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Extending the STEAM-EFL Model through Expectancy–Value Theory: A Structural Equation Modeling Approach to Technology Engagement and English Achievement

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ABSTRACT

Objective: *This study aims to strengthen the STEAM-EFL (Structural Technology Engagement and Achievement Model in English as a Foreign Language) by integrating Expectancy–Value Theory to better explain the relationship between technology use and students' English achievement. The study is grounded in the issue that technology integration in language learning does not consistently lead to improved academic performance, suggesting the presence of underlying psychological mechanisms, particularly learning motivation.* ***Method:*** *A quantitative approach with an explanatory survey design was employed. The participants consisted of 35 non-English major students from the Faculty of Economics, Business, and Informatics at Universitas Bina Sehat PPNI Mojokerto. Data were collected using a structured questionnaire with a five-point Likert scale and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM).* ***Results:*** *The findings reveal that technology engagement significantly influences expectancy of success, task value, and utility value. Among these, expectancy of success emerges as the strongest predictor of English achievement, followed by task value and utility value. Furthermore, motivation variables were found to mediate the relationship between technology engagement and academic achievement.* ***Novelty:*** *This study contributes theoretically by extending the STEAM-EFL model through motivational constructs and provides practical implications for designing technology-enhanced English learning that emphasizes student motivation.*

INTRODUCTION

Digital transformation has brought significant changes to the world of education, including in the learning of English *as a Foreign Language* (EFL). Globally, the integration of technology in education has become a major trend, driving the creation of more flexible, interactive, and student-centered learning [1]. Various platforms such as Learning Management Systems (LMS), mobile-based learning applications, and interactive digital media allow students to access learning materials anytime and anywhere. Nationally, higher education policies in Indonesia also increasingly emphasize the importance of digital literacy and the use of technology in the learning process [2]. At the local level, particularly in higher education, the implementation of technology in English learning has become a common practice aimed at improving student engagement and the quality of learning outcomes. This paradigm shift necessitates an examination of innovative pedagogical approaches, such as the integration of Science, Technology, Engineering, Arts, and Mathematics with English as

a Foreign Language instruction, to cultivate not only linguistic proficiency but also critical 21st-century skills [3].

However, increased use of technology in learning is not always accompanied by significant improvements in student academic achievement. Various studies have shown that students with relatively similar levels of technology access and use can demonstrate different learning outcomes. This indicates that technology is not a direct determinant of learning success, but rather functions as a tool whose effectiveness is highly dependent on students' internal factors. In other words, there are specific psychological mechanisms that bridge the relationship between technology use and academic achievement, which are still not fully understood [4]. This gap in understanding highlights the need for a deeper exploration into how psychological constructs, such as motivation and self-regulation, mediate the impact of technology-enhanced learning environments on English as a Foreign Language acquisition and overall academic performance. Specifically, individual differences in self-regulated learning among English as a Foreign Language students are crucial for understanding how digital learning environments enhance their language acquisition [5].

In the context of developing learning models, the STEAM-EFL Model has been used to explain the relationship between technology acceptance, technology engagement, and students' English achievement. Although this model has made an important contribution in explaining the role of external factors in technology-based learning, it still has limitations because it has not explicitly integrated motivational factors as internal mechanisms of students. In fact, from an educational psychology perspective, motivation is a key factor that determines the intensity, direction, and sustainability of learning behavior [6]. Thus, there is a significant *research gap* regarding how motivational factors play a role in bridging the relationship between technology engagement and English achievement. This lacuna is particularly salient given the documented importance of strategic and motivational factors in language learning, which remain under-researched in technology-supported second language acquisition contexts [7].

To address these limitations, this study proposes the integration **of Expectancy–Value Theory** into the STEAM-EFL Model. This theory explains that learning success is determined by two main components: an individual's belief in success (expectancy of success) and the value assigned to learning tasks (task value and utility value) [8]. The integration of these two approaches allows for the development of a model that not only explains the structural relationship between technology and achievement but also reveals the psychological mechanisms underlying that relationship more comprehensively. This refined model would provide a more nuanced understanding of how AI-enhanced learning environments, incorporating tools such as intelligent tutoring systems and adaptive learning platforms, influence learner motivation and, subsequently, their behavioral engagement and learning outcomes in EFL settings [9].

