

The Impact of E-Learning Practices and Assessment Competency on Academic Performance: A Structural Equation Modeling Approach

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ABSTRACT

E-learning has become an essential component of higher education, yet its contribution to academic performance depends not only on digital learning practices but also on students' assessment competency. This study examined the effects of e-learning practices, assessment knowledge, assessment skills, and attitudes toward assessment on undergraduate students' academic performance. A quantitative correlational survey design was employed involving 440 undergraduate students from four teacher education programs at Pattimura University, Indonesia. Data were collected using a structured questionnaire measuring e-learning practices and three dimensions of assessment competency: knowledge, skills, and attitudes. Students' academic performance was measured using Grade Point Average (GPA). The data were analyzed using Structural Equation Modeling to evaluate the measurement model and test the hypothesized relationships among variables. The findings showed that e-learning practices had a positive and significant effect on academic performance. Assessment knowledge, assessment skills, and attitudes toward assessment also significantly predicted students' GPA. The measurement model demonstrated acceptable reliability and convergent validity, indicating that the indicators adequately represented the proposed constructs. The structural model confirmed that both digital learning practices and assessment competency contributed to students' academic achievement. These findings suggest that effective e-learning implementation should be supported by students' ability to understand assessment criteria, use feedback, and develop positive attitudes toward assessment. Universities should strengthen digital learning systems while integrating assessment literacy into teaching and learning practices. The study provides empirical evidence for improving technology-supported learning in higher education, particularly in developing contexts where e-learning quality and assessment capacity remain uneven.

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1. INTRODUCTION

Digital transformation has reshaped higher education by expanding access to learning resources, enabling flexible instruction, and supporting more interactive forms of academic engagement. E-learning has become especially important in contexts where universities must respond to geographic barriers, infrastructure limitations, and the growing demand for flexible learning environments. Through learning management systems, digital content, online discussions, and multimedia-based instruction, e-learning allows students to access course materials beyond the limits of time and place. Previous studies have shown that e-learning can support student engagement, learning autonomy, and academic achievement when it is designed around meaningful interaction, timely feedback, and pedagogically sound learning activities (Abdullah et al., 2023; Gumantan et al., 2021; Malkawi, 2022; Villesseche et al., 2019).

The rapid expansion of e-learning during and after the COVID-19 pandemic has also revealed that technology alone does not guarantee better learning outcomes. The effectiveness of e-learning depends on several interconnected factors, including students' digital readiness, lecturers' pedagogical competence, the quality of online platforms, internet accessibility, and the extent to which online learning is integrated with appropriate assessment practices. Yahiaoui et al. (2022) found that students' motivation and familiarity with technology significantly shaped their participation in online learning environments. Similarly, studies in developing-country contexts indicate that limited infrastructure, unequal access to devices, and insufficient digital literacy can reduce the effectiveness of e-learning implementation (Daud et al., 2022; Njambi & Mayoka, 2021; Van der Merwe et al., 2023; Zarei & Mohammadi, 2022). These findings suggest that e-learning should be understood not merely as the use of digital platforms, but as a broader instructional system that requires technological, pedagogical, and evaluative support.

In higher education, e-learning has been associated with improved academic performance when it is combined with active learning strategies and effective instructional design. For example, online and blended learning environments can increase students' access to learning materials, support self-paced learning, and provide opportunities for repeated practice and feedback (Krishan et al., 2023; Purnama et al., 2023; Wong & Lim, 2023). However, other studies have emphasized that the impact of e-learning is not uniform across institutions or disciplines. Che Hussin et al. (2022) reported that interactive learning elements are necessary to strengthen students' academic achievement, particularly in subjects requiring conceptual understanding and problem-solving. Likewise, Zuber and Sulaiman (2019) argued that students' perceptions of system quality and learning experience influence the effectiveness of e-learning. Therefore, the relationship between e-learning and academic achievement needs to be examined alongside other educational factors that shape how students engage with learning tasks.

