

COLLABORATIVE LEARNING AND USE OF DIGITAL TOOLS: IMPACTS ON UNIVERSITY STUDENTS' LEARNING MOTIVATION AND SATISFACTION

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Abstract

Collaborative learning is widely recognised as a pedagogical approach that enhances students' active engagement, supports the co-construction of knowledge, and improves learning outcomes in higher education. The growth of digital and hybrid teaching has expanded opportunities to integrate online collaborative tools, enabling more flexible interaction, communication, and resource sharing, even across geographical distances. However, the effectiveness of these tools depends not only on their technical affordances but also on how they are perceived and adopted by students. The Technology Acceptance Model (TAM) therefore offers a robust framework for understanding the factors that shape students' acceptance, motivation, and satisfaction when using educational technologies.

In the university context, collaborative learning has been associated with improved critical thinking, stronger cognitive and emotional engagement, shared responsibility, and increased intrinsic motivation. This study examines how collaborative learning supported by online tools influences university students' learning motivation and satisfaction, integrating key TAM variables, namely perceived usefulness (PU) and perceived ease of use (PEOU), using a PLS-SEM approach. Data were collected from 752 Portuguese students through a validated questionnaire including nine constructs and sociodemographic variables. All nineteen hypotheses were supported (thirteen direct and six indirect effects). Findings show that attitude strongly predicts perceived enjoyment and satisfaction, and that learning motivation is a powerful determinant of learning satisfaction. Perceived ease of use also strongly enhances learning motivation, while collaborative learning exerts significant positive effects on multiple outcomes.

The use of online collaborative tools mediates the relationships between collaborative learning, perceived usefulness, perceived ease of use, and both learning motivation and satisfaction. Overall, combining collaborative learning with user-friendly digital tools leads to higher levels of motivation and satisfaction among university students. Careful instructional design, robust technological support, appropriate training, and the provision of clear guidance materials are essential for higher education institutions seeking to maximise the benefits of digital collaborative learning.

Keywords: Collaborative learning, use of digital tools, university students' learning motivation and satisfaction, technology acceptance model, PLS-SEM.

1 INTRODUCTION

In a rapidly changing technological world, university students face a range of challenges, including information overload, often involving content of questionable quality, the widespread use of artificial intelligence, and the increasing availability of diverse online platforms. These factors may generate both frustration and excessive enthusiasm. However, students' perceptions regarding the use of such tools, as well as their motivation and satisfaction with the resulting learning experiences, are not always properly assessed [1].

In order to foster active student engagement, promote the co-construction of knowledge, and enhance learning outcomes in higher education, collaborative learning is increasingly employed as a pedagogical approach in which students work together to achieve common goals, share perspectives, and solve problems [2]. Within the university context, collaborative learning has been associated with benefits such as the improvement of critical thinking skills, greater emotional and cognitive engagement, the development of shared responsibility, and an increase in intrinsic motivation [3].

Collaborative learning, particularly when supported by online tools, is strongly associated with increased motivation, engagement, and satisfaction among university students. Collaborative activities encourage social interaction, a sense of belonging, and active participation—factors that enhance intrinsic motivation and academic satisfaction [4-5]. The use of platforms such as Moodle, OneDrive, and

ChatGPT facilitates communication and cooperation, as well as the development of critical skills, while also reducing technological anxiety and strengthening self-confidence [6-7].

Technology adoption was further intensified in higher education during the Covid-19 pandemic, as digital tools proved to be valuable instruments for ensuring continuity in emergency contexts [8]. Nevertheless, students' attitudes continue to represent one of the most influential factors in determining the effectiveness of technology-mediated educational experiences [9]. Previous studies have highlighted that perceived enjoyment—referring to the extent to which students regard learning experiences as pleasant, interesting, and rewarding—is closely linked to the emotional dimension of student engagement [10].

On the other hand, technology also plays a key role in enhancing online collaborative work processes, for example through the use of learning analytics. In this regard, Cerro et al. [11] demonstrated that the use of these monitoring tools can improve student performance, suggesting that such systems are useful for promoting student collaboration and learning.

