Does the use of a Web-based Collaborative Platform reduces Cognitive Load and influence Project-based Student Engagement?

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Abstract

The web-based supported collaborative learning is increasingly used to support student social activities in higher institutions. However, little is known about the factors of collaborative learning in a web-based supported learning environment. Therefore, this study examines the use of a web-based supported collaborative platform to enhance project-based student engagement. This research aims to determine the factors that determine collaborative learning and subsequent student satisfaction. Moreover, this research determines students' cognitive load understanding, social influence, and learner's motivation towards collaborative learning and the resultant impact of the web-based supported collaborative platform on student satisfaction. The data was collected from university post-graduate students who used the TRELLO platform. A total of 115 post-graduate students participated in this study, and the resulting data were analyzed based on partial least squares structural equation modelling statistical approach. The study results suggest that students' social influence and motivation positively influence collaborative learning; directly and indirectly, students are satisfied with the use of a web-based supported collaborative learning platform to support project-based student engagement.

1. Introduction

There is a rapid increase in the use of different technology-enhanced collaborative learning for learning activities, especially the migration from the course/classroom-based to web-based delivery or the application of web-based supported learning collaboration to project-based activities has increased and is of interest to educational stakeholders. Collaborative learning aims to promote environments that are built on a small group to exchange and sustain knowledge (Hernández-Sellés, Muñoz-Carril & González-Sanmamed, 2019). For instance, many universities have channeled their teaching and learning through the different collaborative learning approaches to improve teaching and learning outcomes, of which students gain access to various online learning experiences (Al-Samarraie, & Saeed, 2018; De Freitas, Morgan & Gibson, 2015). However, the complexity of collaborative learning ecosystems is based on the knowledge-based cognitive content, its practices, transmigrate of modern educational technology, and student engagement with the technology. For example, some students admit that they struggled with this notion of knowledge-sharing, perhaps due to a lack of familiarity with the technologies or a sense of unease over what constituted knowledge in a social media environment (Donlan, 2014). More so, these challenges or arguable views, such as intellectual conflicts that happen among learners, are due to cognitive development and understanding of collaborative learning activities (O'Sullivan, Krewer & Frankl, 2017).

Many studies have proposed various methods or approaches to improve student engagement through collaborative learning using a different approach (Chen & Chiu, 2016; Zheng, Zhang & Gyasi, 2019; Sanz-Martínez, Martínez-Monés, Dimitriadis & Bote-Lorenzo, 2019; Oluwajana & Adeshola, 2021). Some researchers have investigated a project-based learning method on collaborative learning (O'Sullivan, Krewer & Frankl, 2017; Almulla, 2020), wiki-supported collaborative learning for students' engagement (Yusop & Basar, 2017). However, most of the prior studies focus on teachers' role in promoting students'

engagement in collaborative learning, ignoring other group members' roles. Few studies have considered the visualization of participation tools and positively affected computer-supported collaborative learning (Janssen, Erkens, Kanselaar, & Jaspers, 2007). Previous studies focused more on the practicality of project-based to foster student engagement (Carrabba & Farmer, 2018; Rosé & Ferschke, 2016) and less attention on how student cognitive load behavior is affected by active collaborative learning. Due to the importance of collaborative learning factors to improve understanding, opportunities, and challenges of collaborative learning, this study builds up an empirical view that fosters identification and interconnection among the key factors of a web-based supported collaborative learning platform to support student engagement. Generally, this study proposes a model that explores the relationships between cognitive load, social influence, learning motivation, collaborative learning in groups project, and student' satisfaction. Trello platform is a visual collaboration platform that gives teams the ability to collaborate, communicate and coordinate on all of the projects easily was employed in this study. The Trello platform was adopted because it provides the team with a straightforward picture of project status, development, and success. Trello Power-Ups also help a board make better choices by bringing new ideas to the table. Not only that, but it facilitates cross-team collaboration by allowing you to work across boards. The paper is organized as follows: First, the paper presents the theoretical foundations of the study, reviews articles on previous studies on the cognitive load, social influence, learning motivation, collaborative learning, and student' satisfaction. Then, a discussion on the model development and hypotheses, followed by research design and methods. The results of the empirical model tests are presented. The paper concludes with a discussion and theoretical and practical implications of the study findings.

2. Literature Reviews

Many studies have been immersed in computer and web-supported collaborative learning on students' engagement in the learning environment. Different educational scholars had different perspectives and conclusions on the subject matter. For instance, some studies focus on using a computer and web-supported collaborative learning to foster students’ engagement for educational development (Wang & Hwang, 2017; Salam, Mailok, Ubaidullah & Ahmad, 2016). Salam and Farooq (2020) based their study on the relationship between sociability quality, web-based collaborative learning, student satisfaction, and system usage. Further, the study by Molinillo, Aguilar-Illescas, Anaya-Sánchez, and Vallespín-Arán (2018) uses technology-enhanced collaborative learning tools to investigate students' interactions, social presence, and emotional engagement in web-supported collaborative learning on active collaborative learning. Therefore, this study focused on using web-supported collaborative learning based on the relationship between cognitive load, collaborative learning in a group's project, and the interconnection between collaborative learning in a group's project and perceived student satisfaction.