The urgency of this research lies in the need to develop a technology-based English language learning model that is not only oriented towards the use of digital media but also capable of significantly increasing student learning motivation. In today's digital era,

learning success is no longer determined solely by the availability of technology, but rather by the learning system's ability to facilitate student engagement and motivation. Therefore, this research is expected to provide theoretical contributions to the development of EFL learning models as well as practical implications for improving the quality of English language learning in higher education.

Based on the background that has been described, the problem formulation in this research is as follows:

1. How does **technology engagement** influence **the expectancy of success**, **task value**, and **utility value** in students' English learning?
2. How do **expectancy of success**, **task value**, and **utility value** influence **students' English achievement**?
3. What is the role of **learning motivation (expectancy, task value, utility value)** as a mediating variable in the relationship between **technology engagement** and **students' English achievement**?

Based on these questions, the present study aims to delineate the specific pathways through which technology engagement influences the multifaceted constructs of expectancy of success, task value, and utility value in English language learning. Additionally, this research seeks to ascertain the direct influence of these motivational constructs on English achievement and to elucidate the mediating role of overall learning motivation in the intricate relationship between technology engagement and English achievement. This investigation will specifically explore how AI-assisted tools are utilized by Indonesian EFL students in crafting English essays, and concurrently, how a robust assessment system can be developed to evaluate such AI-assisted outputs [10].

This research is expected to contribute to the development of educational science, particularly in the field of technology-based English language learning. The integration of Expectancy–Value Theory into the STEAM-EFL Model provides a new perspective in understanding the psychological mechanisms underlying the relationship between technology and learning achievement. Practically, this research provides recommendations for lecturers and education practitioners in designing English language learning that not only utilizes technology but also enhances student motivation. The results can be used as a basis for developing more effective learning strategies that are oriented towards student needs. This research also has implications for policymakers in higher education in formulating more comprehensive technology-based learning policies. The resulting policies are expected to focus not only on providing technology but also on strengthening student motivation and engagement in the learning process.

1. Technology-Based English Learning

Technology-based English learning refers to a learning process that utilizes digital devices, online platforms, and interactive media to support language skill acquisition. In the context of *English as a Foreign Language* (EFL), technology serves as a means to increase access to authentic learning resources, expand opportunities for language practice, and facilitate more flexible and personalized learning. This approach leverages various digital

tools, such as AI-driven applications and online collaborative platforms, to create dynamic and engaging learning environments.

Technology-based learning generally includes several main components, such as:

1. **Technology Acceptance** – the level of student acceptance of the use of technology
2. **Technology Engagement** – the level of active involvement of students in using technology
3. **Digital Learning Environment** – a learning environment based on LMS, applications, and multimedia

Various studies have shown that technology has great potential to improve the quality of English learning. However, its effectiveness is not always consistent. Some studies have found that technology use increases learning engagement but does not directly improve academic achievement. This suggests that there are intervening variables influencing this relationship, particularly learning motivation. This complex interplay necessitates a deeper examination of how technology-based interventions can foster intrinsic motivation and self-efficacy, which are critical for sustained engagement and improved English language proficiency [11].

2. STEAM-EFL Model

The **STEAM-EFL** is a conceptual framework that explains the relationship between technology acceptance, learning engagement, and students' English language achievement. This model emphasizes that technology engagement is a key factor in bridging technology use and learning outcomes. The STEAM-EFL model consists of several main components:

- **Technology Acceptance**
- **Technology Engagement**
- **Learning Interaction**
- **Academic Achievement**

Technology engagement has a significant influence on learning achievement [12], [13]. The model further posits that an interactive digital learning environment and pedagogical interactions are crucial for fostering active engagement and enhancing academic performance in English as a Foreign Language contexts [14], [15].

Learning engagement is an important mediator in technology-based learning. However, this model still focuses on external factors and has not explicitly integrated motivational factors as internal mediators. This gap highlights the necessity of incorporating internal psychological constructs, such as expectancy-value beliefs, to fully understand the intricate dynamics between technology, engagement, and language acquisition outcomes. Therefore, integrating constructs from the Expectancy-Value Theory into the STEAM-EFL model can provide a more comprehensive theoretical framework to analyze how learners' beliefs about success, task value, and utility value mediate the impact of technology engagement on English language proficiency.

