

# Factors affecting students' performance in web-based learning during the COVID-19 pandemic

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## Abstract

**Purpose** – This paper aims to identify and discuss factors affecting students' performance in web-based learning (WBL) during the COVID-19 pandemic.

**Design/methodology/approach** – This study uses a quantitative method to analyze data collected using an online structured questionnaire. Responses were gathered from undergraduate students ( $n = 270$ ) studying engineering education at a university in Indonesia. A measurement analysis is used to validate the instruments, and structural equation modeling is used to examine the associations among constructs.

**Findings** – Attitude, anxiety and motivation affected students' performance in WBL. Motivation played an essential role in influencing WBL. The results also showed equal opportunities between men and women in WBL.

**Research limitations/implications** – This research may provide a foundation for future research designing WBL in higher education. This study provides valuable insights in policy formulation and an effective web-based e-learning design by considering students' personal characteristics potentially affecting WBL performance.

**Originality/value** – This study identifies factors influencing students' performance in WBL. Furthermore, it added students' genders to explore the moderating effect on the model.

**Keywords** Online learning, Engineering education, Students performance, COVID-19 pandemic, Web-based learning

**Paper type** Research paper

## Introduction

In early 2020, people worldwide faced an invisible enemy, namely, the COVID-19. The COVID-19 pandemic has forced most people to change many cultural routines, daily



activities, such as personal, organizational, outdoor and public activities (Al-Kumaim *et al.*, 2021). Moreover, the pandemic has directly impacted all sectors of life, including education. In response to this, the Ministry of Education and Culture of Indonesia issued a regulation concerning the implementation of working from home and studying from home through online learning platforms for schools and universities (Padmo *et al.*, 2020; Hermanto and Srimulyani, 2021). The online learning process using various media must be carried out to avoid human contacts that can spread and transmit the COVID-19 (Gani *et al.*, 2020; Basith *et al.*, 2020; Irawan *et al.*, 2020; Yamamura and Tsustsui, 2021). Web-based learning (WBL) is considered the right choice of web-based online learning media.

In this regard, lecturers need to pay attention to students' attitudes, involvement, satisfaction and motivation during online learning activities (Crawford *et al.*, 2020; Hodges *et al.*, 2020). Attitude is a person's way to think, feel and act (Bhuaneswari and Dharanipriya, 2020). Furthermore, students with strong intention during the web-based online learning process will have the willingness, awareness, independence, self-confidence and desire to earn achievement satisfaction and effects to friends (Patricia Aguilera-Hermida, 2020; Rahayu, 2018). This confirms that attitudes and motivations determine successful WBL.

Researchers conducted initial studies through literature studies, observations and interviews with students during web-based online learning and revealed that online learning services during the COVID-19 pandemic could negatively impact students' life because several problems arose, as follows.

- inhibiting and reducing students' motivation during the learning process (Al-Kumaim *et al.*, 2021);
- arising complaints, including inadequate network and limited internet quota; and
- weak endurance of looking at computer screens for a long time and busy tasks.

This initial study emphasized the need for further investigation on motivation and anxiety aspects in online learning.

Several previous studies put the effectiveness of web-based online learning into questions. A study found that 30% of students experienced anxiety during the use of web-based online learning (Saadé *et al.*, 2017). This study confirms that anxiety is an essential factor for further review according to the context of this research. Furthermore, limited interviews of this research provided information that technological capabilities, complex content and closed interactions could cause anxiety that affected online learning performance. Anxiety can affect motivation and performance, especially for students' demographic subset (England *et al.*, 2019). Therefore, another focus of this study was the demographic dimension.

Preliminary studies emphasized the importance of research on students' characteristics considering attitude, anxiety and motivation aspects. To date, no study has investigated these three aspects that mainly cause severe problems of students' performance in WBL. These three aspects likely occur in every university student from any faculty or major. However, the fundamental problems described earlier occur in engineering education. Therefore, this study explored three aspects influencing engineering education students' learning performance in WBL. This research is fundamental because the COVID-19 pandemic is predicted to continue for the next few years or other pandemics are unpredictable to occur. The quality of education is at stake when this web-based online learning continues.

Previous research examined the impact of WBL on learning performance in practical courses during the COVID-19 pandemic. The research discovered that WBL significantly

improved students' learning performance (Tseng and Chen, 2020). Another study investigated the influence of WhatsApp on students' attitudes, motivation and anxiety in language learning and revealed that WhatsApp positively impacted students' attitudes, motivation and anxiety (Kaid Mohammed Ali and Rashad Ali Bin-Hady, 2019). Other studies investigated students' attitudes towards online learning during the COVID-19 pandemic (Peytcheva-Forsyth *et al.*, 2018; Wijaya *et al.*, 2020). These studies used descriptive, inferential, qualitative and statistical analysis methods. They discovered several factors and impacts of web-based online learning in several countries during the COVID-19 pandemic. However, this research is different from the previous studies. Moreover, this research added several factors with other methods and analyses and various objects and locations.

This study focused on several factors identified as causes of high and low performance. It used three factors affecting the WBL performance of engineering education students. Moreover, it added students' gender to examine the moderating effect on the model using the structural equation method to sharpen the analysis. This study provides valuable inputs for considering students' characteristics in selecting online learning methods and activities for universities and learning designers. In addition, this research helps future researchers interested in developing the effectiveness of WBL of engineering education students.

*RQ.* To identify and discuss factors affecting students' performance in using web-based learning during the COVID-19 pandemic.

## Theoretical background and hypotheses development

### *Engineering education*

Engineering education refers to education focusing on science that combines academic knowledge and engineering to solve a problem. Engineering education is content-centered, hands-on, design-oriented education and teaching and focuses on developing analytical thinking skills (Grodotzki *et al.*, 2021). Most engineering education lecturers have applied WBL platforms with blended flipped classroom strategies to implement and deliver learning materials during the COVID-19 pandemic.