With the growth of digital and hybrid learning modalities, further opportunities arise to integrate online collaborative tools that expand the possibilities for interaction, communication, and resource sharing, even in geographically distributed contexts. However, the effectiveness of these tools depends not only on their technical functionalities but also on how they are perceived and adopted by students within collaborative learning environments. In this regard, the Technology Acceptance Model (TAM) [12] contributes to understanding the factors that influence students' acceptance, motivation, and satisfaction in the use of educational technologies in a collaborative learning context.

Al-Rahmi and Zeki [13] found that the use of online collaborative tools in university learning environments contributes to higher levels of student engagement and satisfaction when students perceive them as useful and easy to use. Research by Lee et al. [14] indicates that perceived usefulness (PU) and perceived ease of use (PEOU) significantly influence both satisfaction and motivation to adopt e-learning tools.

In this study, the following research hypotheses are examined:

- H1: Attitude has a positive effect on perceived enjoyment;
- H2: Attitude has a positive effect on satisfaction;
- H3: Satisfaction has a positive effect on collaborative learning;
- H4: Perceived enjoyment has a positive effect on collaborative learning;
- H5: Collaborative learning has a positive effect on online collaborative tools use;
- H7: Perceived ease of use has a negative effect on online collaborative tools use;
- H8: Perceived ease of use has a negative effect on learning motivation;
- H9: Perceived usefulness has a positive effect on online collaborative tools use;
- H10: Perceived usefulness has a positive effect on learning satisfaction;
- H11: Online collaborative tools use has a positive effect on learning motivation;
- H12: Online collaborative tools use has a positive effect on learning satisfaction;
- H13: Learning motivation has a positive effect on learning satisfaction;
- H14: Satisfaction mediates the relationship between attitude and collaborative learning;
- H15: Perceived enjoyment mediates the relationship between attitude and collaborative learning;
- H16: Online collaborative tools use mediates the relationship between perceived ease of use and learning motivation;
- H18: Online collaborative tools use mediates the relationship between perceived usefulness and learning Motivation;
- H19: Online collaborative tools use mediates the relationship between perceived usefulness and learning satisfaction.

2 METHODOLOGY

Data were collected via an online questionnaire hosted on the Google Forms platform between February and June 2025. The survey was distributed to university students who had previously used at least one online tool as part of their collaborative teaching and learning activities in the course they were attending.

The questionnaire employed a seven-point Likert-type scale, ranging from “completely disagree (1)” to “completely agree (7),” to measure the following constructs: Attitude (4 items; [15]), Perceived Enjoyment (3 items; [16]), Satisfaction (4 items; [17]), Collaborative Learning (4 items; [18]), and Use of Online Collaborative Tools (4 items; [19]).

This study extends the Technology Acceptance Model (TAM) by incorporating additional constructs, including Collaborative Learning and antecedent factors such as Attitude, Perceived Enjoyment, and Satisfaction, as well as Learning Motivation and Learning Satisfaction, within the context of research supported by the use of online collaborative tools. The constructs Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Learning Motivation (LM), and Learning Satisfaction (LS) were measured using a five-point Likert scale, where 1 corresponds to “Strongly disagree” and 5 to “Strongly agree”.

Perceived Ease of Use (PEOU) reflects university students’ perceptions of the simplicity and effort required to understand and use online collaborative tools. Previous research in the field of educational technology has consistently identified perceived ease of use as a key determinant of technology acceptance and adoption among students [20].

Perceived Usefulness (PU) reflects university students’ evaluations of the benefits of using online collaborative tools. Several studies have demonstrated that students are more likely to adopt and continue using technological tools when they perceive them as effective in supporting the achievement of their academic goals [21].

Learning motivation (LM) captures the innate drive of university students to enhance their knowledge and abilities. This intrinsic motivation promotes engagement and improves learning outcomes [22]. Learning Satisfaction (LS) reflects the extent to which students are satisfied with the use of online collaborative tools in supporting their research and learning experiences [23].