2.1 Collaborative Learning in Groups Project

Collaborative learning in a group project involves the interdependent or jointly shared regulatory processes, beliefs, and knowledge that brings about interactivity or collective learning outcomes (Hadwin

et al., 2010; Järvelä et al., 2015; Oluwajana, Nat, & Fadiya, 2019). Hadwin et al. (2010) stated that it involves the creative activity of co-constructing shared task through methods, shared goals, and strategies; that allow students to collaborate with a group of people engage in knowledge building processes and to support instructional guidance that manages groups project (Kizilcec, 2013; Kwon, Hong, & Laffey, 2013). Collaborative learning in groups project has been identified as knowledge sharing which are grounded on cognitive task, content, understanding, strategies, behavior; motivational - group members' goals, priorities, and expectations and emotions - social interaction, trust, sense of community (Hadwin et al., 2010). Most studies highlighted the evidence of collaborative learning in groups work from different collaborative processes, and students tend to interact based on designed processes or plans, which often failed to address the difficulties in factors that influence group work. It is, therefore, necessary to channel collaborative learning in groups towards socio-metacognitive activities such as models of collaborative learning, motivation, collective thinking processes, and group coordination/regulation to promote learning (Kwon, Hong, & Laffey, 2013; Borge, & White, 2016; Borge, Ong, & Rosé, 2018; Teng, & Reynolds, 2019).

2.2 Cognitive Load

Cognitive load rooted from individuals engaging in specific work is affected by the work's difficulty and the individual's professional knowledge (Su, 2016). The introduction of cognitive load into collaborative learning involves tasks that require processes of multiple interacting of elements with a limited amount of time, in which learners are opportune to execute numerous cognitive activities (Zambrano, Kirschner, Sweller, & Kirschner, 2019). In group learning environments, one factor influencing cognitive load is transactional activities, which comprise the communication and coordination activities among groups during collaborative learning, apart from sharing information about the task. Others include the development of teamwork ability in collaborative learning to help ineffectiveness of instructional method that facilitates the transfer and acquisition of curricular knowledge through social interaction and also help in reducing individual’s cognitive load (Kirschner, Paas, & Kirschner, 2009; Curşeu, Chappin & Jansen, 2018). Trello boards (overview board, product roadmap, and copy board) help optimize transparency in teamwork and reduce information silos. The Trello board is helpful to set and track team activities. While making the process collaborative, easy to update, and also establishing team accountability. Cognitive load relates to the amount of information that working memory can hold at one time. According to Sweller (1988), working memory has a limited capacity, and instructional methods should avoid overloading it with additional activities that do not directly contribute to learning. Therefore, Trello platform boards are perceived to help solve the information overload, and cognitive load is considered an antecedent of the learning process and one of the major determinants of successful instructional intervention (Paas, Tuovinen, Tabbers & Van Gerven, 2003; Ayres, & Paas, 2012).

2.3 Social Influence

The social influence shows the degree to which users are free and collectively interact with themselves (Molinillo, Aguilar-Illescas, Anaya-Sánchez, & Vallespín-Arán, 2018), and creating groups for a particular

project are now recognized as one of the factors that influence knowledge building, especially during group task or when working on tasks (Miyake & Kirschner, 2014). With the increase in collaborative learning, social influence, and web-based technologies. Many users can easily modify and create, intercommunicate, and enjoy online content. The Trello platform supported a nested comment section on a collaborative project display card, and all users involved in the group get an email notification and reminder after few days if they failed to access the platform. Moreover, the comment can be edited, add an attachment, and even delete when not needed. Lastly, the integration of another platform is available on the Trello platform, which makes it interoperable for team members to use any application with it. Lin (2020) explained that the user's ability to group work socially combines with their emotions within a community of inquiry. Therefore, in the environment of web-supported collaborative learning, social influence attribute to a factor that influences group collaboration (Harvey, & Koubek, 2000; Chan, Chong, & Zhou, 2012). According to Balakrishnan, Liew, and Pourgholaminejad (2015), the social influence comprises features like the profile page of user with most recent activities, the page links that allows one to communicate with one another, adding and searching for other users. The study findings concluded that educational technologies supporting social influence attributes can improve learner educational experience, still not broadly supported at the present state. Moreover, it is better if instructors mandate web-based technologies to the users, and institutions should involve professionals in influencing users to acquaint with the use of this technology and assist other users to participate (Tarhini, Al-Busaidi, Mohammed, & Maqableh, 2017). Accordingly, the broader the social environment - culture, society, and institution; the more significant the strategies needed to influence web-supported collaborative learning within the learning environment.

2.4 Learning Motivation

The learning motivation works with a different element of the learning environment. According to Ciampa (2014), educational practice and learning benefits combine different instructional design components - psychological feature, learning, and interactional components. Consequently, most users are motivated intrinsically to carry out a specific task for maximum satisfaction. Also, users are motivated extrinsically to carry out a specific task for a desirable result (Martínez-Núñez, Fidalgo-Blanco, & Borrás-Gené, 2015). Many literatures on motivation have been investigated from different perspectives (Deci & Ryan, 1985; Hynd, Jodi Holschuh, & Sherrie Nist, 2000). For instance, the self-determinant theory stated that motivation is determined by 1. Autonomy: user controls the activity, 2. Relatedness: the user is comprehensive in performing task 3. Competency: the user is competent in performing or completing the tasks and learning activities. Also, Giesbers, Rienties, Tempelaar, and Gijselaers (2013), these three factors have positively influenced users' motivation to use web-based technologies and, in essence, promote collaborative learning. Teams using the Trello platform have complete control over their tasks and can set a due date for each task, which helps team members not forget about their responsibilities, and their success reflects their competency within the team and on the project as it progresses. This boosts the motivation of students to use the Trello platform, and all these features stand out compares to non-online collaborative platforms.