### *Web-based learning*

WBL is one of the online learning media or pages with reasonable educational goals (Astuti *et al.*, 2020). WBL constitutes learning through the internet, such as web pages, to meet students' needs (Zhang, 2020). WBL provides simple, easy-to-use and affordable access to information anywhere and anytime (Cahyana and Supatmi, 2019; Valverde-Berrocso *et al.*, 2020). WBL provides content and group interaction opportunities as well as synchronous and asynchronous interactions between individuals and groups. WBL creates more interactive activities, such as asking and responding to questions (Hamzah *et al.*, 2017). This online learning activity can be controlled remotely with various WBL platforms, such as Moodle, Google Classroom, Edmodo, Schoology and institutional or educational websites (van Twillert *et al.*, 2020). The central WBL platform used in engineering education at Universitas Negeri Makassar, Indonesia, during the COVID-19 pandemic is the Moodle-based Learning Management System and Application Management Open Knowledge (LMS SYAM-OK) with the support of participation and collaboration platforms.

### *Students' performance*

Students' attitudes can vary depending on online learning and can positively and significantly improve students' achievement (Male *et al.*, 2020). Online learning plays an essential role because its activities and materials affect students' motivation and academic

achievement (Na *et al.*, 2020). Several studies revealed that blended learning could improve students' learning experience and engagement, mainly if additional methods are provided for face-to-face classes (Rasheed *et al.*, 2020). Many studies discovered positive attitudes towards online learning, e-learning or WBL, but they conclude that the values taught in face-to-face and online systems are not equal (Hong *et al.*, 2003; Lin *et al.*, 2020). Students prefer blended learning, which combines face-to-face lectures with online/e-learning (Raheem and Khan, 2020). More specifically, Other studies deployed that factors influencing learning performance were anxiety, attitudes and motivation (Malanchini *et al.*, 2020; Bai, 2020; Ritonga *et al.*, 2020). A detailed explanation of factors affecting students' learning performance is described in the development of hypotheses.

#### *Attitude*

Knowledge of student attitudes and perspectives will help universities develop and implement online learning models and forms that suit students' needs. Some research denoted that educational institutions necessarily studied and reported students' attitudes towards online learning (Edwards, 2018; Kaid Mohammed Ali and Rashad Ali Bin-Hady, 2019; Unger and Meiran, 2020; Zhu *et al.*, 2020). Meanwhile, other researchers contend that students' attitudes and perspectives on online learning are critical factors for students' learning performance (McKimm, 2003; Rahayu, 2018; Wu *et al.*, 2019). Therefore, it is assumed that the attitude factor affects the performance of WBL. Based on this explanation, this study formulated the following hypothesis:

H1. Attitude (At) is positively related to web-based learning performance (LP).

#### *Anxiety*

Students who experience anxiety about specific online lectures have difficulties during the learning process. A study discovered that 60% of students experienced psychological pressure because of anxiety about online learning (Khawar *et al.*, 2021). This anxiety reduces cognitive efficiency, such as self-evaluation, increases worries about task performance, misses task completion, calculates assessment scenarios and meets final project deadlines (Baloran, 2020). Preliminary studies inform that most students feel anxious because of insufficient communication with lecturers (Ajmal and Ahmad, 2019), internet network and endurance in front of a computer screen. This anxiety can affect students' learning performance (England *et al.*, 2019). Based on this explanation, this study formulated the following hypothesis:

H2. Anxiety (An) is positively related to web-based learning performance (LP).

#### *Motivation*

Motivation is a basic recipe for a student's academic success (Leenknecht *et al.*, 2021). Students with optimal motivation will receive advantages of online learning because they have adaptive attitudes and strategies, such as maintaining intrinsic interest, goal setting and self-monitoring (Islam *et al.*, 2018). A study revealed that students' learning performance was related to their learning motivation; the higher the student's learning motivation is, the better their learning performance will be (Rafique *et al.*, 2021). Based on this explanation, this study formulated the following hypothesis:

H3. Motivation (Mo) is positively related to web-based learning performance (LP).

*Gender*

Gender describes male and female characteristics shaped by the social environment. Several studies indicated significant differences in the learning motivation between male and female students during online learning (Puspitaningrum *et al.*, 2021; Behforouz *et al.*, 2021). Moreover, another study presents that the gender factor significantly depended on respondents' attitudes to online learning (Peytcheva-Forsyth *et al.*, 2018). Another study reports that female students are more anxious in online learning than male students (Saadé *et al.*, 2017). This study considers that gender is an essential factor to investigate in different contexts. Therefore, this study formulated the following hypotheses:

- H4a.* Gender moderates the relationship between learning anxiety and web-based learning performance.
- H4b.* Gender moderates the relationship between learning attitude and web-based learning performance.
- H4c.* Gender moderates the relationship between learning motivation and web-based learning performance.

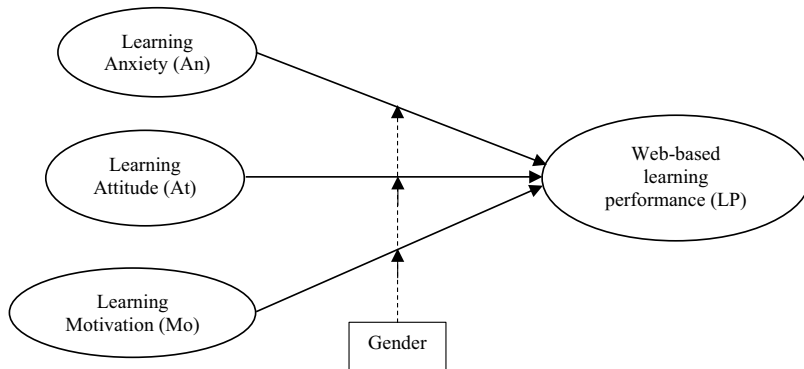
The theoretical framework shows the research hypotheses in [Figure 1](#).