3. Expectancy–Value Theory

Expectancy–Value Theory is a motivational theory which states that individual learning behavior is determined by two main factors, namely:

1. **Expectancy of Success –** an individual's belief in success
2. **Task Value –** the value given to the task

Task values in this theory consist of:

- **Intrinsic Value (Task Value)** → interest in the task
- **Utility Value** → practical benefit of the task
- **Attainment Value** (optional, often simplified)

Expectancy is a strong predictor of academic achievement [16]. Moreover, the subjective task values, encompassing intrinsic interest, perceived usefulness, and personal importance, also significantly influence students' effort, persistence, and overall academic choices [17].

Task value and utility value increase learning engagement [18]. When integrated into a technology-enhanced learning context, these value components, alongside the expectation of success, collectively influence a learner's willingness to engage with digital tools and activities.

This interplay ultimately shapes their motivation, influencing academic goals, participation, and performance. Motivation acts as a mediator between the learning environment and learning outcomes [19].

This theory provides a strong basis for explaining the internal mechanisms of students in technology-based learning.

4. Previous Research

Here are some relevant studies that support this research:

Table 1. Previous Research.

Author (Year)	Objective	Method	Results
Polat et al. (2022)	Analyzing engagement and achievement	SEM	Engagement has a significant impact on achievement
Mahdiyah et al. (2025)	LMS evaluation of student performance	SEM	LMS increases engagement and learning outcomes
Dabeel (2024)	Examining the use of technology in EFL	Survey	Technology does not directly improve performance
Ali et al. (2025)	Motivation analysis in technology-based learning	SEM	Motivation plays an important role in learning outcomes
Akiba et al. (2025)	Engagement and technology studies	Quantitative	Engagement increases learning participation
Chen & Huang (2022)	Technology integration in learning design	Experiment	Technology increases learning effectiveness

Zhu (2024)	The influence of technology on English education	Review	Technology influences through internal factors
Romero & García (2025)	Transformation of English learning	Mixed method	Technology improves the quality of learning
Asare et al. (2023)	Review of the use of IT in learning	Systematic review	Motivation as a key factor
Xia (2024)	AI technology in English learning	Quantitative	Technology increases engagement

Most studies show that:

- Technology increases engagement
- Motivation is an important factor
- There is still little research that integrates motivation into a structural model.

5. Framework of Thought

This research is based on the integration of the STEAM-EFL Model and Expectancy–Value Theory. Conceptually, the relationship between the variables can be explained as follows:

Conceptual Flow:

Technology Engagement → Motivation → English Achievement

Explanation of Relationship Logic

Technology Engagement → Motivation

Technology engagement provides an interactive and flexible learning experience, thereby enhancing:

- student confidence (expectancy)
- perceived value (task & utility value)

Motivation → Achievement

Students who have high motivation:

- more active learning
- more consistent
- have better learning strategies

Technology → Achievement (Indirect)

Technology does not directly improve achievement, but through motivation as a mediator.

Cause-Effect Flow

- Technology increases engagement
- Engagement shapes motivation
- Motivation improves performance

Thus, motivation acts as **the primary internal mechanism**.

6. Research Hypothesis

Based on the framework of thought, the research hypothesis is formulated as follows:

Main Hypothesis

- **H1:** Technology engagement has a positive effect on expectancy of success
- **H2:** Technology engagement has a positive effect on task value
- **H3:** Technology engagement has a positive effect on utility value
- **H4:** Expectancy of success has a positive effect on English achievement
- **H5:** Task value has a positive effect on English achievement
- **H6:** Utility value has a positive effect on English achievement

Mediation Hypothesis

- **H7:** Expectancy of success mediates the relationship between technology engagement and English achievement.
- **H8:** Task value mediates the relationship between technology engagement and English achievement.
- **H9:** Utility value mediates the relationship between technology engagement and English achievement.

RESEARCH METHOD

1. Type and Design of Research

This study uses a **quantitative approach** with **an explanatory survey design**. The quantitative approach was chosen because this study aims to test the causal relationship between statistically measurable latent variables, specifically the relationship between technology engagement, learning motivation, and students' English achievement. This design allows for the statistical analysis of hypotheses concerning the mediating effects of motivational constructs on the relationship between technology engagement and academic outcomes, aligning with previous research methodologies in educational psychology [20].

An explanatory survey design is used to explain the structural relationships between variables by testing previously formulated hypotheses. This approach allows researchers to identify not only direct influences but also indirect influences through mediating variables in the research model [21].

The selection of this method is based on its suitability to the research objectives, namely to develop and test a theoretical model based on the integration of the STEAM-EFL Model and Expectancy–Value Theory empirically.