2.5 Student Satisfaction

It is essential to assess overall student satisfaction beyond cognitive load, social influence, learning motivation, and collaborative learning in a web-based supported collaborative learning environment. Accordingly, student satisfaction is defined as how students gratify with specific technology and acknowledge the assistance services (Mohammadi, 2015), with the combined effort of users, full participation, and; individual and group development. The project's goal is achieved by measuring learner perceptual experience of system services (Lai, & Chen, 2014). Generally, student satisfaction is an essential concept used in measuring learning outcomes and the successful implementation of online educational technology (Ke, & Kwak, 2013). student' satisfaction measures an individual's gross satisfaction in collaborative learning, and the completion of a project or task is given. The measurement of student satisfaction in a web-based supported collaborative learning environment is through users' intention and willingness to use and cooperate with the group (Salam, & Farooq, 2020). The purpose is to measure the level of productivity and gratification of the web-based supported collaborative tools for subsequent use. In essence, student satisfaction in a web-based supported collaborative learning environment measures an individual's overall satisfaction, assessment, and learning outcome.

3. Model Development And Hypotheses

This study investigates cognitive load, learning motivation, social influence, collaborative learning on student satisfaction during web-supported collaborative learning. The aim is to empirically develop a conceptual research model, as shown in Fig. 1 and is built upon the perceptive of the cognitive load, motivational, and social factors related to web-supported collaborative learning. The study was established based on existing literature reviews, and the cognitive load, motivational, social factors, and collaborative learning form the fundamental of the conceptual research model. The discussions on the model development and hypotheses are presented as follows.

3.1. Cognitive Load and Collaborative Learning in Group's Project

Of notable fact, the structure of cognitive processes of humans is built to discuss, active and conscious share, the necessary cognitive process of valuable task-relevant information and psychological feature held by each group member for information processing in a collaborative learning environment (Janssen et al., 2010). Learners should monitor and evaluate their collaborative processes and activity during actual learning engagement to observe, manage, and evaluate their processes through notes, search histories, chats, or workings toward final project goals (Gress, Fior, Hadwin, & Winne, 2010). Concerning learning from instruction emphasizing produced examples, learners working individually or as group members should retain sufficient cognitive capacity to process all information (Kirschner, Paas, Kirschner, & Janssen, 2011; Su, 2016). Thus, the higher the load imposed by the learning tasks, the more likely collaborative learning will lead to better effectiveness and efficient learning outcomes. As a result, since cognitive load refers to the amount of knowledge that a person's working memory can carry at one time, it is understandably difficult for an individual to remember all of the details of a collaborative project.

Nevertheless, using an online collaborative platform like Trello with features available to keep information and making it available on a dashboard could significantly help reduce the cognitive load. Therefore, we posited that:

H1: Cognitive load negatively influences collaborative learning.

3.2. Learning Motivation and Collaborative Learning in Group's Project

Learners' active regulation of learning is motivated by various cognitive and metacognitive strategies, which is vital to their online learning success (Lin, Zhang, & Zheng, 2017). Learning motivation is identified by students as a feeling of connectedness with peers (Xiong et al., 2015) and also related to cognitive, emotional, intrinsic, performances, collaborative learning groups; of which students' intrinsic motivation and ensuring the development and continuation of the learning process (Alhinty, 2014; Järvelä et al., 2015; Lin, Zhang, & Zheng, 2017). According to Järvelä et al. (2015), the activation of the student's cognitive, motivational, and emotional predispositions for a specific project help providing the information needed to have successful collaborative learning and performance. Also, with the stream of studies such as Gomez, Wu, and Passerini (2010); Taki, and Fardafshari, (2012); Serrano-Cámara, Paredes-Velasco, Alcover, and Velazquez-Iturbide, (2014); Magen-Nagar and Shonfeld, (2018) and Zhang, Meng, de Pablos, and Sun (2019) have shown the interconnection between learning motivation and students collaborative learning in groups project. Therefore, the study hypothesized that:

H2: Learning Motivation positively influences collaborative learning.

3.3. Social Influence and Collaborative learning

In a web-based supported collaborative learning environment, social influence is defined by its ability to function in a specific mediated environment with a healthy social and collaborative state to improve learning (Salam, & Farooq, 2020). The usefulness of social influence in collaborative learning provides the user with a discussion on ideas, interactivity, engagement, and more active with learning (Molinillo et al., 2018; Salam & Farooq, 2020; Yueh, Huang, & Chang, 2015). Moreso, Chan, Cheung, Brown, and Luk (2015) stated that students tend to engage in deep learning, which positively predicts higher-order thinking and learning and collaborative learning with peers. Also, Cheung and Vogel (2013) stated that investigating the effects of social ties on adopting information technologies in the virtual environment will increase social influence on individuals' behavior and group decision-making. Thus, the following hypothesis is presented in order to test the relationship between the students' social influence on collaborative learning in a group project:

H3: Social Influence positively influences collaborative learning.