One critical factor that complements e-learning is assessment competency. In digital and blended learning environments, assessment is not only a mechanism for measuring achievement but also a process that guides learning, provides feedback, and helps students monitor their progress. Assessment competency generally includes knowledge of assessment principles, skills in applying assessment strategies, and attitudes toward assessment as part of learning improvement. Students who understand assessment criteria, interpret feedback effectively, and develop positive attitudes toward evaluation are more likely to use assessment information to improve their performance. Prior research has emphasized that assessment literacy and e-assessment practices can strengthen learning outcomes by making feedback more timely, relevant, and actionable (Amien & Hidayatullah, 2023; Martha et al., 2021; Sagala et al., 2022). In this sense, assessment competency is closely connected to students' capacity for self-regulated learning, particularly in online environments where learners are expected to take greater responsibility for their academic progress.

The integration of e-learning and assessment competency is especially important in Indonesian higher education. Universities in Indonesia have increasingly adopted digital learning systems, yet

implementation remains uneven due to differences in institutional readiness, lecturer training, internet connectivity, and students' access to technological resources. Research has shown that Indonesian students and lecturers are generally open to e-learning, but successful implementation requires continuous support, digital skills development, and reliable learning infrastructure (Martha et al., 2021; Owen et al., 2020; Solichin & Wijaya, 2021). These conditions are highly relevant for universities located outside major urban centers, where digital transformation may face additional challenges related to infrastructure and institutional capacity. Consequently, empirical studies situated in specific local contexts are needed to understand how e-learning practices and assessment-related competencies contribute to student achievement.

Although previous studies have examined the relationship between e-learning and academic performance, fewer have investigated how e-learning practices operate together with assessment competency in shaping students' academic outcomes. Many studies focus primarily on technological acceptance, learning motivation, or platform quality, while the role of assessment knowledge, assessment skills, and attitudes toward assessment receives less attention. This gap is important because e-learning environments often require students to engage with digital quizzes, online assignments, feedback systems, rubrics, and self-assessment activities. Without sufficient assessment competency, students may not fully benefit from the feedback and learning opportunities offered through digital platforms. Thus, examining e-learning and assessment competency in a single model can provide a more comprehensive understanding of factors that influence academic performance.

Based on this background, the present study investigates the effects of e-learning practices and assessment competency on undergraduate students' academic performance at Pattimura University, Indonesia. Assessment competency is examined through three dimensions: assessment knowledge, assessment skills, and attitudes toward assessment. Academic performance is measured using students' Grade Point Average (GPA). By applying a structural equation modeling approach, this study aims to analyze the direct contributions of e-learning practices and assessment competency dimensions to academic achievement. The findings are expected to provide empirical evidence for improving digital learning implementation and strengthening assessment literacy in higher education, particularly in developing-country contexts where institutional resources and technological readiness may vary substantially.

2. METHODS

2.1 Research Design

This study employed a quantitative research design with a correlational survey approach. This design was selected because the study aimed to examine the relationships and predictive effects among e-learning practices, assessment competency, and students' academic performance. A quantitative approach enabled the researcher to measure the constructs systematically using numerical data and to analyze the relationships among variables through inferential statistical procedures. Specifically, Structural Equation Modeling (SEM) was used because the proposed model involved several latent constructs measured by multiple indicators and required simultaneous testing of the direct effects among variables.

2.2 Research Site and Participants

The study was conducted at Pattimura University, Ambon, Indonesia. This university was selected because it has implemented e-learning systems in undergraduate teaching and learning activities, particularly in teacher education programs. The target population consisted of undergraduate students from four teacher education programs: Geography Education, History Education, Economics Education,

and Pancasila and Civic Education. These programs were selected because they had actively used e-learning platforms in their courses and were considered relevant to the focus of the study.

A total of 440 undergraduate students participated in the study. The sample was selected using stratified random sampling to ensure proportional representation from each study program. This sampling technique was considered appropriate because the population consisted of several academic programs with different numbers of students. The sample size was also considered adequate for SEM analysis, as it provided sufficient statistical power to estimate the relationships among the latent constructs in the proposed model.

2.3 Research Variables

The study consisted of four independent variables and one dependent variable. The independent variables were e-learning practices, assessment knowledge, assessment skills, and attitudes toward assessment. E-learning practices referred to students' experiences in using online learning platforms, including frequency of use, access to learning materials, interaction with lecturers, and perceived quality of online learning activities.