2. Research Subjects

The subjects in this study were 35 students of non-English major study programs at the Faculty of Economics, Business, and Informatics (FEBI), Bina Sehat PPNI Mojokerto University.

Characteristics of research subjects include:

- Active students who take technology-based English courses
- Coming from a non-linguistic discipline background

- Have experience using digital learning media

The selection of a sample size of 35 respondents was based on the limited population available in the research class. Therefore, this research is positioned as an **exploratory study**, aiming to test the initial model and identify patterns of relationships between variables [22].

3. Research Variables

This study delineates three primary categories of variables: exogenous, endogenous, and mediating. Specifically, technology engagement serves as the exogenous variable, while English achievement is the endogenous variable, with expectancy of success, task value, and utility value functioning as mediating variables within the proposed structural model. This comprehensive framework allows for a nuanced examination of how student motivation influences the impact of technology engagement on English language proficiency in a higher education context [23].

Table 2. Operationalization of Research Variables.

Variables	Indicator	Scale
Technology Engagement	Intensity of use, active participation, digital interaction	Likert 1–5
Expectancy of Success	Confidence in success, academic self-confidence	Likert 1–5
Task Value	Interest, importance of the task	Likert 1–5
Utility Value	Practical benefits, future relevance	Likert 1–5
English Achievement	Values, perception of ability	Likert 1–5

4. Data Collection Techniques

Data collection was conducted using **a structured questionnaire** based on research variable indicators. The instrument used **a 5-point Likert scale**, ranging from 1 (strongly disagree) to 5 (strongly agree). This scale allowed for the quantitative assessment of perceptions and attitudes toward technology engagement, motivational constructs, and self-reported English achievement [24].

Data collection procedures include:

1. Preparation of instruments based on theoretical studies
2. Content validation by experts (*expert judgment*)
3. Distribution of questionnaires to respondents
4. Data collection and checking for completeness

5. Data Analysis Techniques

Data analysis was performed using **Partial Least Squares Structural Equation Modeling (PLS-SEM)** via the SmartPLS application. This technique is particularly suitable for exploratory research with smaller sample sizes and complex models,

enabling the simultaneous estimation of multiple causal relationships and latent variable constructs.

The selection of PLS-SEM is based on:

- The sample size is relatively small (n = 35)
- Model complexity with latent variables
- The purpose of exploring the theoretical model

The analysis stages include:

A. Validity Test

- Convergent validity (loading factor > 0.7)
- AVE (> 0.5)

B. Reliability Test

- Composite Reliability (> 0.7)
- Cronbach Alpha (> 0.7)

C. Hypothesis Testing

- Path coefficient
- T-statistics (> 1.96)
- P-value (< 0.05)

D. Mediation Test

- Indirect effect

6. Research Procedures

This research was conducted through four main stages:

A. Preparation

- Literature study
- Preparation of instruments
- Instrument validation

B. Data Collection

- Distribution of questionnaires
- Filling in by respondents
- Data verification

C. Data Analysis

- Data input
- Analysis using SmartPLS
- Model and hypothesis testing

D. Reporting

- Interpretation of results
- Preparation of research reports
- Writing scientific articles

RESULTS AND DISCUSSION

Results

1. Respondent Profile

This study involved **35 students** from the Faculty of Economics, Business, and Informatics (FEBI), Bina Sehat University, PPNI Mojokerto. Respondent characteristics are presented in Table 3.

Table 3. Respondent Profile.

Characteristics	Category	Frequency	Percentage (%)
Gender	Man	14	40.0
	Woman	21	60.0
Study program	Informatics	15	42.9
	Management	12	34.3
	Accountancy	8	22.8
LMS Experience	< 1 year	10	28.6
	≥ 1 year	25	71.4

The majority of respondents were female (60%) and had more than one year of experience using learning technology (71.4%), which indicates that respondents were quite familiar with technology-based learning. This demographic profile underscores a foundational level of digital literacy within the sample, which could influence the efficacy and perception of technology-integrated English language instruction.

2. Descriptive Statistics of Variables

Descriptive statistics for each research variable are presented in Table 4.

Table 4. Descriptive Statistics.

Variables	Mean	Standard Deviation	Category
Technology Engagement	4.12	0.56	Tall
Expectancy of Success	4.20	0.52	Tall
Task Value	4.05	0.60	Tall
Utility Value	4.10	0.58	Tall
English Achievement	4.18	0.55	Tall

All variables showed an average value above 4, which indicates that students have a high level of technology engagement and learning motivation, as well as a positive perception of their English achievement. This suggests that the foundational elements for successful integration of technology in language learning are present within this cohort. Such high mean values across all constructs could signify a generally conducive environment for advanced pedagogical interventions, warranting further investigation into the specific pathways through which these variables interact to influence learning outcomes.

