate.net/publication/255665548

Huang, F., Wang, Y., & Zhang, H. (2024). Modelling Generative AI Acceptance, Perceived Teachers' Enthusiasm and Self-Efficacy to English as a Foreign Language Learners' Well-Being in the Digital Era. *European Journal of Education*, *59*(4). https://doi.org/10.1111/ejed.12770

Javaid, Z. K., Ijaz, S., Latif, E., & Azam, S. (2024). A qualitative study on student-teacher interaction: Student engagement and teacher feedback. *International Journal of Contemporary Issues in Social Sciences*, *3*(2), 1670-1683. https://www.researchgate.net/publication/383231734

Jia, M., & Cheng, J. (2024). Effect of teacher social support on students' emotions and learning engagement: a U.S.-Chinese classroom investigation. *Humanities and Social Sciences Communications*, *11*(1). https://doi.org/10.1057/s41599-024-02634-0

Kamran, F., Kanwal, A., Afzal, A., & Rafiq, S. (2023). Impact of interactive teaching methods on students learning outcomes at university level. *Journal of Positive School Psychology*, *7*(7), 89-105. https://www.researchgate.net/publication/372289203

Kang, L., Li, C., Chen, D., & Bao, X. (2024). Parental Involvement, Academic Self-Efficacy, and Depression on Academic Performance Among Chinese Students During COVID-19 Pandemic. *Psychology research and behavior management*, *17*, 201-216. https://doi.org/10.2147/PRBM.S447485

Kaspar, K., Burtniak, K., & Rüth, M. (2023). Online learning during the Covid-19 pandemic: How university students' perceptions, engagement, and performance are related to their personal characteristics. *Current psychology (New Brunswick, N.J.)*, 1-20. https://doi.org/10.1007/s12144-023-04403-9

Katebi, K., Ghaffarifar, S., Dehghani, G., & Pourabbas, A. (2024). Exploring the experiences of dentistry students of Tabriz University of Medical Sciences of academic motivation: a content analysis study. *BMC medical education*, *24*(1), 245-245. https://doi.org/10.1186/s12909-024-05237-0

Khanal, J. (2023). Shifting identities: an examination of student perceptions and experiences in face-to-face and online learning in Nepal. *Education and Information Technologies*, *29*(4), 4287-4315. https://doi.org/10.1007/s10639-023-12020-z

Lasekan, O. A., Pachava, V., Godoy Pena, M. T., Golla, S. K., & Raje, M. S. (2024). Investigating Factors Influencing Students' Engagement in Sustainable Online Education. *Sustainability*, *16*(2), 689. https://doi.org/10.3390/su16020689

Lep, Ž., Klemenčič Mirazchiyski, E., & Mirazchiyski, P. V. (2023). The relative effect of job demands, resources, and personal resources on teaching quality and students' engagement during the COVID-19 pandemic. *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1282775

Li, J., & Wang, R. (2024). Determining the role of innovative teaching practices, sustainable learning, and the adoption of e-learning tools in leveraging academic motivation for students' mental well-being. *BMC psychology*, *12*(1), 163-163. https://doi.org/10.1186/s40359-024-01639-3

Li, X., Zhang, F., Duan, P., & Yu, Z. (2024). Teacher support, academic engagement and learning anxiety in online foreign language learning. *British Journal of Educational Technology*, *55*(5), 2151-2172. https://doi.org/10.1111/bjet.13430

Liu, X., Zhu, C., Dong, Z., & Luo, Y. (2024). The Relationship between Stress and Academic Self-Efficacy among Students at Elite Colleges: A Longitudinal Analysis. *Behavioral sciences (Basel, Switzerland)*, *14*(7), 537. https://doi.org/10.3390/bs14070537

Luan, L., Hong, J.-C., Cao, M., Dong, Y., & Hou, X. (2020). Exploring the role of online EFL learners' perceived social support in their learning engagement: a structural equation model. *Interactive Learning Environments*, *31*(3), 1703-1714. https://doi.org/10.1080/10494820.2020.1855211

Lysenko, I., Verbytska, A., Novomlynets, O., Stepenko, S., & Dyvnych, H. (2023). Analysis of Online Learning Issues within the Higher Education Quality Assurance Frame: 'Pandemic Lessons' to Address the Hard Time Challenges. *Education Sciences*, *13*(12), 1193. https://doi.org/10.3390/educsci13121193

Oladipupo, O., & Samuel, S. (2024). A Learning Analytic Approach to Modelling Student-Staff Interaction From Students' Perception of Engagement Practices. *IEEE Access*, *12*, 10315-10333. https://doi.org/10.1109/access.2024.3352440

Ortega, F. Z. N., Suarez, C. J., Yuipco, W. A., & Cabanilla Jr, A. (2023). Systematic Review on the Academic Stresses of College Students in Blended Instruction. *International Journal of Social Science, Educational, Economics, Agriculture Research and Technology (IJSET)*, *2*(5), 43-52. https://doi.org/10.54443/ijset.v2i5.158

Pandita, A., & Kiran, R. (2023). The Technology Interface and Student Engagement Are Significant Stimuli in Sustainable Student Satisfaction. *Sustainability*, *15*(10), 7923. https://doi.org/10.3390/su15107923

Persello, B. F. (2023). *Determining a Relationship Between Attitude Towards E Learning and Academic Stress Levels in Higher Education Students* [Master's dissertation, , University of the Witwatersrand, Johannesburg]. https://hdl.handle.net/10539/39877