Assessment knowledge refers to students' understanding of the purposes, criteria, procedures, and functions of assessment in the learning process. Assessment skills refer to students' ability to understand assessment rubrics, interpret feedback, reflect on learning results, and use assessment information to improve their academic performance. Attitudes toward assessment referred to students' perceptions, acceptance, and readiness to use assessment as part of learning improvement. The dependent variable was students' academic performance, measured using Grade Point Average (GPA) based on official academic records or verified academic data.

2.4 Research Instrument

Data were collected using a structured questionnaire developed based on relevant theoretical concepts and instruments used in previous studies on e-learning, assessment literacy, and academic performance. The questionnaire used a five-point Likert scale ranging from 1, indicating "strongly disagree," to 5, indicating "strongly agree."

The instrument included several items representing each research construct. E-learning practices were measured using four indicators. Assessment knowledge, assessment skills, and attitudes toward assessment were each measured using three indicators. The academic performance variable was measured using students' GPA. Before being used in the main data collection, the questionnaire was reviewed to ensure that all items were relevant to the context of higher education and understandable for undergraduate students.

2.5 Validity and Reliability Testing

A pilot study was conducted with 30 students who had similar characteristics to the main respondents but were not included in the final sample. The pilot test aimed to examine item clarity, contextual suitability, and the consistency of students' responses. Based on the pilot results, minor revisions were made to improve the wording of several items.

The reliability of the instrument was examined using Cronbach's alpha, with a minimum acceptable value of 0.70. In the SEM analysis, the measurement model was further evaluated using factor loadings, Composite Reliability (CR), and Average Variance Extracted (AVE). Indicators were considered acceptable when their factor loadings exceeded 0.70. Convergent validity was established when the AVE value was greater than 0.50, while construct reliability was supported when Cronbach's alpha and CR values exceeded 0.70. Discriminant validity was also examined to ensure that each construct was empirically distinct from the others, using the Fornell-Larcker criterion or the Heterotrait-Monotrait Ratio (HTMT).

2.6 Data Collection Procedure

The data collection process was carried out after obtaining permission from the relevant academic authorities. Participants were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of their responses. Students who agreed to participate completed the questionnaire either in printed form or through an online survey format, depending on accessibility and course arrangements.

The completed questionnaires were screened before analysis to identify incomplete responses or response patterns that could affect data quality. Only valid and complete responses were included in the final dataset. Academic performance data were collected in the form of GPAs and verified in accordance with the university's academic reporting system.

2.7 Data Analysis

Data analysis was conducted in several stages. First, descriptive statistics were used to summarize the data, including the mean, median, standard deviation, minimum score, and maximum score for each variable. This analysis provided an overview of students' perceptions of e-learning practices, assessment knowledge, assessment skills, attitudes toward assessment, and academic performance.

Second, the measurement model was evaluated to determine the validity and reliability of the constructs. This stage involved examining factor loadings, Cronbach's alpha, Composite Reliability, AVE, and discriminant validity. The purpose of this stage was to ensure that the indicators accurately represented their respective latent constructs.

Third, the structural model was assessed to test the proposed hypotheses. The direct effects of e-learning practices, assessment knowledge, assessment skills, and attitudes toward assessment on academic performance were examined using path coefficients, t-statistics, p-values, and confidence intervals generated through the bootstrapping procedure. A relationship was considered statistically significant when the p-value was below 0.05. The model was also evaluated using R-square values to determine the proportion of variance in academic performance explained by the independent variables. Effect size values were examined to assess the relative contribution of each predictor to the structural model.

2.8 Ethical Considerations

This study followed ethical principles for educational research. Participation was voluntary, and all respondents were informed that they could withdraw from the study at any time without academic consequences. The confidentiality and anonymity of respondents were maintained throughout the research process. No personal identifiers were reported in the findings, and all collected data were used only for academic purposes. Informed consent was obtained before students completed the questionnaire.

3. FINDINGS AND DISCUSSION

3.1 Findings

The purpose of this study is to assess how well students' academic achievement is improved by e-learning practices, assessment knowledge, assessment skills, and attitudes toward assessment. To achieve this, researchers used a Structural Equation Modeling (SEM) approach, making use of SmartPLS software's capabilities, guaranteeing a thorough examination of the correlations between the model's variables. For examining and simulating intricate interactions between latent and measured variables, SEM is a useful statistical technique. It offers a strong analytical foundation for comprehending how factors interact in a learning environment.