3.4. Collaborative Learning and student' satisfaction

There is a need to balance student's inadequacies in web-based supported collaborative learning. Students should measure the performance of tools and applications used for any given task or project. Moreover, web-based supported collaborative learning tools do not facilitate or increase their participation in learning activities but help in personalization, curriculum support, and support connectedness among

users and ultimately lead to perceived learning satisfaction (Al-Rahmi, Othman, & Yusuf, 2015). According to Jiménez-Zarco, González-González, Saigí-Rubió, and Torrent-Sellens, (2015), the degree of individual collaboration in the project or task influence the level of perceived student' satisfaction. Also, web-based supported collaborative learning used satisfaction shows that most students believed that group learning with collaborative tools increases their interest, emotional state, and achievements in a collaborative learning environment (Su, Yang, Hwang, & Zhang, 2010). In line with these, many literature support web-based supported collaborative learning tools to measure student' satisfaction (Lwoga, 2014; Su, Yang, Hwang, & Zhang, 2010; Al-Rahmi, & Othman, 2013; Troussas, Virvou, & Alepis, 2014). Therefore, the study hypothesized that:

H4: Collaborative learning positively influences student' satisfaction.

4. Methodology

The research model of this study is depicted in Fig. 1. Accordingly, this study focuses on factors such as "cognitive load," "learning motivation," and "social influence" on collaborative learning to determine student satisfaction on the use of a web-based supported collaborative learning platform to support project-based student engagement.

4.1 Procedure and participants

This paper presents an empirical study on factors that influence the use of a web-based supported collaborative learning platform - Trello, to support project-based engagement. The instructor randomly divided fifty-six first-semester post-graduate university students of the information systems department into seven groups to work on a group project using an online collaborative platform. The same method was also applied to fifty-nine post-graduate students in their first year second semester of the same department, and they were divided into six groups. The two groups worked on different projects related to management and business information system courses. This collaborative project aimed to use a web-based supported collaborative platform to support online and offline learning activities. Part of the project was to share information among students, decrease cognitive loads, motivate, interact, work on group projects, and increase collective tasks. Specifically, a TRELLO platform was used for the research. TRELLO is an effective collaboration platform for teams (groups of people and boards). It helps teams work more collaboratively. It uses boards with adaptable features and integrations to improve the team's capability to meet their unique basic and business needs, as shown in Fig. 2.

The instructor also provided guidance and guidelines to the students on the use and functionality of this platform.

However, at the beginning of the semester, the instructor provides the students' overall course activities consist of:

- Teachers were setting out the guidelines of the project.

- Teachers regularly interact with the students on the platform usage.
- Participating and monitoring the discussion section.
- Continuous monitoring of student activity on the platform to ensure participation in the collaborative learning process.
- Checking out the new and better idea to improve the project.
- Overall, ensuring that the group members participate and provide solutions to problems during the learning collaborative learning process.

The group members (students) are obliged to create all-inclusive collaborative learning activities while using the platform based on the instructor decision:

- Follow the activities laid out by the teacher.
- Share information, exchanges document, submit reports or progress with the group members.
- Time distance, working, planning, and team management.
- Include the teacher in the group created.
- Work collectively and individually to achieve satisfaction over the use of the platform.

After two months, a questionnaire was sent via the platform to the participants to examine the interconnection of cognitive load, social influence, learning motivation, level of collaboration, and student' satisfaction on a web-based supported collaborative learning platform to support project-based engagement. The participants participated voluntarily, and anonymity was guaranteed. Further, a total of 115 students participated in the survey, among which 74. 3% were male, and 40.7% were female. Of the respondents, 52.4 % were between 25 and 29 years of age, 37.8% were between 30 and 34 years of age, and 24.8 % were between 35 and above.

4.2 Data Collection

The items of each construct were adapted and modified from previous studies to meet the research purpose. The measurement items were measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Five hypotheses interlinked with five constructs comprised of twenty-four items were tested in this research, viz. cognitive load, social influence, learning motivation, collaborative learning, and student' satisfaction. The measures for cognitive load were developed by Leppink et al. (2014). Venkatesh et al. (2003) and Godin (2013) developed the measurement item for social influence. The learning motivation was developed from a study by Schoor and Bannert (2011). The measurement item for collaborative learning in groups project was adopted from So and Brush (2008), Venkatesh et al. (2003), and Godin (2013. Measures for student' satisfaction were adapted from studies by DeLone and McLean (2003), So and Brush (2008), and Lee (2010). The questionnaire was reported in Appendix A.

4.3 Data Analysis

This research applied Partial Least Squares - Structural Equation Modelling (PLS-SEM) to measure the proposed model's measurement and structural model analysis. This was performed through advanced analysis of composites (ADANCO version 2.0.1). ADANCO is fit for the use of PLS-SEM (Henseler, 2017). PLS-SEM approach is commonly used for the small sample population's small size, saturated, estimated constructs, multiple formative constructs, and the model fit of the proposed model (Anderson & Gerbing, 1988; Chin 1998; Henseler, Hubona & Ray, 2016). Based on the study's theoretical knowledge, the data analysis guidelines were thoroughly followed and established to measure the measurement models and structural model using PLS-SEM (Henseler, 2017).