**Method**

*Participants, survey instruments and data collection*

The participants of this study were undergraduate students of the Engineering Education Department, Universitas Negeri Makassar, Indonesia, who have taken online lectures during the COVID-19 pandemic. The survey instrument on WBL performance was developed by investigating various literature on online learning, e-learning or web-based learning (Saadé *et al.*, 2017; Kaid Mohammed Ali and Rashad Ali Bin-Hady, 2019, 2019; Law *et al.*, 2019). The survey instrument developed and used in this research is as follows:

The validity and reliability of the survey items were tested in the developed questionnaire. The research instrument consisted of two parts. The first part is students' demographics, such as gender and department. The second part consisted of questions about attitude, anxiety, motivation and learning performance factors. All survey questions were designed on a four-point Likert scale (4 = strongly agree, 3 = agree, 2 = disagree and 1 = strongly disagree). To check the clarity and validity, the questionnaire was initially



**Figure 1.**  
Theoretical  
framework

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*Attitude*

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- AT1: I think web-based learning or online learning is a suitable learning method during the COVID-19 pandemic  
 AT2: I think that web-based learning and face-to-face learning on campus are equally effective  
 AT3: I feel very enthusiastic during web-based learning  
 AT4: I prefer face-to-face learning on campus to web-based learning  
 AT5: After the COVID-19 pandemic, I hope that online learning will still be applied with the blended learning method

*Anxiety*

- AN1: I am very confident when studying online  
 AN2: I feel anxious about my internet network during web-based learning  
 AN3: I feel anxious about my immune systems if I spend a long time in front of the computer during web-based learning  
 AN4: I feel confident when communicating with my lecturers during online learning  
 AN5: I am not nervous during the web-based learning process

*Motivation*

- MO1: I am motivated when doing college assignments during web-based learning  
 MO2: I am interested in course content and the way lecturers deliver the materials during web-based learning  
 MO3: I am motivated to learn because I have a good relationship with my teachers during web-based learning  
 MO4: I am motivated to learn because I have a good relationship with my classmates during web-based learning  
 MO5: I am happy because I am connected to various material sources during web-based learning

*Web-based learning performance*

- LP1: My knowledge has increased during web-based learning  
 LP2: My self-study ability has improved during web-based learning  
 LP3: My critical thinking skills have improved during web-based learning  
 LP4: My collaborative learning skills have improved during web-based learning  
 LP5: I could learn more flexibly and affordably during web-based learning
- 

tested on 30 students. The pilot test showed that the question items did not contain difficult words or understanding. Therefore, the questionnaire did not need any changes.

Furthermore, the questionnaire was submitted to three experts, including researchers and academics, to gain feedback. Because no anomalies were found, a full-scale survey was carried out. The proportional sampling method was used considering the structural equation analysis used and the recommended sample size was 100 samples or above (Hair *et al.*, 2010). The data were collected during the learning-from-home process and physical distancing conditions from June to July 2021. The survey link was stored in the researcher's Google form to disseminate the survey. Finally, 270 participants responded to the understanding of the WBL performance. Because data was collected via Google forms and all questions were compulsorily answered, no data was lost (Table 1).

*Structural equation modeling*

This study employed a structural equation modeling (SEM) analysis with the help of SmartPLS 3.3.2. Assessments of validity and reflective reliability followed reliability indicators seen through outer loading indicators, internal reliability consistency through composite reliability and Rho A, convergent validity through AVE and discriminant validity through Fornell-Larcker criteria and cross-loadings (Ringle *et al.*, 2012; Hair, 2017). The value of internal consistency ranged from 0 to 1 (Hair, 2017). The higher the internal

QAE 30,1	Items	Respondents	(%)
156	<i>Genders</i>		
	Male	132	48.9
	Female	138	51.1
	<i>Departments</i>		
	Informatics and Computer Engineering Education	68	25.2
	Mechanical Engineering Education	23	8.5
	Automotive Engineering Education	26	9.6
	Electrical Engineering Education	27	10
	Electronic Engineering Education	17	6.3
	Civil Engineering Education	19	7
	Agricultural Technology Education	35	13
	Mechatronics Vocational Education	17	6.3
Family Welfare Engineering Education	38	14.1	

**Table 1.**  
Sample  
characteristics

consistency value is, the higher the level of reliability will be. Internal consistency criteria are determined with composite reliability of 0.70 (Nunnally and Bernstein, 1994; Barclay *et al.*, 1995; Hair, 2017). The higher the internal consistency value is, the higher the level of reliability will be. The internal consistency criteria through composite reliability are 0.70 (Nunnally and Bernstein, 1994; Barclay *et al.*, 1995; Hair, 2017). This study did not use Cronbach's alpha because it underestimates the reliability of internal consistency and composite reliability; thus, Rho A (Dijkstra–Henseler's  $\rho_A$ ) was more appropriate to use (Benitez *et al.*, 2020). Likewise, the reliability indicator is determined by the outer loading value higher than 0.70 (Hair, 2017). However, the indicator or item is considered valid if its outer loading value is  $>0.50$  (Ghozali, 2014). Besides, the outer loading less than 0.4 must be removed from constructions (Ketchen, 2013). Convergent validity through the average variance extracted (AVE) must be higher than 0.50 (Hair, 2017). The discriminant validity is at an indicator level with cross-loadings. The outer loading indicator for a construct must be the highest among all cross-loadings for other constructs (Barclay *et al.*, 1995; Hair, 2017). The discriminant validity at the construct level was tested by comparing the square root of the AVE of a construct with the construct correlated to other constructs. Specifically, the square root of the AVE of each construct must be higher than the correlation of different constructs (Fornell and Larcker, 1981). The bootstrap process and T-statistics for the structural model were used above 1.96 at 95% confidence intervals to determine the level of significant path coefficients. To test the hypotheses on the moderating variable of gender, the PLS of multiple group analysis was used. Percentages higher than 0.95 and less than 0.05 indicated a significant difference among groups in the PLS path coefficient (Henseler, 2012).

## Data analysis and results

### *Reflective measurement model analysis*

The reflective measurement model analysis in Table 2 shows that the outer loading value for each item or construct indicator from the student assessment results is above the minimum value of 0.60. Because all effects are more significant than 0.70, the indicator is considered reliable (Hair, 2017). The three items have an outer loading greater than 0.6 (At2, At5 and An4), but they neither reach a value of 0.70 nor are eliminated. This item is not omitted because outer loadings between 0.40 and 0.70 should be removed if the removal increases the composite reliability and AVE values above the recommended threshold value

(Hair Jr. *et al.*, 2017). There are several items or indicators marked “out.” This item is omitted because its outer loadings are less than 0.40 and likely increase the composite reliability and AVE (Ketchen, 2013). The obtained internal consistency value is above 0.7. This number means that the internal consistency value is satisfactory (Nunnally and Bernstein, 1994). This criterion was also used for Rho A and composite reliability. Two constructs have composite reliability above 0.70, and this number means that the constructs are reliable. The composite reliability and the value of Rho A constructs show that all constructs are reliable. Convergent validity is indicated by the AVE. The analysis results in Table 2 signify that all AVE values are higher than 0.50. The AVE values must be greater than 0.50 to explain more than half of the indicator variance (Hair Jr. *et al.*, 2017).