3.1.1 Descriptive Statistical Analysis

Descriptive statistical analysis describes the essential characteristics of the data collected, providing an understanding of the profile of respondents and the distribution of critical variables.

Table 1. Descriptive Statistics for Key Variables

Variables	Code	N	Mean	Median	Standard Deviation	Minimum	Maximum
E-learning Practice	PEL	440	4.12	4.20	0.68	2.00	5.00
Knowledge Assessment	PP	440	4.05	4.10	0.65	2.10	5.00
Assessment Skills	KP	440	4.00	4.05	0.70	2.00	5.00
Attitude Toward Assessment	SP	440	4.08	4.15	0.67	2.50	5.00
Academic Achievement (GPA)	GPA	440	3.50	3.50	0.45	2.00	4.00

Descriptive data for the primary variables of this study – e-learning practices, academic performance (GPA), assessment knowledge, assessment abilities, and attitude toward assessment – are shown in Table 1. The mean score for e-learning practices, which came from 440 respondents, is 4.12, suggesting that students typically have a positive opinion of using e-learning. Students' high comprehension and attitude toward the assessment procedure were demonstrated by their assessment knowledge and attitude, which both had averages above 4, at 4.05 and 4.08, respectively. The assessment skills average of 4.00 indicated a comparatively good ability level. With a mean of 3.50 for academic success as determined by GPA, pupils demonstrated strong academic performance. The comparatively low standard deviation indicates consistency in student responses.

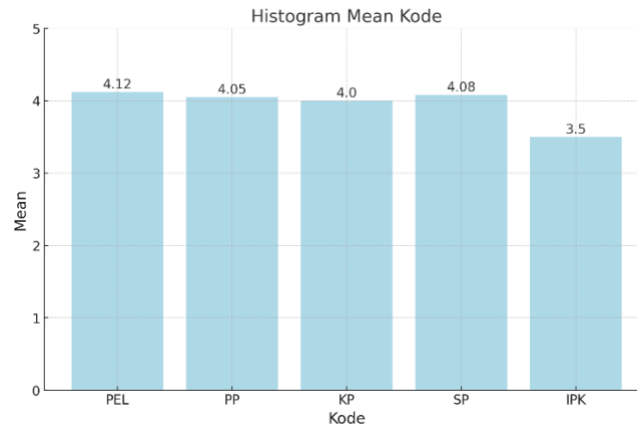


Figure 1. Bar Histogram of Mean Values of Descriptive Statistics for Main Variables

3.1.2 Multiple Regression Analysis

Multiple regression analysis was used to examine the influence of independent variables (e-learning practices, assessment knowledge, assessment skills, and attitude toward assessment) on the dependent variable (academic achievement).

Table 2. Multiple Regression Results

Free Variable	Path Coefficient	t-Value	p-Value	Significance
E-learning Practice (PEL)	0.35	2.85	< 0.01	Significant
Knowledge Assessment (PP)	0.28	2.14	< 0.05	Significant
Assessment Skills (KP)	0.30	2.50	< 0.05	Significant
Attitude Toward Assessment (SP)	0.33	2.80	< 0.01	Significant

The findings of a multiple regression analysis evaluating the effects of four independent variables on students' academic performance—e-learning practices (PEL), assessment knowledge (PP), assessment skills (KP), and attitude toward assessment (SP)—are shown in Table 2. With a path coefficient of 0.35, a t-value of 2.85, and a p-value < 0.01 , the analysis shows that e-learning practice (PEL) has the strongest effect, showing a statistically significant moderate-to-strong positive influence. Practically speaking, the result means that, when all other variables are held constant, the expected academic achievement score (such as GPA) will rise by 0.35 for every unit increase in the efficacy of e-learning techniques. This highlights how effectively designed e-learning platforms can significantly improve students' academic performance. With a path coefficient of 0.28, a t-value of 2.14, and a $p < 0.05$, assessment knowledge (PP) also contributes significantly, suggesting that students who have a deeper comprehension of assessment concepts typically perform better academically. With a coefficient of 0.30 and a t-value of 2.50, assessment skills (KP) also make a positive contribution, suggesting that students who are proficient in using assessment methods have a higher chance of academic success. Last but not least, a significant effect is shown by attitude toward assessment (SP), with a path coefficient of 0.33, a t-value of 2.80, and $p < 0.01$, indicating that students who have more positive attitudes toward assessment procedures typically perform better academically. These results collectively suggest that improving academic performance necessitates the cultivation of robust assessment skills and the integration of technology through e-learning. Each variable reinforces the role of a thorough, well-rounded learning experience that combines digital instruction with reflective and evaluative learning techniques, along with its independent contributions. These findings may be especially helpful for curriculum designers and university administrators looking to enhance learning processes in higher education.