5. Results

5.1 Measurement model

The evaluation of measurement models comprise convergent validity, and scale reliability is presented in Table 1. Hair et al. (2010) recommended measuring the model's reliability, convergent validity, and discriminant validity. The reliability and convergent validity results show that *I.* Factor loadings are > 0.5, which satisfied the recommended value stated by Bagozzi (1981) that factor loadings must > 0.50. *II.* The composite reliability and Cronbach's alpha values must > 0.7, and these satisfy the threshold values recommended by Fornell and Larcker (1981), Nunnally (1978), and Hair et al. (2010), which stated that composite reliability and Cronbach's alpha values exceeded 0.7. *III.* Lastly, we tested the common method bias suggested by Ringle et al. (2015) that the maximum level of Variance Inflation Factor (VIF) values should be “5”. Therefore, convergent validity and scale reliability satisfied the requirement recommended values, and our model is free from common method bias.

Table 1
Factor Loadings, Composite Reliability, and Convergent Validity.

Indicators	Factor Loadings	VIF	Composite Reliability	Cronbach's Alpha	Average Variance Extracted (AVE)
SS1	0.807	1.791	0.873	0.815	0.633
SS2	0.864	1.765			
SS3	0.817	2.055			
SS4	0.683	1.724			
CO1	0.667	1.556	0.898	0.860	0.640
CO2	0.791	1.649			
CO3	0.840	2.450			
CO4	0.872	2.405			
CO5	0.814	2.130			
LM1	0.879	2.897	0.917	0.885	0.689
LM2	0.856	2.511			
LM3	0.873	2.726			
LM4	0.828	2.234			
LM5	0.700	1.483			
SI1	0.827	2.291	0.923	0.895	0.705
SI2	0.832	2.494			
SI3	0.913*	3.480			
SI4	0.840	2.377			
SI5	0.782	1.994			
CL1	0.812	1.828	0.899	0.850	0.690
CL2	0.813	1.890			
CL3	0.876	2.210			
CL4	0.820	1.925			

Note: CO: Cognitive Load, SI: Social Influence, LM: Learning Motivation, CL: Collaborative Learning, and the SS: student' satisfaction.

To confirm discriminant validity, we consider Fornell and Larcker's (1981) criterion to determine whether the square root of the Average Variance Extracted (AVE) of each construct is > the correlation between that constructs. Also, the study determines the heterotrait-monotrait ratio (HTMT) to check the correlation between the two constructs is < 0.9 (Henseler, Ringle, & Sarstedt, 2015; Henseler et al., 2015). However, Tables 2 and 3 satisfy the required recommended values, which indicate satisfactory and valid results. So we then proceed to the structural model to determine the relationships among the hypothesized proposed model.

Table 2
Discriminant validity: Fornell-Larcker criterion

Construct	SM	SI	SS	CL	CO
LM	0.689				
SI	0.523	0.705			
SS	0.215	0.247	0.633		
CL	0.446	0.360	0.267	0.690	
CO	0.300	0.218	0.127	0.191	0.640
Squared correlations; AVE in the diagonal					

Table 3
Discriminant validity: HTMT

Construct	SM	SI	SS	CL	CO
LM					
SI	0.805				
SS	0.499	0.547			
CL	0.762	0.672	0.565		
CO	0.625	0.516	0.375	0.482	
Note: CO: Cognitive Load, SI: Social Influence, LM: Learning Motivation, CL: Collaborative Learning, and the SS: student' satisfaction.					

5.2 Structural Model

In evaluating the structural model, the significance of the relationships between the constructs is established, and their predictive power was measured. Figure 3 shows the graphical representation of the structural model and predictive power. The study tested the structural method using a bootstrapping procedure it makes it possible to estimate statistics on a population by re-sampling the dataset multiple times. We, therefore, used ADANCO with 4999 bootstrap samples to evaluate the process of obtaining the results (the relationships between the constructs, estimates of the original coefficients (β), and level of significance) are listed in Table 4 based on the study by Henseler, (2017).

Table 4
PLS- Goodness of fit

	Value	**HI95**	**HI99**
SRMR	0.077	0.072	0.078
d_{ULS}	1.630	1.436	1.681
d_G	0.708	0.816	0.912

Also, the graphical representation of the structural model explains the variance of the endogenous constructs: As depicted in Fig. 3, the R^2 for CL is 47%, and the SS is 26.7%, which proven to be significant, as stated by Chin (1988). Therefore, the predictive power of CL (47%) proved to be a strong predictor for factors of cognitive load, social influence, and learning motivation, and the predictive power of SS (26.7%) proved to be a strong predictor of CL to support project-based student engagement

Further, we evaluated the Standardized Root Mean Square Residual (SRMR), and based on PLS-SEM guidelines by Henseler (2017), the goodness of fit is tested with the unweighted least squares discrepancy (d_ULS), the geodesic discrepancy (d_G), and the SRMR. However, a model fit is considered valid when the SRMR < 0.08; the squared Euclidean distance (d_ULS) of the saturated model < bootstrapped HI 95% of d_ULS estimated model. From Table 4, the SRMR value for this hypothesized model is 0.077, which shows that the proposed model is satisfactory.