The minimum sample size required for Structural Equation Modelling (SEM) was determined using Soper’s [24] guidelines. Considering the number of latent variables (nine) and observed variables (39), an anticipated effect size of 0.16, a statistical power of 0.80, and a significance level of 0.05, the minimum required sample size was estimated to be 741 respondents. The final sample exceeded this requirement, comprising 752 valid responses, thereby strengthening the reliability of the statistical analyses.

Of the 752 participants, 70.6 per cent were engaged exclusively in study, while 29.4 per cent combined study with employment. Regarding gender, 55.9 per cent identified as female and 44.1 per cent as male. Participants’ ages ranged from 17 to 60 years; 44.5 per cent were under 20 years old, and the remaining 55.5 per cent were aged 20 years or above.

3 RESULTS

The hypotheses were tested using Partial Least Squares Structural Equation Modelling (PLS-SEM) implemented in SmartPLS 4 [25]. This approach is particularly well suited to complex conceptual models comprising multiple reflective constructs, as it allows for the simultaneous estimation of the structural relationships specified in the theoretical framework (Figure 1). The use of PLS-SEM enabled an examination of how collaborative learning supported by online tools influences university students’ learning motivation and satisfaction, while incorporating the key Technology Acceptance Model (TAM) variables: perceived usefulness (PU) and perceived ease of use (PEOU).

Data analysis followed the two-step approach recommended by Hair et al. [26], which involves, first, the evaluation of the measurement model and, subsequently, the estimation of the structural model. In the initial stage, the constructs’ reliability and validity were assessed to ensure that all latent variables met the required psychometric standards.

Table 1 presents the reliability indicators for the measurement model, including Cronbach’s alpha (α), Composite Reliability (CR), and Average Variance Extracted (AVE). Cronbach’s alpha values ranged from 0.82 to 0.93, thereby comfortably exceeding the recommended threshold of 0.70 [27] and confirming strong internal consistency among the items within each construct. Composite reliability coefficients ranged from 0.89 and 0.95, and together with AVE values above 0.50, provided further

evidence of convergent validity, indicating that the items consistently measure the same underlying latent concept [26].

Table 1. Reliability and convergent validity indicators

Constructs	α	CR	AVE
1) Attitude (At)	0,931	0,951	0,829
2) Collaborative Learning (CL)	0,862	0,906	0,708
3) Learning Motivation (LM)	0,912	0,938	0,792
4) Learning Satisfaction (LS)	0,917	0,938	0,751
5) Online Collaborative Tools Use (OCTU)	0,857	0,903	0,700
6) Perceived Ease of Use (PEOU)	0,895	0,923	0,705
7) Perceived Usefulness (PU)	0,897	0,924	0,709
8) Perceived enjoyment (PE)	0,818	0,892	0,733
9) Satisfaction (S)	0,835	0,901	0,751

Discriminant validity was assessed using both the Fornell–Larcker criterion [28] and the Heterotrait–Monotrait (HTMT) ratio [25]. The results of these analyses are summarised in Table 2.

Table 2. Discriminant Validity: Fornell-Larcker Criterion and Heterotrait-Monotrait (HTMT) Ratio*

Constructs	1	2	3	4	5	6	7	8	9
1) Attitude	0,910	0,767	0,712	0,731	0,768	0,759	0,761	0,788	0,767
2) Collaborative learning	0,867	0,841	0,775	0,779	0,799	0,730	0,730	0,775	0,751
3) Learning Motivation	0,838	0,863	0,890	0,815	0,729	0,759	0,788	0,716	0,717
4) Learning Satisfaction	0,857	0,869	0,929	0,866	0,758	0,768	0,717	0,741	0,733
5) Online collaborative tools use	0,865	0,859	0,820	0,849	0,837	0,730	0,751	0,811	0,801
6) Perceived Ease of Use	-0,788	-0,818	-0,867	-0,878	-0,819	0,840	0,790	0,717	0,710
7) Perceived Usefulness	0,879	0,818	0,801	0,830	0,833	-0,801	0,842	0,789	0,789
8) Perceived enjoyment	0,863	0,819	0,788	0,813	0,846	-0,786	0,848	0,856	0,826
9) Satisfaction	0,853	0,807	0,798	0,815	0,846	-0,789	0,855	0,848	0,867

*Fornell–Larcker Criterion and Heterotrait–Monotrait (HTMT) ratio: the values in bold represent the square root of AVE. HTMT ratios are displayed above the diagonal, while Fornell–Larcker criterion values are shown below the diagonal.