3.1.3 Structural Equation Model Analysis (SEM)

Structural equation modeling (SEM) allows the exploration of more complex relationships between latent and measured variables. SEM is divided into two main parts: outer model and inner model evaluation.

The first step in SEM analysis is to evaluate the outer model or measurement model, which aims to ensure that the indicators used in this study are valid and reliable. Indicator validity is measured through the loading factor, which indicates how well an indicator reflects the measured construct. Construct reliability, on the other hand, is assessed through Cronbach's Alpha and Composite Reliability (CR), which measure the internal consistency of the indicators. Average Variance Extracted (AVE) is also calculated to ensure that the construct can explain most of the Variance of its indicators. The results of the outer model analysis are presented in Table 3.

Table 3 shows that all indicators used in this study have a loading factor above 0.7, which indicates good convergent validity. Convergent validity suggests that the indicators can accurately reflect the measured constructs. Cronbach's Alpha values above 0.7 for all constructs indicate internal solid reliability, meaning the indicators consistently measure the same construct. Composite Reliability (CR) is also above 0.7 for all constructs, confirming measurement consistency. In addition, Average Variance Extracted (AVE) values exceeding 0.5 indicate that more than half of the Variance of the indicators can be explained by the constructs, corroborating the convergent validity of the constructs.

With these indicators' good validity and reliability, the outer model can be considered solid and suitable for further analysis. The next step in SEM analysis is to evaluate the **inner** or structural model, which aims to test the hypothesis of the relationship between latent constructs in the context of student academic achievement.

Table 3. Outer Model (Measurement Model) - Convergent Validity and Reliability

Construct	No. of Items	Average Loading Factor	Cronbach's Alpha	Composite Reliability (CR)	AVE
E-learning Practice (PEL)	4	0.74	0.87	0.89	0.68
Knowledge Assessment (PP)	3	0.72	0.83	0.85	0.66
Assessment Skills (KP)	3	0.72	0.85	0.88	0.67
Attitude Toward Assessment (SP)	3	0.72	0.88	0.90	0.69

After the validity and reliability of the constructs were confirmed through the outer model analysis, the analysis continued on the inner model. The inner model evaluates the relationship between the latent constructs, specifically how variables such as E-learning Practices, Assessment Knowledge, Assessment Skills, and Attitude toward assessment affect students' Academic Achievement. This analysis aims to test the hypotheses proposed in the study, using path coefficients, t-values, and p-values to assess the statistical significance of the hypothesized relationships.

Table 4. Inner Model (Structural Model) - Hypothesis Testing

Hypothesis	Path	Path Coefficient	t-Value	p-Value	Results
H1	PEL -> Academic Achievement	0.35	2.85	< 0.01	Significant
H2	PP -> Academic Achievement	0.28	2.14	< 0.05	Significant
H3	KP -> Academic Achievement	0.30	2.50	< 0.05	Significant
H4	SP -> Academic Achievement	0.33	2.80	< 0.01	Significant

Table 4 shows the hypothesis testing results of the inner model. All the hypotheses proposed in this study proved statistically significant, as indicated by the p-value below 0.05. For example, E-learning Practice has a path coefficient of 0.35 on Academic Achievement, with a t-value of 2.85 and a p-value <0.01, indicating that an increase in E-learning Practice will significantly improve students' Academic Achievement. Similar results were also found for the other variables, where Assessment Knowledge, Assessment Skills, and Attitude Towards Assessment significantly influenced Academic Achievement.