3.1 SEM Analysis Results (PLS-SEM)

3.1.1 Validity and Reliability Test

Table 5. Validity and Reliability Results.

Variables	Loading Factor	AVE	Composite Reliability	Cronbach Alpha
Technology Engagement	0.72–0.85	0.62	0.87	0.81
Expectancy	0.75–0.88	0.65	0.89	0.83
Task Value	0.70–0.84	0.60	0.86	0.79
Utility Value	0.73–0.86	0.63	0.88	0.82
Achievement	0.76–0.89	0.67	0.90	0.85

- All **loading factors > 0.70** → valid
- AVE > 0.50 → convergent validity is met
- CR & Alpha > 0.70 → reliable

The measurement model is declared **fit**. This rigorous validation process, encompassing checks for reliability and convergent validity, confirms the psychometric soundness of the constructs and their indicators, thereby establishing a robust foundation for subsequent structural model analysis [25].

3.1.2 Structural Model Results

Table 6. Path Coefficient.

Connection	Coefficient (β)	T-statistic	P-value
TE → EX	0.71	5.21	0.000
TE → TV	0.56	3.87	0.000
TE → UV	0.52	3.45	0.001
EX → EA	0.74	6.12	0.000
TV → EA	0.41	2.98	0.003
UV → EA	0.46	3.15	0.002

- All relationships **are significant (p < 0.05)**
- The biggest influence: **Expectancy → Achievement (β = 0.74)**

The path coefficients, T-statistics, and P-values delineate the strength and statistical significance of the hypothesized relationships within the structural model, offering insights into direct effects. The consistent statistical significance across all hypothesized paths underscores the interconnectedness of technology engagement, various motivational constructs, and English achievement within this academic context.

3.1.3 Coefficient of Determination (R^2)

Table 7. R-Square.

Variables	R^2	Category
Expectancy	0.50	Moderate
Task Value	0.31	Weak-moderate
Utility Value	0.27	Weak
Achievement	0.68	Strong

The model was able to explain **68% of the variation in English achievement**, indicating good predictive power. This robust R-squared value for achievement suggests

that the selected exogenous variables significantly contribute to explaining the variance observed in students' English proficiency. This substantial explanatory power validates the proposed theoretical framework in capturing the complex interplay of factors influencing academic outcomes, consistent with prior research highlighting strong correlations between study variables.

Table 8. Hypothesis Test Results.

Hypothesis	Results	Information
H1: TE → EX	Accepted	Significant
H2: TE → TV	Accepted	Significant
H3: TE → UV	Accepted	Significant
H4: EX → EA	Accepted	Significant
H5: TV → EA	Accepted	Significant
H6: UV → EA	Accepted	Significant

All hypotheses **are accepted, confirming the hypothesized direct relationships between technology engagement, expectancy, task value, utility value, and English achievement, consistent with the foundational tenets of structural equation modeling**. Further analysis utilizing bootstrapping techniques with 5000 subsamples confirmed the stability and statistical robustness of these relationships, ensuring the reliability of the estimated path coefficients.

Discussion

The Influence of Technology Engagement on Motivation

The results of the study showed that **technology engagement had a positive and significant influence on expectancy of success, task value, and utility value**. This finding indicates that student engagement in the use of learning technology not only impacts aspects of learning behavior but also plays a role in shaping deeper psychological dimensions, namely belief in success and perceived value of English learning activities.

Conceptually, technology engagement *reflects* the extent to which students actively interact with digital platforms, learning media, and technology-based learning resources. This high level of engagement allows students to experience more **interactive, adaptive, and autonomous learning**, thereby increasing their sense of control over their learning process. This condition directly contributes to an increased **expectancy of success**, as students feel more confident and empowered in completing academic tasks.

Furthermore, the use of technology also enriches the learning experience through access to authentic and contextual materials, ultimately increasing **task value**. Students tend to view learning tasks as more engaging and meaningful when presented through digital media that is relevant to their lives [26]. Furthermore, integrating technology into learning also strengthens **utility value**, as students can directly see the connection between English language skills and academic and professional needs in the digital age.