Lastly, the study estimates the original coefficients (β), f^2 coefficients, T statistics, and the structural model's significance levels (p-value). The purpose is to establish relationships and check if the hypotheses support the hypothesized model. Table 5 shows the relationship of factors that influence web-based supported collaborative learning usage to support project-based student engagement. First, the findings indicate that cognitive load shows an insignificant impact on collaborative learning to support project-based student engagement H1 ($\beta = 0.078$, $f^2 = 0.008$). Also, learning motivation shows a positive impact on collaborative learning to support project-based student engagement H2 ($\beta = 0.457$, $p < 0.01$; $f^2 = 0.168$); social influence shows a positive impact on collaborative learning to support project-based student engagement H3 ($\beta = 0.233$ $p < 0.01$; $f^2 = 0.049$) and collaborative learning shows a

significant impact on student' satisfaction when using the platform for project-based student engagement H4 ($\beta = 0.517$; $p < 0.01$; $f^2 = 0.364$). Thus, H1, H2, H3, and H4 are empirically supported. Therefore, all original coefficients using the bootstrapping process of PLS-SEM confirmed that the hypotheses for this proposed model were supported. However, the proposed hypotheses are positively significant.

Table 5
Results of hypotheses testing

Effect	Original coefficient	Standard bootstrap results				
		Mean value	Standard error	t-value	p-value (2-sided)	p-value (1-sided)
LM -> CL	0.457	0.456	0.120	3.790	0.000	0.000
SI -> CL	0.233	0.229	0.112	2.084	0.037	0.019
CL -> SS	0.517	0.523	0.071	7.297	0.000	0.000
CO -> CL	0.078	0.091	0.103	0.760	0.448	0.224
Note: *P < 0.05, ** p-value < 0.01; *** p-value < 0.001.						

6. Discussion

6.1. Theoretical and practical implications

This research aims to determine the factors that determine collaborative learning and subsequent student satisfaction. Moreover, this research determines students' cognitive load understanding, social influence, and learner's motivation towards collaborative learning and the resultant impact of the web-based supported collaborative platform (TRELLO) on student satisfaction. The results of the study support the relationships among the constructs in the hypothesized model. First, cognitive load, social influence, and learner motivation serve as crucial antecedents of collaborative learning that were identified: and the four variables interact directly and indirectly influence student satisfaction. However, this study revolves around collaborative learning, which has been identified as a key element to support student satisfaction in using web-based supported collaborative learning tools, and it is in line with the many studies (Jiménez-Zarco et al., 2015; Kalizhanova et al., 2019; Horváth, 2019). The TRELLO platform usage also improves student autonomy as well as their analytical skills and critical thinking (Kalizhanova et al., 2019). Accordingly, the more motivated by the degree of collaboration among the students in a web-based group project, the more they preoccupied with personal and group learning.

Furthermore, this study shows that students' learning motivation has a positive influence on collaborative learning, which is in line with the results of many studies on the influence of motivational behaviors on collaboration, engagement, and communication in online learning (Järvelä et al., 2015; Xie, 2013; Testers et al. 2020). Consequently, it is noted that the more positive motivational rationale (e.g., extrinsic, relational, and intrinsic rationale), the higher the possibility of students involved in collaborative learning. Similarly, Testers et al. (2020) proposed that in order to help the motivation process, educational designers should include trainees in the content design process, for example, by allowing students to use cases from their everyday experience in their projects.

Second, this study's results on the relationship between cognitive load and collaborative learning show an insignificant relationship based on the social activities on TRELLO. Accordingly, there is no clear and unequivocal representation of any relationship between cognitive load and collaborative learning, but the difference is the complexities of web-based learning support learning tasks (Yang et al., 2020). The cognitive load role in the group project may need instructional control to help students collaborate effectively because cognitive load generates substantial knowledge based on the instructional design met for individuals, which might influence groups' problem-solving tasks in collaborative learning. According to Yang et al. (2020), when developing a competitive learning environment or proposing a shared forum, instructors should understand students' cognitive capacities and provide them with learning material of sufficient cognitive complexity.

Third, literature acknowledges a positive relationship between social influence and collaborative learning (e.g., Yueh, Huang, & Chang, 2015; Salam & Farooq, 2020); our study results show support for this relationship. This is due to the existing relationship between students' social activities in the online environment and the engagement during group interactions. In addition, social influence in the collaborative project assists students in adopting social habits, as shown by their interactions with one another and in generating new ideas across groups (Yadegaridehkordi et al., 2019). Furthermore, the members of a group have different social influence (e.g., peer engagement, group heterogeneity, social norms, cultural and individual difference) that may help in collaborative learning (Popov et al., 2013; Chen & Kuo, 2019) and consequently lead to increase social interaction within the group and also encourage collaborative learning with TRELLO.