The significance of these results underscores the importance of these elements in improving student learning outcomes. Effective E-learning practices, good assessment knowledge, strong assessment skills, and a positive attitude toward assessment contribute to better academic achievement and support the assumption that educational technology and good assessment competencies can significantly influence academic achievement.

Researchers actively perform a Goodness of Fit (GoF) assessment to determine how accurately the proposed model aligns with the collected data, ensuring the model effectively represents the observed relationships. This process involves analyzing key statistical indicators that measure the model's accuracy in representing the observed data. The goodness of Fit measures the model's overall Fit to the data and helps assess the model's validity in reflecting the observed reality. Some of the indicators used include Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA). The GoF evaluation results are presented in Table 5.

Table 5. Goodness of Fit (GoF) Indices

Fit Indicator	Value
GFI (Goodness of Fit Index)	0.95
CFI (Comparative Fit Index)	0.96
NFI (Normed Fit Index)	0.93
RMR (Root Mean Square Residual)	0.030
RMSEA (Root Mean Square Error of Approximation)	0.040

Table 5 shows that the proposed model fits well with the observed data. The Goodness of Fit Index (GFI) of 0.95 indicates that the model fits the collected data very well, where GFI values close to 1 indicate a perfect fit. The Comparative Fit Index (CFI) of 0.96 and Normed Fit Index (NFI) of 0.93 also indicate an excellent level of Fit, with values above 0.90 indicating a robust model. **The Root Mean Square Residual (RMR) of 0.030 indicates that the residual mean or difference between the observed value and the value predicted by the model is very small, which means the model successfully predicts results that are very similar to the actual data. The Root Mean Square Error of Approximation (RMSEA) value of 0.040 also indicates that the model fits well with the data. RMSEA values below 0.08 are generally considered to indicate good model fit.

Figure 2 illustrates the structural equation model (SEM) developed in this study, representing the relationships between the latent variables: e-learning practices (PEL), knowledge of assessment (PP), assessment skills (KP), and attitude toward assessment (SP), with students' academic achievement (GPA) as the dependent variable. The model demonstrates the direct pathways and standardized coefficients between constructs, indicating the strength and direction of influence. This visualization provides a comprehensive overview of how each dimension contributes to academic performance and supports the statistical findings presented in the inner model analysis.

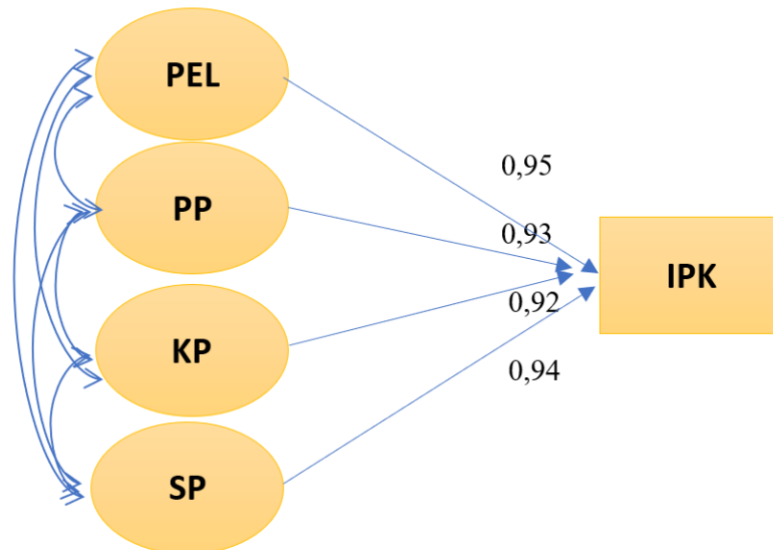


Figure 2. Structural Equation Model (SEM) for Study Variables Using Student Grades during Teaching Practice as Dependent Variable

Notes: * $p < 0.05$; PEL: E-learning practice; PP: Knowledge in assessment; KP: Skills in assessment; SP: Attitude in assessment; GPA: Grade Point Average (GPA)

Figure 2 presents the Structural Equation Model (SEM) that illustrates the relationships between the study's latent variables: e-learning practices (PEL), knowledge of assessment (PP), assessment skills (KP), and attitude toward assessment (SP), with academic performance—measured through student grades during teaching practice—serving as the dependent variable. The figure shows the standardized path coefficients that quantify the influence of each independent variable on academic achievement (GPA). All paths indicate positive and statistically significant relationships, confirming that improvements in each construct contribute meaningfully to higher academic outcomes. The double-headed arrows between exogenous variables reflect the intercorrelations among them, suggesting that these factors do not operate in isolation but are interconnected. The diagram also includes a residual term (d_1), representing the portion of GPA variance not explained by the included constructs. Overall, the model confirms that e-learning effectiveness and strong assessment competencies jointly enhance students' academic success during practical teaching experiences.