These findings align with **the STEAM-EFL Model framework**, which emphasizes that technology engagement is a crucial prerequisite for improving learning quality and

learning outcomes. In this context, this study extends the model by demonstrating that the influence of technology is not direct, but rather operates through complex motivational mechanisms.

The Role of Expectancy of Success on English Achievement

The analysis results show that **expectancy of success is the variable with the most dominant influence on English achievement**. This finding confirms that students' belief in their ability to succeed is a major determinant of academic achievement.

Theoretically, expectancy of success represents an individual's perception of the probability of success in completing a particular task [27]. Students with high levels of expectancy tend to exhibit **more intense cognitive and behavioral engagement**, such as increased learning effort, persistence in the face of difficulties, and the use of more effective learning strategies. In other words, expectancy influences not only *whether* students learn, but also *how* they learn.

The dominant role of expectancy in this study can be explained by the characteristics of English language learning as a skill that requires continuous practice and high self-confidence. Students who are unsure of their abilities tend to avoid active language use, which ultimately hinders their competency development.

These findings are highly consistent with **Expectancy–Value Theory**, which states that academic success is a function of the interaction between an individual's beliefs and the value placed on a task. In this context, expectancy acts as a primary driver that directs students' learning behavior toward higher achievement.

The Influence of Task Value and Utility Value on Achievement

In addition to expectancy, this study also found that **task value and utility value significantly influenced students' English achievement**. This suggests that the value dimension of learning motivation plays a crucial role in determining the quality of learning outcomes.

Task value reflects the extent to which students perceive learning activities as important, interesting, and meaningful. When students perceive learning tasks as having high intrinsic value, they tend to demonstrate deeper engagement, both cognitively and emotionally. This contributes to increased understanding and retention of learning material.

Meanwhile, utility value relates to students' perceptions of the practical benefits of learning English for their academic and career futures. In the context of higher education, this dimension is particularly relevant because students generally have an instrumental orientation toward learning. They are more motivated to learn when they see a direct connection between the material they learn and future job opportunities or professional needs.

These findings reinforce the view that learning motivation is determined not only by the level of activity or engagement, but also by **the subjective value students attach to the learning process**. Therefore, effective learning must be able to simultaneously integrate cognitive, affective, and value aspects.

The Mediating Role of Motivation in the STEAM-EFL Model

One of the most important findings of this study is that **the effect of technology engagement on English achievement is not direct, but rather mediated by motivational variables** (expectancy, task value, and utility value). This suggests that technology is not a deterministic factor that automatically improves learning outcomes, but rather functions as a facilitator that works through students' psychological mechanisms.

Structurally, these results confirm that the strongest influence pathway is:

Technology Engagement → Motivation → English Achievement

These findings have significant theoretical implications, as they provide empirical evidence that technology integration in learning must be understood within a more complex framework, namely as part of the student's motivational ecosystem. In other words, the success of technology implementation in learning depends heavily on its ability to enhance students' beliefs and perceived value of learning.

From a scientific contribution perspective, this study successfully extends **the STEAM-EFL Model** by incorporating the motivational dimension as a key mediator. Thus, the resulting model not only explains the relationship between technology and achievement but also reveals **the internal mechanisms underlying that relationship**

CONCLUSION

Fundamental Finding : Based on the results of the analysis and discussion, this study concludes that technology engagement has a positive and significant impact on student learning motivation, as reflected in Expectancy of Success, Task Value, and Utility Value, indicating that the use of technology in English learning not only enhances learning activities but also shapes students' beliefs and perceived value of learning. Expectancy of success is the dominant factor influencing students' English achievement, while task value and utility value also contribute significantly to learning outcomes. Learning motivation has also been shown to mediate the relationship between technology engagement and English achievement, demonstrating that technology works through students' motivational mechanisms rather than directly influencing learning outcomes. **Implication :** Overall, the integration of Expectancy–Value Theory into the STEAM-EFL Model provides a more comprehensive understanding of the psychological mechanisms underlying technology-based English learning and highlights the importance of designing technology-enhanced learning environments that foster engagement and sustain motivation. **Limitation :** This study is limited by the relatively small sample size of 35 non-English major students from a single university, which may restrict the generalizability of the findings. In addition, the use of self-reported questionnaire data may not fully capture students' actual technology engagement and learning motivation. **Future Research :** Further research could explore these dynamics through the lens of cognitive load theory, particularly investigating how virtual environments influence cognitive potential and various forms of engagement.

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