Four, the results show that students' collaborative learning positively influences students' satisfaction. These results are consistent with previous studies (Abuhassna et al. 2020; Salam & Farooq, 2020). In the context of web-based supported collaborative learning for group project (Al-Rahmi, & Othman, 2013), there are series of factors that link students' collaborative learning and student' satisfaction (e.g., social influence, cognitive motivation loads - task complexity), all these attributes are to increase social activities and ultimately lead to perceived learning satisfaction. Abuhassna et al. (2020) reported that the student's background, experience, collaborations, interactions, and autonomy positively affected students' satisfaction. Also, Salam and Farooq (2020) stated that the sociability quality of students has a significant influence on the platform use and overall user satisfaction. In general, this empirical study contributes to theoretical and practical knowledge of web-based supported collaborative learning to

support project-based student engagement based on model development. Therefore, this study focuses on web-based supported collaborative learning methodological approaches, emphasizing the influence of cognitive load, learning motivation, social influence, and collaborative learning to support project-based student engagement. Also, on practical implications, the study emphasizes the importance of student engagement in collaborative learning by using web-based supported platforms that support project-based engagement among students. The results have shown that the most influential factors of collaborative learning are social influence and motivation during a group project. These offer an insight into the online learning environment, which comprises peer engagement, cognitive capacity, social activities, and knowledge sharing. When using the platform for social activities, such discussion during the project contributes to increased engagement and increased learning satisfaction for using the platform. Notably is the role of the instructor in collaborative learning, which is to coordinate and support student online activities, design course or project content, pedagogical attributes, personal management, technical abilities, social responsibilities, and managerial role (Gómez-Rey, Barbera, & Fernández-Navarro, 2018), to increase student engagement and learning satisfaction in a group project. Therefore, instructors should work towards performing their duties and coordinating effectively in online learning. It is important to encourage creative thinking, share ideas and knowledge among students. This will facilitate team building and development to influence collaborative learning, whether directly and indirectly, perceived satisfaction on web learning platforms.

6.2. Limitations and Future Research

There are some limitations to this study. First, three antecedents of collaborative learning were used for this study. However, other factors could be added, such as peer engagement, computer, and self-efficacy, to determine a better future study outcome. Additionally, this study focuses on student social activities on web-based supported collaborative learning, but instructors were partially part of the research, so there is a need to include both instructor and student factors in future research to create a balanced setting. This study only considers the use of only one web-based supported collaborative learning tool. However, the new trend in web-based supported collaborative learning is the use of multi-modal learning technologies. Thus, future research could further consider the use of a multi-modal learning approach. Also, a control group should be introduced in future studies to compare the results obtained from the experimental group. The control group results will give more accurate details of what happens when the variable examines changes. Pretest measurements should also be considered to get a clearer understanding that the population sample considered understanding the questions and if they can perform the tasks or have the information that questions require. Finally, future studies could explore using the learning analytics approach to measure student performance and engagement to improve web-based collaborative learning within learning environment.

Declarations

Data Availability Instruments and databases are available.

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical Approval: There is ethics approval.

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Appendix 1

Appendix 1. Design of the Study

Constructs	Items	Source
Learning Motivation (ML)	• 1. I am sure I can do excellently using TRELLO platform. 1. I find the TRELLO 'collaborative learning' platform fascinating. 2. It's essential for me to be able to use TRELLO conveniently. 3. I know that I will be able to use the TRELLO platform for group project. 4. When thinking about the learning objective of TRELLO, I am a little concerned.	Schoor & Bannert (2011)
Cognitive Load (CO)	1. The instructions and/or explanations during the collaborative activity were very unclear. 2. The instructions and/or explanations during the collaborative activity were, in terms of using TRELLO, very ineffective 3. I invested a very high mental effort in the complexity of collaborative activity when using TRELLO 4. The activity really enhanced my understanding of concepts of using TRELLO for collaborative learning. . 5. This activity really enhanced my understanding of the problem/s of using TRELLO for collaborative learning was/ were covered..	Leppink et al., (2014).
Social Influence (SI)	1. Collaboration influences my behaviour when using the TRELLO. 2. Collaboration with people who are important to me think I should use the TRELLO. 3. The group project has been helpful in the use of the TRELLO. 4. Using TRELLO is similar to collaboration technology which is easy for me 5. In general, the manual provided for TRELLO is easy to understand.	Venkatesh et al., (2003) and Godin (2013)
Collaborating learning	1. I have the resources necessary to use the TRELLO platform. 2. I have the knowledge necessary to use TRELLO 3. The TRELLO is simple with multi-function for group project. 4. I was able to develop problem-solving skills through group project using TRELLO.	So and Brush, (2008) Godin (2013)
Student satisfaction (SS)	1. Discussions assisted me in understanding other points of view.	Lee, (2010) and So and Brush, (2008)

2. Overall, the learning activities and assignments of participating met my learning expectations..
3. My level of understanding that took place during participation was of the highest quality.
4. The diversity of collaborative activities while using the TRELLO prompted me to participate in the discussions.