3.2 Discussion

The findings of this study indicate that e-learning practices, assessment knowledge, assessment skills, and attitudes toward assessment significantly contribute to students' academic performance. Overall, the results support the assumption that academic achievement in higher education is shaped not only by students' access to digital learning environments but also by their ability to understand and use assessment as part of the learning process. The positive effect of e-learning practices on GPA suggests that students who experience more effective online learning activities tend to demonstrate stronger academic performance. This finding is consistent with previous studies showing that e-learning can improve learning outcomes when it provides flexible access to learning resources, supports interaction, and allows students to manage their learning more independently (Abdullah et al., 2023; Gumantan et al., 2021; Malkawi, 2022).

The significant relationship between e-learning practices and academic performance also confirms that digital learning platforms can function as more than repositories of instructional materials. When implemented effectively, e-learning can create a learning environment that enables students to revisit course content, participate in online discussions, complete assignments, and receive feedback from lecturers. These features may help students regulate their learning pace and deepen their understanding of course concepts. This result aligns with Wong and Lim (2023), who found that e-learning positively influenced university students' academic performance, particularly when online learning was integrated with structured learning activities. Similarly, Krishan et al. (2023) emphasized that e-learning can increase students' motivation when it provides accessible, relevant, and engaging learning experiences.

However, the positive effect of e-learning should not be interpreted as evidence that technology alone improves academic achievement. The effectiveness of e-learning depends on the quality of instructional design, students' readiness, lecturer support, and institutional infrastructure. Previous research has shown that online learning is less effective when it is limited to content delivery without meaningful interaction, guidance, and feedback (Che Hussin et al., 2022; Yahiaoui et al., 2022). In the context of Indonesian higher education, this issue is particularly important because disparities in internet access, digital literacy, and institutional readiness continue to influence the quality of e-learning implementation (Daud et al., 2022; Owen et al., 2020; Solichin & Wijaya, 2021). Therefore, the present findings should be understood as support for pedagogically designed e-learning rather than for the mere adoption of digital platforms.

The study also found that assessment knowledge had a significant positive effect on students' academic performance. This result suggests that students who understand the purpose, criteria, and procedures of assessment are more likely to perform well academically. Assessment knowledge may help students interpret learning expectations, understand how their work is evaluated, and align their learning strategies with course outcomes. This finding is consistent with the concept of assessment literacy, which emphasizes that learners benefit when they understand assessment standards and use them to guide their

learning. In online and blended learning contexts, assessment knowledge becomes even more important because students often encounter digital quizzes, online assignments, rubrics, and automated or written feedback that require active interpretation (Amien & Hidayatullah, 2023; Martha et al., 2021).

Assessment skills were also found to significantly predict academic performance. This result indicates that students' ability to use assessment information, interpret feedback, reflect on their performance, and apply improvement strategies contributes to higher academic achievement. In practice, students with stronger assessment skills may be better able to identify weaknesses in their learning, revise their work, and prepare more effectively for future academic tasks. This finding supports previous research suggesting that assessment practices can improve learning outcomes when they are connected to feedback and self-regulated learning (Sagala et al., 2022; Widjaja et al., 2022). In e-learning environments, these skills are especially relevant because students are often expected to monitor their own progress and respond independently to feedback provided through digital platforms.

The significant contribution of attitudes toward assessment further shows that affective factors play an important role in academic achievement. Students who view assessment as useful, fair, and supportive of learning may be more willing to engage with feedback and improve their performance. Conversely, students who perceive assessment only as a source of pressure may not fully use assessment information for learning improvement. The present finding is consistent with studies indicating that positive attitudes toward learning and assessment can increase student engagement and academic outcomes (Annisa et al., 2020; Zuber & Sulaiman, 2019). In this study, attitudes toward assessment appear to function as an important motivational factor that supports students' willingness to participate in evaluative activities and use assessment results constructively.