Pricilia, A., Abdurrahman, A., & Herlina, K. (2020). Teacher expectation towards interactive multimedia integrated with STEM in learning physics: Preliminary study on geometry optic learning material. *Journal of Physics: Conference Series*, *1572*(1), 012065. https://doi.org/10.1088/1742-6596/1572/1/012065

Saleem, F., Chikhaoui, E., & Malik, M. I. (2024). Technostress in students and quality of online learning: role of instructor and university support. *Frontiers in Education*, *9*. https://doi.org/10.3389/feduc.2024.1309642

Shahzad, M. F., Xu, S., Lim, W. M., Yang, X., & Khan, Q. R. (2024). Artificial intelligence and social media on academic performance and mental well-being: Student perceptions of positive impact in the age of smart learning. *Heliyon*, *10*(8), e29523-e29523. https://doi.org/10.1016/j.heliyon.2024.e29523

Singh, A. K., & Meena, M. K. (2023). Online teaching in Indian higher education institutions during the pandemic time. *Education and Information Technologies*, *29*(4), 4107-4157. https://doi.org/10.1007/s10639-023-11942-y

Skulmowski, A., & Xu, K. M. (2021). Understanding Cognitive Load in Digital and Online Learning: a New Perspective on Extraneous Cognitive Load. *Educational Psychology Review*, *34*(1), 171-196. https://doi.org/10.1007/s10648-021-09624-7

Sun, H.-L., Sun, T., Sha, F.-Y., Gu, X.-Y., Hou, X.-R., Zhu, F.-Y., & Fang, P.-T. (2022). The Influence of Teacher-Student Interaction on the Effects of Online Learning: Based on a Serial Mediating Model. *Frontiers in psychology*, *13*, 779217-779217. https://doi.org/10.3389/fpsyg.2022.779217

Tharapos, M., Peszynski, K., Lau, K. H., Heffernan, M., Vesty, G., & Ghalebeigi, A. (2022). Effective teaching, student engagement and student satisfaction during the Covid-19 pandemic: Evidence from business students' qualitative survey evaluations. *Accounting & Finance*, *63*(3), 3173-3192. https://doi.org/10.1111/acfi.13025

Wang, X., Wang, Y., & Ye, Y. (2023). Subjective socioeconomic status predicts e-learning engagement in college students: the mediating role of perceived social support and self-efficacy. *European Journal of Psychology of Education*, *39*(2), 1119-1134. https://doi.org/10.1007/s10212-023-00725-1

Wang, Y., Xin, Y., & Chen, L. (2024). Navigating the emotional landscape: Insights into resilience, engagement, and burnout among Chinese High School English as a Foreign Language Learners. *Learning and Motivation*, *86*, 101978. https://doi.org/10.1016/j.lmot.2024.101978

Yang, X., & Geng, Y. (2024). Corona virus anxiety and Chinese students' cognitive, affective, and behavioral engagement, and academic resilience: correlations and perceptions. *BMC psychology*, *12*(1), 107-107. https://doi.org/10.1186/s40359-024-01548-5

Yuan, L. (2024). EFL teacher-student interaction, teacher immediacy, and Students' academic engagement in the Chinese higher learning context. *Acta Psychologica*, *244*, 104185. https://doi.org/10.1016/j.actpsy.2024.104185

Zapata-Cuervo, N., Montes-Guerra, M. I., Shin, H. H., Jeong, M., & Cho, M.-H. (2021). Students' Psychological Perceptions Toward Online Learning Engagement and Outcomes during the COVID-19 Pandemic: A Comparative Analysis of Students in Three Different Countries. *Journal of Hospitality & Tourism Education*, *35*(2), 108-122. https://doi.org/10.1080/10963758.2021.1907195

Appendix 1

Interactive teaching materials
1. I only use visual learning media
2. I only use audio learning media
3. I use audio visual learning media
4. Iuse non-electronic modules in the learning process
5. I use electronic modules in the learning process
6. I don't use virtual laboratories in the learning process
7. I easily understand the lesson with text module teaching materials
8. I easily understand the lesson with interactive teaching materials
9. I only need text modules learning media
10. I don't need interactive learning media
11. Teachers deliver science material with stimulation or animation
12. Teachers deliver science material with the Flipped classroom approach
13. Teachers deliver subject matter integrated with STEM
14. I use mobile learning for the learning process
15. My school is equipped with accessible wifi facilities

Learning engagement
1. In online education, I can complete basic exercises and do extended exercises.
2. In online education, I can solve many problems with divergent and comprehensive thinking abilities.
3. In online education, I can solve problems through multiple solutions.

Academic stress
1. Mental health has a valuable impact on students' academic learning.
2. Academic pressure leads to stress in students' life.
3. I have difficulty in understanding basic concepts.

Students' perception of teaching quality
Teaching content
1. Richness of theoretical content
2. Practical content of the curriculum
3. Advanced nature and novelty of teaching content
4. Systematic teaching content

Teaching method
1. Appropriate teaching behavior and good teaching atmosphere
2. Key parts of the lecture are prominent, and difficult and simple points complement each other
3. Teaching is a combination of theory and practice
4. Attention paid to students' thinking training and ability training

Teaching condition
1. Basic teaching equipment
2. Qualifications of teachers
3. Online learning platform
4. raining base for entrepreneurship education

Teaching management
1. Curriculum Timetable
2. How students choose the curriculum
3. Curriculum schedule
4. Evaluation method