Table 3 shows the Fornell–Larcker criteria based on the AVE and the most popular validity measurement in the PLS-SEM. For the reflective model, the AVE must be greater than the squared correlation to investigate the discriminant validity of the model (Mehmetoglu, 2021). All constructs in the model have good discriminant validity.

Construct/factors	Item	Outer loadings	Rho A	Composite reliability (CR)	Average variance extracted (AVE)
Attitude	At1	0.771	0.711	0.802	0.507
	At2	0.632			
	At3	0.819			
	At4	Out			
	At5	0.604			
Anxiety	An1	0.867	0.717	0.787	0.557
	An2	Out			
	An3	Out			
	An4	0.602			
	An5	0.746			
Motivation	Mo1	0.750	0.881	0.910	0.671
	Mo2	0.759			
	Mo3	0.825			
	Mo4	0.844			
	Mo5	0.764			
Web-based learning performance	Lp1	0.832	0.891	0.918	0.691
	Lp2	0.843			
	Lp3	0.867			
	Lp4	0.852			
	Lp5	0.759			

**Table 2.** Analysis results of the reflective measurement model

**Note:** The value of loading items marked “out” was excluded because it did not meet the criteria of >0.6

Construct/factors	Mean	SD	An	At	Mo	Lp
AN	8.10	1.75	<b>0.746</b>			
AT	10.38	2.49	0.714	<b>0.712</b>		
MO	19.10	4.29	0.681	0.712	<b>0.819</b>	
LP	12.82	3.30	0.627	0.645	0.783	<b>0.831</b>

**Table 3.** Descriptive correlation between factors and roots of AVE



The cross-loadings of all indicators (Table 4) show the highest load on each construct. As a result, all indicators or items in a particular construct meet the criteria of good discriminant validity.

*Structural model analysis (hypotheses testing)*

PLS estimation results from SEM, path coefficient values and item loads for research construction are presented in Figure 2.

The hypothesized effects of attitude on learning performance ( $\beta = 0.124$ ,  $t$ -values =  $2.031 > 1.96$ ), anxiety on learning performance ( $\beta = 0.120$ ,  $t$ -values =  $1.993 > 1.96$ ) and motivation on learning performance ( $\beta = 0.613$ ,  $t$ -values =  $12.294 > 1.96$ ) are significant and supported *H1–H3*. The analysis results of R-squared show that the variance level of the lecturer’s trust model is acceptable (63.6%) at a 95% confidence interval. This means that other factors explained a 36.4% (100%–63.6%) variance of the dependent variable.

*Partial least squares–multiple group analysis*

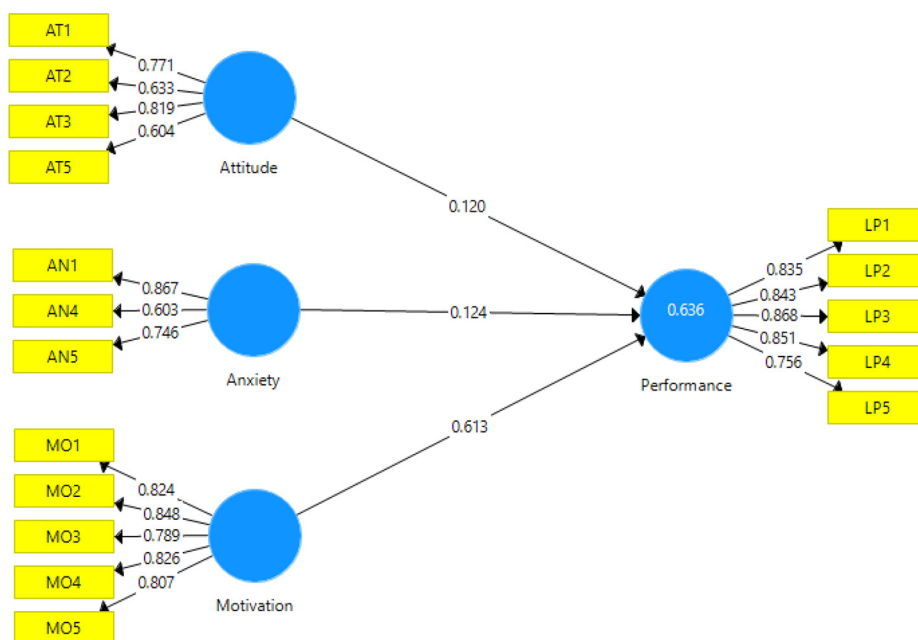
This study investigated the moderating effects of gender on the relationship between learning attitude, anxiety and motivation on WBL performance. The findings indicated that male and female students did not show significantly different factors. However, the results of separate analyses on men and women indicated potentials for a moderating effect to persist although these potentials were not significant.

**Discussion**

The current study results provide a model for understanding students’ performance in WBL during and after the COVID-19 pandemic. The research results showed that learning attitude influenced students’ performance in WBL. The research results are relevant to previous studies that attitude is a crucial factor influencing students’ performance in online learning (Kaid Mohammed Ali and Rashad Ali Bin-Hady, 2019; Rahayu, 2018; Wu *et al.*, 2019; Tseng and Chen, 2020; Malanchini *et al.*, 2020; Bai, 2020). The analysis results showed

**Table 4.**  
Cross-loading  
indicators of latent  
variables

Indicators	Anxiety	Attitude	Motivation	Learning performance
AN1	<b>0.867</b>	0.699	0.662	0.631
AN4	<b>0.602</b>	0.354	0.409	0.291
AN5	<b>0.746</b>	0.460	0.448	0.391
AT1	0.453	<b>0.771</b>	0.544	0.510
AT2	0.460	<b>0.632</b>	0.462	0.346
AT3	0.694	<b>0.819</b>	0.641	0.570
AT5	0.388	<b>0.604</b>	0.381	0.365
MO1	0.559	0.570	<b>0.750</b>	0.614
MO2	0.541	0.523	<b>0.759</b>	0.548
MO3	0.602	0.552	<b>0.825</b>	0.636
MO4	0.561	0.609	<b>0.844</b>	0.663
MO5	0.510	0.497	<b>0.764</b>	0.540
MO6	0.544	0.616	<b>0.798</b>	0.690
MO7	0.567	0.626	<b>0.793</b>	0.659
LP1	0.581	0.579	0.673	<b>0.832</b>
LP2	0.479	0.503	0.619	<b>0.843</b>
LP3	0.512	0.524	0.668	<b>0.867</b>
LP4	0.515	0.532	0.715	<b>0.852</b>
LP5	0.517	0.543	0.601	<b>0.759</b>



**Figure 2.**  
SEM analysis

that students' enthusiasm during WBL has played an essential role in influencing learning performance attitudes. Moreover, the research confirms that WBL is a suitable learning method during the COVID-19 pandemic.