Figures

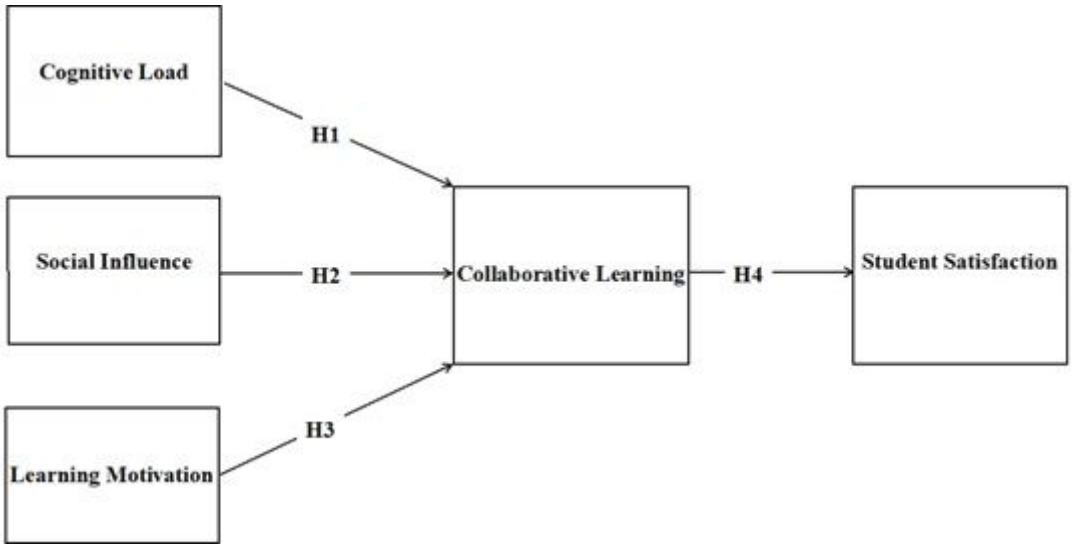

Figure 1

Research Model

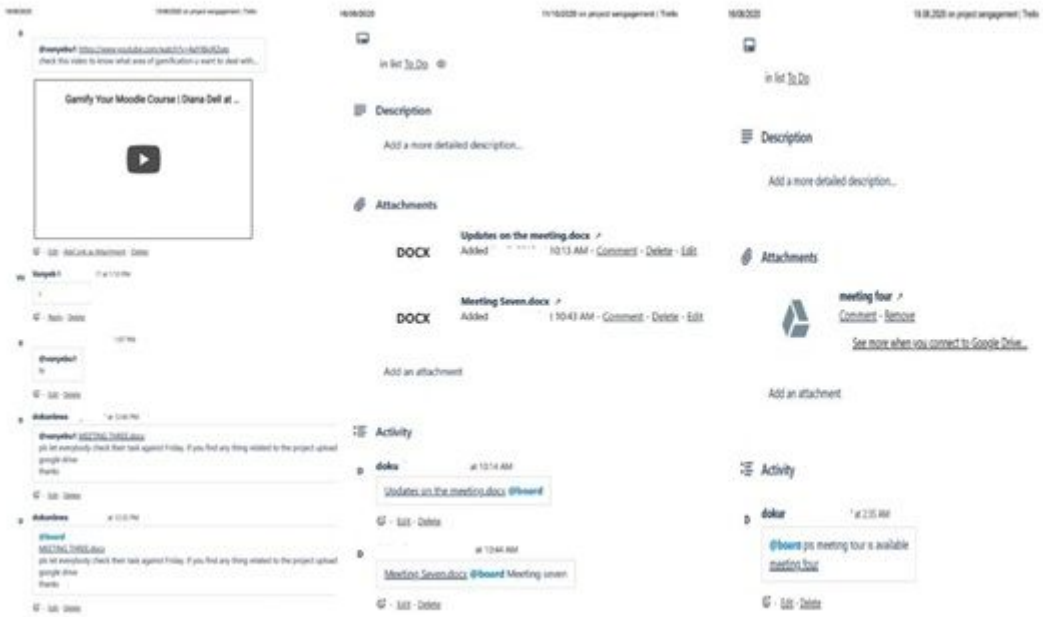

Figure 2

Screen-shot of online student engagement using Trello- Discussion and engagement Board.

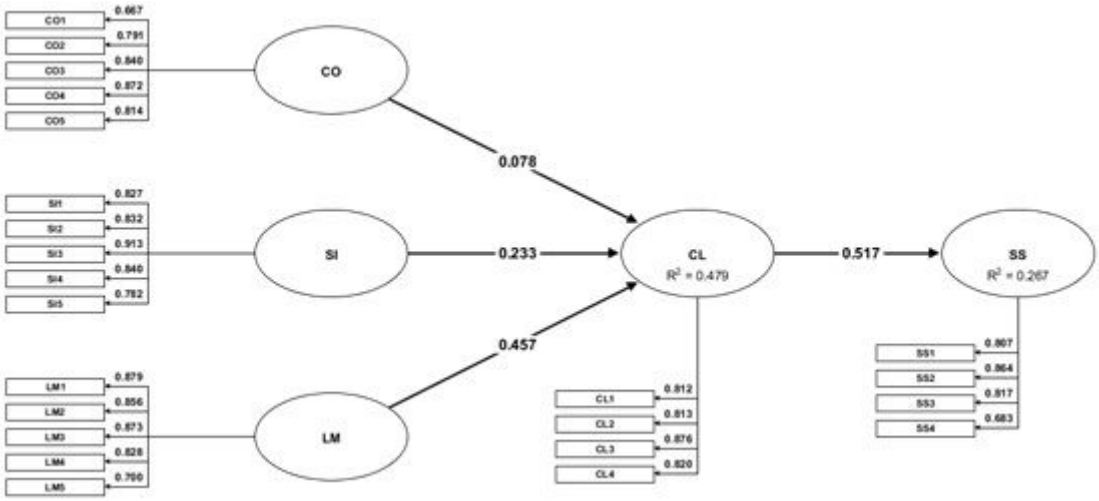

Figure 3

Graphical representation of the structural model