All HTMT ratios remained below the recommended threshold of 0.90 [25]. In addition, the square root of the AVE for each construct exceeded its correlations with all other constructs, thereby confirming the discriminant validity of the measurement model. Overall, these results provide evidence of the robustness of the measurement framework and establish a solid foundation for the subsequent estimation of the structural model.

Following confirmation of construct reliability and validity, the structural model was estimated to test the statistical significance of the path coefficients [26]. The endogenous constructs yielded R^2 values ranging from 0.670 to 0.892. Learning satisfaction achieved an R^2 value of 0.892, indicating that 89.2 per cent of its variance is jointly explained by the use of online collaborative tools, perceived usefulness, and learning motivation. Similarly, the use of online collaborative tools reached an R^2 of 0.804, driven by collaborative learning, perceived usefulness, and perceived ease of use. The structural model, including the R^2 values for each endogenous construct, is presented in Figure 1.

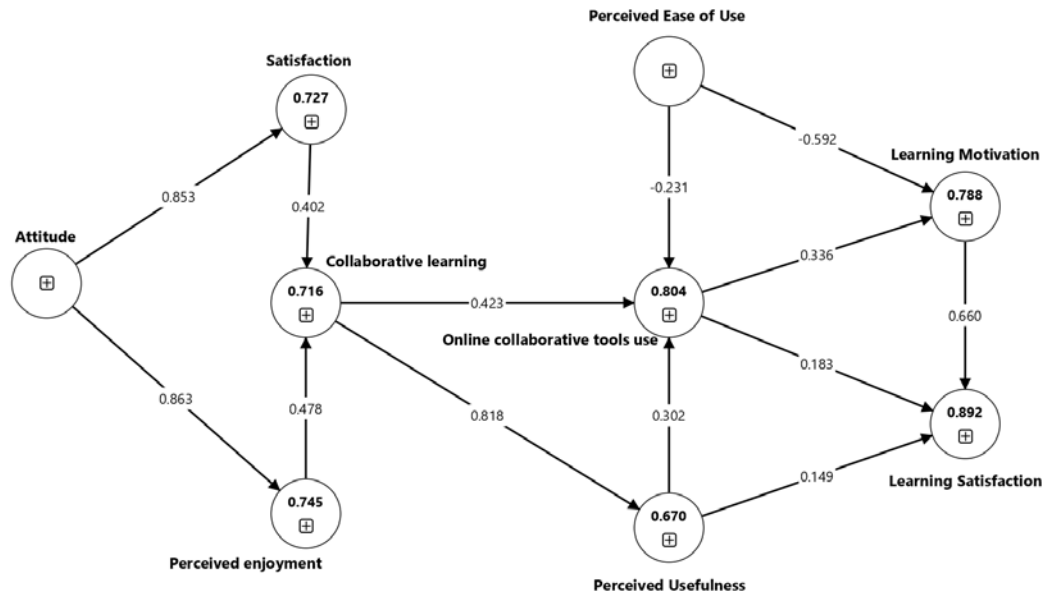


Figure 1. Structural model with R² values for each endogenous construct

The results of the significance tests for all hypothesised paths are summarised in Table 3.