The research results showed that learning anxiety influenced students' performance in WBL. The results of this study are relevant to those of a previous study that 30% of students have experienced anxiety during online web learning (Saadé *et al.*, 2017). Moreover, previous studies confirm that anxiety can affect learning performance (Heckel and Ringeisen, 2019; England *et al.*, 2019; Malanchini *et al.*, 2020; Ritonga *et al.*, 2020). Online learning positively reduces students' anxiety (Kaid Mohammed Ali and Rashad Ali Bin-Hady, 2019). This study discovered that self-confidence, good communication when learning online and the absence of nervousness when learning online were essential indicators of the results of investigating the learning anxiety.

Interests in course contents, lecturers' delivery methods, good relationships with friends and the desire to do assignments during online learning played an important role in motivating students during WBL. The motivation was an essential factor in this study and had the most vital relationship to learning performance. The results of this study agree with those of previous studies (Bai, 2020; Ritonga *et al.*, 2020). Another study states that students' learning performance is related to their learning motivation in which students' higher learning motivation will create better learning performance (Rafique *et al.*, 2021). Motivation is essential in students' academic performance because it helps them determine, consider, assess, try and show interest in assignments (Leenknecht *et al.*, 2021). The results of this study are also relevant to those of previous studies that students are motivated to choose online learning when they interact with other students and good lecturers (Vanslambrouck *et al.*, 2018).

This study suggests decision-makers consider male and female perspectives before creating WBL performance. In general, the study discovered no significant difference between male and female students' perspectives. This finding is relevant to those of previous studies. This study found no significant difference between male and female students' perspectives and readiness towards online learning (Kaid Mohammed Ali and Rashad Ali Bin-Hady, 2019). Men likely had higher learning attitudes, anxiety and motivation than women towards WBL performance. Another previous study deployed that the gender factor had a significant dependence on respondents' attitudes towards online learning (Peytcheva-Forsyth *et al.*, 2018). Male students have higher readiness than female students (Rafique *et al.*, 2021). This study found that although both genders had equal opportunities in WBL, female students required more understanding to have a better attitude and motivation towards WBL. Meanwhile, men were expected to reduce the level of anxiety in WBL. This condition is different from the previous research results confirming that female students are more anxious in online learning than boys (Saadé *et al.*, 2017). The research results informed that men experienced the anxiety of WBL and communication with lecturers.

#### *Implications*

This study contributes to the literature aspects and provides better knowledge about the concept of performance WBL in technical education concerning attitude, anxiety and motivation factors. Moreover, this study pays attention to different characteristics and strategies for students by considering genders. This study more deeply investigated indicators or items constructing factors. The results suggest that excellent relationships and communication between students and lecturers during online learning are necessarily improved because they affect students' performance in WBL. Independent learning and critical thinking abilities are indicators that significantly improve the performance of WBL during the COVID-19 pandemic.

Furthermore, this study has practical implications for lecturers and instructional designers to pay attention to students' characteristics to design and choose proper methods and strategies for WBL. The blended learning method and strategy is a preferable solution by students and can sustain WBL in the future. Blended learning can also become a solution to reduce students' anxiety. Thus, the effective web-based teaching and learning practices of students and lecturers in the engineering education department continuously increase.

*Limitations and future research.* This research limited the investigation on students majoring in engineering education at one university in Indonesia. The results may have been different if this study had involved more students and lecturers from diverse departments, faculties and universities as well as teachers and students at schools. Moreover, this study did not map the participants' sample areas. The discussion would have been much broader if this study had mapped rural or urban areas. In addition, this research lays the foundation for future research to conduct several actions as follows:

- design WBL for higher education;
- form a blended learning team;
- collaborating with lecturers and students' content;
- deal with psychological anxiety, attitudes and self-confidence;
- handling students' motivation; and
- continuously improving students' online learning performance and satisfaction.

Future research can also focus on differences in WBL performance between school and college students. Finally, cross-provincial studies in Indonesia and cross-national studies in Asia can reveal whether the attitude, anxiety, motivation and other factors of students from different cultures influence them to choose an online learning mode.

## Conclusions

This study revealed positive and significant relationships between the performance of WBL and the three factors of attitude, anxiety and motivation. Motivation played the most essential role in WBL performance. Meanwhile, gender did not show significant differences in WBL performance. The findings clearly stated that attitude, anxiety and motivation were accepted. These values reflected a need for improving this area and students' performance in WBL during the COVID-19 pandemic. Students' enthusiasm and self-confidence as well as lecturers' presentation, and course content delivery were essential indicators that the three factors contributed to students' performance in WBL.

Meanwhile, critical thinking skills and independent learning were performance indicators that played an essential role in WBL. However, future learning requires improvement. Thus, future learning is expected to apply a blended learning system. Finally, good relations and communication between students and teachers during learning are necessarily improved to support WBL. Thus, the WBL approach is the right learning method for students during and after the COVID-19 pandemic.