Taken together, the findings demonstrate that e-learning and assessment competency are interrelated elements of effective learning. E-learning provides the digital environment in which learning activities occur, while assessment competency enables students to interpret expectations, use feedback, and improve their academic performance. This relationship is important because online learning requires students to become more autonomous and reflective. Without adequate assessment knowledge, skills, and attitudes, students may access digital materials but fail to use feedback and assessment criteria effectively. Therefore, improving academic performance requires an integrated approach that strengthens both the technological and evaluative dimensions of learning.

The SEM results provide empirical support for the proposed model. The positive and significant path coefficients indicate that each predictor contributes to academic performance. The measurement model also demonstrated acceptable reliability and convergent validity, suggesting that the indicators adequately represented the constructs under investigation. These findings support the use of SEM in educational research, particularly when examining multiple latent variables that interact within complex learning environments. As Van der Merwe et al. (2023) noted, e-learning implementation involves a range of interconnected factors, including technological, institutional, pedagogical, and learner-related dimensions. The use of SEM in the present study therefore provides a useful framework for understanding how these dimensions contribute to academic outcomes.

Despite these contributions, the findings should be interpreted with caution. First, the study was conducted at one university and involved students from four teacher education programs. Although the sample size was adequate, the results may not be fully generalizable to students from other universities, disciplines, or national contexts. Second, the study used a cross-sectional survey design, which limits the ability to establish causal relationships among variables. Although the model shows significant predictive relationships, it cannot confirm that e-learning practices or assessment competency directly cause improvements in GPA over time. Future studies should consider longitudinal designs to examine how changes in e-learning quality and assessment competency influence academic performance across semesters.

Third, the study relied partly on students' self-reported perceptions of e-learning practices and assessment competency. Self-report data may be influenced by social desirability, personal expectations, or students' subjective interpretations of their learning experiences. Future research could strengthen the evidence by combining survey data with learning analytics, lecturer assessments, interview data, classroom observations, or objective records of online learning activity. Such mixed-method approaches would provide a deeper understanding of how students actually engage with e-learning platforms and assessment feedback.

The findings have several practical implications for higher education institutions. Universities should not only invest in learning management systems but also ensure that e-learning platforms are used to support interaction, feedback, and active learning. Lecturers need professional development in designing online learning activities that are pedagogically meaningful and aligned with assessment criteria. In addition, students should receive explicit guidance on how to understand rubrics, interpret feedback, conduct self-assessment, and use assessment results to improve their learning. These strategies are particularly important in developing-country contexts, where technological infrastructure and digital readiness may vary across institutions and student groups (Njambi & Mayoka, 2021; Zarei & Mohammadi, 2022).

In conclusion, this study confirms that students' academic performance is influenced by both e-learning practices and assessment competency. Effective e-learning can support academic achievement, but its impact is strengthened when students possess the knowledge, skills, and attitudes needed to use assessment as a tool for learning improvement. The findings highlight the need for universities to integrate digital learning development with assessment literacy initiatives. By combining well-designed e-learning systems with stronger assessment competency, higher education institutions can create more supportive, reflective, and achievement-oriented learning environments.

4. CONCLUSIONS

This study concludes that e-learning practices and assessment competency play important roles in improving undergraduate students' academic performance. The findings show that effective e-learning practices have a positive effect on students' GPA, while assessment knowledge, assessment skills, and attitudes toward assessment also significantly contribute to academic achievement. These results indicate that students perform better when digital learning environments are supported by clear assessment understanding, the ability to use feedback, and positive perceptions of assessment as part of the learning process. However, this study has several limitations. It was conducted only at one university and involved students from selected teacher education programs, which may limit the generalizability of the findings to other institutions, disciplines, or educational contexts. In addition, the cross-sectional survey design does not allow strong causal conclusions, and the use of self-reported questionnaire data may be affected by response bias. Future research should involve broader and more diverse samples from multiple universities, apply longitudinal or mixed-method designs, and include objective data such as learning analytics, lecturer evaluations, or academic records to provide a deeper understanding of how e-learning practices and assessment competency influence students' academic performance over time.

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