Table 3. Results of hypothesis significance testing

Hypothesis	β	t-value	p-value
H1: Attitude -> Perceived enjoyment	0,863	82,235	0,000
H2: Attitude -> Satisfaction	0,853	73,600	0,000
H3: Satisfaction -> Collaborative learning	0,402	10,058	0,000
H4: Perceived enjoyment -> Collaborative learning	0,478	12,914	0,000
H5: Collaborative learning -> Online collaborative tools use	0,423	10,849	0,000
H6: Collaborative learning -> Perceived Usefulness	0,818	46,091	0,000
H7: Perceived Ease of Use -> Online collaborative tools use	-0,231	6,471	0,000
H8: Perceived Ease of Use -> Learning Motivation	-0,592	19,142	0,000
H9: Perceived Usefulness -> Online collaborative tools use	0,302	8,167	0,000
H10: Perceived Usefulness -> Learning Satisfaction	0,149	5,334	0,000
H11: Online collaborative tools use -> Learning Motivation	0,336	9,907	0,000
H12: Online collaborative tools use -> Learning Satisfaction	0,183	6,908	0,000
H13: Learning Motivation -> Learning Satisfaction	0,660	27,300	0,000
H14: Attitude -> Satisfaction -> Collaborative learning	0,343	9,569	0,000
H15: Attitude -> Perceived enjoyment -> Collaborative learning	0,413	12,307	0,000
H16: Perceived Ease of Use -> Online collaborative tools use -> Learning Motivation	-0,078	5,614	0,000
H17: Perceived Ease of Use -> Online collaborative tools use -> Learning Satisfaction	-0,042	4,456	0,000
H18: Perceived Usefulness -> Online collaborative tools use -> Learning Motivation	0,101	6,978	0,000
H19: Perceived Usefulness -> Online collaborative tools use -> Learning Satisfaction	0,055	5,533	0,000

Of the nineteen hypotheses tested, all were supported, comprising thirteen direct effects and six indirect effects. All hypothesised relationships were statistically significant. The Technology Acceptance Model (TAM) and its extensions consistently indicate that attitude exerts a positive influence on perceived enjoyment and satisfaction, which in turn enhance collaborative learning, thereby supporting hypotheses H1 to H4. Collaborative learning was found to have a positive effect on both the use of online collaborative tools and perceived usefulness, confirming hypotheses H5 and H6. Furthermore, perceived usefulness positively affected tool use and learning satisfaction, providing support for H9 and H10.

Contrary to hypotheses H7 and H8, perceived ease of use had a positive (rather than negative) effect on tool use and learning motivation, although the strength of this relationship may vary across contexts. The use of online collaborative tools positively influenced learning motivation and satisfaction (H11 and H12), while learning motivation further enhanced satisfaction (H13).

The mediation effects proposed in hypotheses H14 to H19 - including, for example, satisfaction and perceived enjoyment mediating the relationship between attitude and collaborative learning, and tool use mediating the effects of perceived ease of use and perceived usefulness on motivation and satisfaction - are consistent with extended TAM frameworks applied to educational settings. Nevertheless, certain relationships, particularly those positing negative effects of perceived ease of use, remain subject to debate in the literature and appear to be contingent on specific study contexts and samples [29-31].

4 CONCLUSIONS

Collaborative learning, supported by online collaborative tools, has considerable potential to enhance motivation and learning satisfaction among university students. Students' attitudes have a significant impact on perceived enjoyment, particularly through an increased sense of belonging and the fulfilment of psychological needs for autonomy, thereby fostering more positive collaborative learning outcomes. These effects stem from the intensification of social interactions and the co-construction of knowledge, as well as from the promotion of more participatory and meaningful collaborative processes.

The integration of the Technology Acceptance Model enables a clearer understanding that the effectiveness of these tools primarily depends on factors such as perceived usefulness and the use of online collaborative tools. When these factors are favourable, students are more likely to engage with greater motivation and achieve higher levels of satisfaction, resulting in richer and more effective collaborative learning experiences.

Certain relationships between constructs, particularly those that suggest negative effects of perceived ease of use, which were not expected to occur a priori, should be further assessed in future studies and discussed within the literature review to determine whether they depend on specific contexts and samples.

To maximise pedagogical benefits, it is essential that institutions and teachers select intuitive, useful, and appropriate tools for collaborative activities, while ensuring adequate training and support (such as brief tutorials and videos) for students. Future research may further explore how contextual variables (such as learning styles, task characteristics, and tool types) moderate these relationships.

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