## References

- Ajmal, M. and Ahmad, S. (2019), "Exploration of anxiety factors among students of distance learning: a case study of Allama Iqbal open university", *Bulletin of Education and Research*, Vol. 41 No. 2, pp. 67-78, available at: [http://pu.edu.pk/home/journal/32/V41\\_2\\_2019.html](http://pu.edu.pk/home/journal/32/V41_2_2019.html)
- Al-Kumaim, N.H., Alhazmi, A.K., Mohammed, F., Gazem, N.A., Shabbir, M.S. and Fazea, Y. (2021), "Exploring the impact of the COVID-19 pandemic on university students' learning life: an integrated conceptual motivational model for sustainable and healthy online learning", *Sustainability*, Vol. 13 No. 5, p. 2546, doi: [10.3390/su13052546](https://doi.org/10.3390/su13052546).
- Astuti, L., Wihardi, Y. and Rochintaniawati, D. (2020), "The development of web-based learning using interactive media for science learning on levers in human body topic", *Journal of Science Learning*, Vol. 3 No. 2, pp. 89-98, doi: [10.17509/jsl.v3i2.19366](https://doi.org/10.17509/jsl.v3i2.19366).
- Bai, Y. (2020), "The relationship of test takers' learning motivation, attitudes towards the actual test use and test performance of the college English test in China", *Language Testing in Asia*, Vol. 10 No. 1, p. 10, doi: [10.1186/s40468-020-00108-z](https://doi.org/10.1186/s40468-020-00108-z).
- Baloran, E.T. (2020), "Knowledge, attitudes, anxiety, and coping strategies of students during COVID-19 pandemic", *Journal of Loss and Trauma*, Vol. 25 No. 8, pp. 635-642, doi: [10.1080/15325024.2020.1769300](https://doi.org/10.1080/15325024.2020.1769300).
- Barclay, D., Higgins, C. and Thompson, R. (1995), "The partial least square (PLS) approach to causal modeling: Personal computer adoption and use as an illustration", *Technol. Stud*, Vol. 2 No. 2, p. 2.
- Basith, A., Rosmayadi, R., Triani, S.N. and Fitri, F. (2020), "Investigation of online learning satisfaction during COVID 19: in relation to academic achievement", *Journal of Educational Science and Technology (Est)*, doi: [10.26858/est.v1i1.14803](https://doi.org/10.26858/est.v1i1.14803).
- Behforouz, B., Al Gaithi, A. and Fekri, N. (2021), "Omani EFL learner perceptions and motivation toward online learning", *Journal of University Teaching and Learning Practice*, Vol. 18 No. 4, pp. 169-183, doi: [10.53761/1.18.4.13](https://doi.org/10.53761/1.18.4.13).

- Benitez, J., Henseler, J., Castillo, A. and Schuberth, F. (2020), "How to perform and report an impactful analysis using partial least squares: Guidelines for confirmatory and explanatory is research", *Information and Management*, Vol. 57 No. 2, pp. 103-168, doi: [10.1016/j.im.2019.05.003](https://doi.org/10.1016/j.im.2019.05.003).
- Bhuvananeswari, S.S.B. and Dharanipriya, A. (2020), "Attitude of UG students towards e-learning", *International Academy of Science, Engineering and Technology*, Vol. 9 No. 2, pp. 35-40.
- Cahyana, U. and Supatmi, S. (2019), "The influence of web-based learning and learning independence toward student's scientific literacy in chemistry course", *International Journal of Instruction*, Vol. 12 No. 4, pp. 655-668, doi: [10.29333/iji.2019.12442a](https://doi.org/10.29333/iji.2019.12442a).
- Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P. and Lam, S. (2020), "COVID-19: 20 countries' higher education intra-period digital pedagogy responses", *Journal of Applied Learning and Teaching*, Vol. 3 No. 1, pp. 1-20, doi: [10.37074/jalt.2020.3.1.7](https://doi.org/10.37074/jalt.2020.3.1.7).
- Edwards, F. (2018), *The Relationship between College Student Attitudes towards Online Learning Based on Reading Self-Efficacy, Ethnicity, and Age*, United States: Liberty University.
- England, B.J., Brigati, J.R., Schussler, E.E. and Chen, M.M. (2019), "Student anxiety and perception of difficulty impact performance and persistence in introductory biology courses", *CBE—Life Sciences Education*, Vol. 18 No. 2, p. ar21, doi: [10.1187/cbe.17-12-0284](https://doi.org/10.1187/cbe.17-12-0284).
- Fornell, C. and Larcker, D.F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50.
- Gani, N.S., Fitriana, A.D., Sila, A.M., Fitriani, R., Yuliarti, A., Thalib, F., Hermansyah, B., Aslam, M., Sahid, M. and Umar, N.J. (2020), *Covid 19 Dalam Bingkai Komunikasi*, IAIN Parepare Nusantara Press.
- Ghozali, I. (2014), *Structural Equation Modeling Metode Alternatif Dengan Partial Least Square (PLS) Dilengkapi Software SmartPLS 3.00 Xistat 2014 Dan WarpPLS 4.0*, Edisi Ke-4. Semarang: Badan Penerbit Universitas Diponegoro Semarang.
- Grodotzki, J., Upadhya, S. and Tekkaya, A.E. (2021), "Engineering education amid a global pandemic", *Advances in Industrial and Manufacturing Engineering*, Vol. 3, p. 100058, doi: [10.1016/j.aime.2021.100058](https://doi.org/10.1016/j.aime.2021.100058).
- Hair, J. F. (Ed.) (2017), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, (Second edition). Sage.
- Hair, J.F., Anderson, R.E., Babin, B.J. and Black, W.C. (2010), *Multivariate Data Analysis: A Global Perspective*, Upper Saddle River, NJ: Pearson, Vol. 7.
- Hair, J.F., Jr, Matthews, L.M., Matthews, R.L. and Sarstedt, M. (2017), "PLS-SEM or CB-SEM: updated guidelines on which method to use", *International Journal of Multivariate Data Analysis*, Vol. 1 No. 2, p. 107, doi: [10.1504/ijmda.2017.10008574](https://doi.org/10.1504/ijmda.2017.10008574).
- Hamzah, N., Ariffin, A. and Hamid, H. (2017), "Web-based learning environment based on students' needs", *IOP Conference Series: Materials Science and Engineering*, Vol. 226 No. 1, p. 012196, doi: [10.1088/1757-899X/226/1/012196](https://doi.org/10.1088/1757-899X/226/1/012196).
- Heckel, C. and Ringeisen, T. (2019), "Pride and anxiety in online learning environments: Achievement emotions as mediators between learners' characteristics and learning outcomes", *Journal of Computer Assisted Learning*, Vol. 35 No. 5, pp. 667-677, doi: [10.1111/jcal.12367](https://doi.org/10.1111/jcal.12367).
- Henseler, J. (2012), "PLS-MGA: a Non-Parametric approach to partial least squares-based multi-group", In *Challenges at the Interface of Data Analysis, Computer Science, and Optimization*, Springer Berlin Heidelberg, pp. 495-501, [10.1007/978-3-642-24466-7](https://doi.org/10.1007/978-3-642-24466-7).
- Hermanto, Y.B. and Srimulyani, V.A. (2021), "The challenges of online learning during the Covid-19 pandemic", *Jurnal Pendidikan Dan Pengajaran*, Vol. 54 No. 1, pp. 46-57, doi: [10.23887/jpp.v54i1.29703](https://doi.org/10.23887/jpp.v54i1.29703).
- Hodges, C., Moore, S., Lockee, B., Trust, T. and Bond, A. (2020), "The difference between emergency remote teaching and online learning", *Educause Review*, Vol. 27, pp. 1-12.

- Hong, K.-S., Lai, K.-W. and Holton, D. (2003), "Students' satisfaction and perceived learning with a web-based course", *Journal of Educational Technology and Society*, Vol. 6 No. 1, pp. 116-124.
- Irawan, A.W., Dwisona, D. and Lestari, M. (2020), "Psychological impacts of students on online learning during the pandemic COVID-19", *Konseli : Jurnal Bimbingan Dan Konseling (E-Journal)*, Vol. 7 No. 1, pp. 53-60, doi: [10.24042/kons.v7i1.6389](https://doi.org/10.24042/kons.v7i1.6389).
- Islam, S., Baharun, H., Muali, C., Ghufron, M.I., el Iq Bali, M., Wijaya, M. and Marzuki, I. (2018), "To boost students' motivation and achievement through blended learning", *Journal of Physics: Conference Series*, Vol. 1114 No. 1, p. 012046.
- Kaid Mohammed Ali, J. and Rashad Ali Bin-Hady, W. (2019), "A study of EFL students' attitudes, motivation and anxiety towards WhatsApp as a language learning tool", *Arab World English Journal*, Vol. 5 No. 5, pp. 289-298, doi: [10.24093/awej/call5.19](https://doi.org/10.24093/awej/call5.19).
- Ketchen, D.J. (2013), "A primer on partial least squares structural equation modeling", *Long Range Planning*, Vol. 46 Nos 1/2, doi: [10.1016/j.lrp.2013.01.002](https://doi.org/10.1016/j.lrp.2013.01.002).
- Khawar, M.B., Abbasi, M.H., Hussain, S., Riaz, M., Rafiq, M., Mehmood, R., Sheikh, N., Amaan, H.N., Fatima, S., Jabeen, F., Ahmad, Z. and Farooq, A. (2021), "Psychological impacts of COVID-19 and satisfaction from online classes: disturbance in daily routine and prevalence of depression, stress, and anxiety among students of Pakistan", *Heliyon*, Vol. 7 No. 5, p. e07030, doi: [10.1016/j.heliyon.2021.e07030](https://doi.org/10.1016/j.heliyon.2021.e07030).
- Law, K.M., Geng, S. and Li, T. (2019), "Student enrollment, motivation and learning performance in a blended learning environment: the mediating effects of social, teaching, and cognitive presence", *Computers and Education*, Vol. 136, pp. 1-12, doi: [10.1016/j.compedu.2019.02.021](https://doi.org/10.1016/j.compedu.2019.02.021).
- Leenknecht, M., Wijnia, L., Köhler, M., Fryer, L., Rikers, R. and Loyens, S. (2021), "Formative assessment as practice: the role of students' motivation", *Assessment and Evaluation in Higher Education*, Vol. 46 No. 2, pp. 236-255, doi: [10.1080/02602938.2020.1765228](https://doi.org/10.1080/02602938.2020.1765228).
- Lin, Y.-R., Fan, B. and Xie, K. (2020), "The influence of a web-based learning environment on low achievers' science argumentation", *Computers and Education*, Vol. 151, p. 103860.
- McKimm, J. (2003), "ABC of learning and teaching: web based learning", *BMJ*, Vol. 326 No. 7394, pp. 870-873, doi: [10.1136/bmj.326.7394.870](https://doi.org/10.1136/bmj.326.7394.870).
- Malanchini, M., Rimfeld, K., Wang, Z., Petrill, S.A., Tucker-Drob, E.M., Plomin, R. and Kovas, Y. (2020), "Genetic factors underlie the association between anxiety, attitudes and performance in mathematics", *Translational Psychiatry*, Vol. 10 No. 1, p. 12, doi: [10.1038/s41398-020-0711-3](https://doi.org/10.1038/s41398-020-0711-3).
- Male, H., Murniarti, E., Simatupang, M.S., Siregar, J., Sihotang, H. and Gunawan, R. (2020), "Attitude of undergraduate student's towards online learning during Covid-19 pandemic. Palarch's", *Journal of Archaeology of Egypt/Egyptology*, Vol. 17 No. 4, pp. 1628-1637.
- Mehmetoglu, M. (2021), *Structural Equation Modelling with Partial Least Squares Using Stata and R*, CRC Press.
- Na, K.S., Petsangsri, S. and Tasir, Z. (2020), "The relationship between academic performance and motivation level in e-Learning among Thailand university students", *International Journal of Information and Education Technology*, Vol. 10 No. 3, p. 184, doi: [10.18178/ijiet.2020.10.3.1360](https://doi.org/10.18178/ijiet.2020.10.3.1360).
- Nunnally, B. and Bernstein, I.R. (1994), *Psychometric Theory*, Oxford University Press.
- Padmo, D., Ardiasih, L.S. and Idrus, O. (2020), *Online Learning during the Covid-19 Pandemic and Its Effect on Future Education in Indonesia*, pp. 71-86, doi: [10.51432/978-1-8381524-0-6\\_5](https://doi.org/10.51432/978-1-8381524-0-6_5).
- Patricia Aguilera-Hermida, A. (2020), "College students' use and acceptance of emergency online learning due to COVID-19", *International Journal of Educational Research Open*, Vol. 1, p. 100011, doi: [10.1016/j.ijedro.2020.100011](https://doi.org/10.1016/j.ijedro.2020.100011).
- Peytcheva-Forsyth, R. Yovkova, B. and Aleksieva, L. (2018), "Factors affecting students' attitudes towards online learning – the case of Sofia university", 020025. [10.1063/1.5082043](https://doi.org/10.1063/1.5082043)

- Puspitaningrum, N.P.D., Prodjosantoso, A.K. and Pulungan, D.A. (2021), "Comparison of regarding students' learning motivation by gender during the online learning", *6th International Seminar on Science Education (ISSE 2020)*, Yogyakarta, Indonesia, doi: [10.2991/assehr.k.210326.042](https://doi.org/10.2991/assehr.k.210326.042)
- Rafique, G.M., Mahmood, K., Warraich, N.F. and Rehman, S.U. (2021), "Readiness for online learning during COVID-19 pandemic: a survey of Pakistani LIS students", *The Journal of Academic Librarianship*, Vol. 47 No. 3, p. 102346, doi: [10.1016/j.acalib.2021.102346](https://doi.org/10.1016/j.acalib.2021.102346).
- Rahayu, K.P. (2018), "Pengaruh web based learning terhadap hasil belajar ditinjau dari Self-Directed learning", *SAP (Susunan Artikel Pendidikan)*, Vol. 2 No. 3, doi: [10.30998/sap.v2i3.2450](https://doi.org/10.30998/sap.v2i3.2450).
- Raheem, B.R. and Khan, M.A. (2020), "The role of E-learning in Covid-19 crisis", Vol. 8 No. 3, p. 5.
- Rasheed, R.A., Kamsin, A. and Abdullah, N.A. (2020), "Challenges in the online component of blended learning: a systematic review", *Computers and Education*, Vol. 144, p. 103701, doi: [10.1016/j.compedu.2019.103701](https://doi.org/10.1016/j.compedu.2019.103701).
- Ringle, C.M., Sarstedt, M. and Straub, D.W. (2012), "Editor's comments: a critical look at the use of PLS-SEM in 'MIS quarterly'", *MIS Quarterly*, pp. iii-xiv, doi: [10.2307/41410402](https://doi.org/10.2307/41410402).
- Ritonga, S.N.A., Nasmilah, N. and Rahman, F. (2020), "The effect of motivation and anxiety on students' speaking performance: a study at Dayanu Ikhsanuddin university", *ELS Journal on Interdisciplinary Studies in Humanities*, Vol. 3 No. 2, pp. 198-213, doi: [10.34050/els-jish.v3i2.10263](https://doi.org/10.34050/els-jish.v3i2.10263).
- Saadé, G.R., Kira, D., Mak, T. and Nebebe, F. (2017), "Anxiety and performance in online learning", 147-157, doi: [10.28945/3736](https://doi.org/10.28945/3736)
- Tseng, C.-J. and Chen, T.-C. (2020), "Impact of Web-Based teaching on the learning performance of education and training in the service industry during COVID-19", *Contemporary Educational Technology*, Vol. 12 No. 2 p. ep277, doi: [10.30935/cedtech/8581](https://doi.org/10.30935/cedtech/8581).
- Unger, S. and Meiran, W.R. (2020), "Student attitudes towards online education during the COVID-19 viral outbreak of 2020: Distance learning in a time of social distance", *International Journal of Technology in Education and Science (Science)*, Vol. 4 No. 4, pp. 256-266, doi: [10.46328/ijtes.v4i4.107](https://doi.org/10.46328/ijtes.v4i4.107).
- Valverde-Berrocoso, J., Garrido-Arroyo, M., del C., Burgos-Videla, C. and Morales-Cevallos, M.B. (2020), "Trends in educational research about e-learning: a systematic literature review (2009–2018)", *Sustainability*, Vol. 12 No. 12, p. 5153, doi: [10.3390/su12125153](https://doi.org/10.3390/su12125153).
- van Twillert, A., Kreijns, K., Vermeulen, M. and Evers, A. (2020), "Teachers' beliefs to integrate web 2.0 technology in their pedagogy and their influence on attitude, perceived norms, and perceived behavior control", *International Journal of Educational Research Open*, Vol. 1, p. 100014, doi: [10.1016/j.ijedro.2020.100014](https://doi.org/10.1016/j.ijedro.2020.100014).
- Vanslambrouck, S., Zhu, C., Lombaerts, K., Philipsen, B. and Tondeur, J. (2018), "Students' motivation and subjective task value of participating in online and blended learning environments", *The Internet and Higher Education*, Vol. 36, pp. 33-40, doi: [10.1016/j.iheduc.2017.09.002](https://doi.org/10.1016/j.iheduc.2017.09.002).
- Wijaya, T.T., Ying, Z., Purnama, A. and Hermita, N. (2020), "Indonesian students' learning attitude towards online learning during the coronavirus pandemic", *Psychology, Evaluation, and Technology in Educational Research*, Vol. 3 No. 1, pp. 17-25, doi: [10.33292/petier.v3i1.56](https://doi.org/10.33292/petier.v3i1.56).
- Wu, W., Chen, L., Yang, Q. and Li, Y. (2019), "Inferring students' personality from their communication behavior in web-based learning systems", *International Journal of Artificial Intelligence in Education*, Vol. 29 No. 2, pp. 189-216, doi: [0.1007/s40593-018-00173-9](https://doi.org/0.1007/s40593-018-00173-9).
- Yamamura, E. and Tsustsui, Y. (2021), "Correction to: the impact of closing schools on working from home during the COVID-19 pandemic: evidence using panel data from Japan", *Review of Economics of the Household*, Vol. 19 No. 1, pp. 61-62, doi: [10.1007/s11150-021-09548-9](https://doi.org/10.1007/s11150-021-09548-9).

---

Zhang, X. (2020), "Exploring university teachers' self-directed use of web-based learning in complementing students' needs: a case study", *Interactive Learning Environments*, pp. 1-11, doi: [10.1080/10494820.2020.1839508](https://doi.org/10.1080/10494820.2020.1839508).

Zhu, Y., Zhang, J.H., Au, W. and Yates, G. (2020), "University students' online learning attitudes and continuous intention to undertake online courses: a self-regulated learning perspective", *Educational Technology Research and Development*, Vol. 68 No. 3, pp. 1485-1519, doi: [10.1007/s11423-020-09753-w](https://doi.org/10.1007/s11423-020-09753-w).

### Further reading

Poon, W., Lock-Teng Low, K. and Gun-Fie Yong, D. (2004), "A study of web-based learning (WBL) environment in Malaysia", *International Journal of Educational Management*, Vol. 18 No. 6, pp. 374-385, doi: [10.1108/09513540410554031](https://doi.org/10.1108/09513540410554031).

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