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ANALYSIS LEARNING OUTCOMES OF MATHEMATICS EDUCATION STUDENT IN THE ONLINE LEARNING

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ABSTRACT

This research aims to look at the impact and learning outcomes of using LMS and online learning platforms, so it is necessary to analyze learning outcomes and how they impact students, lecturers, and learning organizing institutions. This research shows that the LMS and online learning platforms used can improve student learning outcomes, which cannot be separated from the readiness of lecturers and students to implement it. This research used factor analysis (CFA), with a total of 150 respondents, students, and 15 lecturers. The impact provided by the use of LMS and online platforms in online learning is in the form of GPA and students' views on the learning process they have gone through. From the research results, several findings were obtained, including the ability to use LMS in online learning is not optimal, the GPA of learning outcomes is relatively high, and the readiness of lecturers and students to use LMS in online learning is still low.

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1. INTRODUCTION

Numerous studies demonstrate that the different effects of COVID-19 require time to heal, taking over ten years to return to normal (Djalante et al., 2020; Naila & Khasna, 2021). Human interactions are becoming less frequent, which has a significant impact on daily living in many nations, including the Republic of Indonesia. The vast field of education, which includes everything from kindergarten to postsecondary education, is likewise impacted by this. The government has released a number of education-related policies, including prevention and handling in the classroom, prevention in educational settings, and education policies for when the corona virus disease-19 is an emergency (Ahmad et al., 2021; Suripah & Susanti, 2022).

Nearly every area in Indonesia has adopted the distant learning method. In the face of a pandemic, online instruction has been offered at all levels, from primary to postsecondary. Because of the circumstances, the parties involved in this case were forced

to adapt and carry out the distance learning process. Universities and schools were prohibited from conducting in-person instruction, but instead, the learning process was carried out by utilizing technological advancements made possible by the fourth industrial revolution. (Faozi et al., 2020; Hidayat, Rohaeti, et al., 2023). Both in-person and virtual learning are popular subjects of conversation. It's common for certain parties to compare the two learning systems and decide which works best for a given approach. In spite of the fact that both in-person and virtual learning have benefits and drawbacks, some people believe that virtual learning is superior to in-person instruction.

The face-to-face educational model has shifted from in-person to online during the current epidemic. Through online learning, large crowds and excessive student interaction are avoided, as these situations can result in the formation of COVID-19 chain transmission clusters. Online learning is a method of learning that makes use of informatics technology via internet applications. It is characterized by an open and flexible learning environment, an unlimited amount of time, and an unspecified location for the delivery of instructional materials (Hidayat et al., 2022; Kusumaningrum & Wijayanto, 2020). It is anticipated that the online learning process will provide a means of overcoming the constraints that have been identified thus far, which are the shortcomings of the traditional model learning method (Annur & Hermansyah, 2020).

There are two components to the online learning method: synchronous and asynchronous. While the learning process uses the asynchronous method, which involves the distribution of teaching materials but involves indirect learning interactions between educators and students, the synchronous method involves direct interaction between educators and students using audio and video with media that is connected to the internet network. by educators, including its distribution through online learning platforms that allow students to access these instructional resources at any time and from any location (Fadila et al., 2021; Pertiwi et al., 2021).

During the process, the online learning model needs to consider how the learning will continue overall. The following six components of learning must be present in the online learning process: (1) The availability of connectivity, which might facilitate student interaction and communication during the learning process; (2) Adaptable, meaning that learning can happen at any time or place; (3) Collaborative, meaning that sufficient discussion is provided to enable interaction during the online learning process; (4) Interactive, meaning that interactive media are available to support the online learning process and student interaction; (5) Open, meaning that students' knowledge and skills can be accessed from a variety of sources and can support the scope of the material being studied; and (6) Motivation and Interest, specifically highlighting how enjoyable and accessible online learning is for all students.

Because of the following, whether learning occurs in-person or virtually, a regular mathematical learning method is still necessary (Annur & Hermansyah, 2020). In order to improve students' learning outcomes in mathematics, teachers should: (1) assign meaningful math assignments; (2) theoretically, teachers should actively listen, observe, and pose trigger questions; (3) help students become more engaged and active learners by listening, asking questions, exploring, and leading discussions; and (4) inspire and motivate students to use learning tools, such as technology, writing tools, presentations, and learning models. (5) A teacher can create a learning environment that promotes the acquisition of mathematical knowledge; (6) A teacher participates in the process of analyzing the learning process. The Merdeka Curriculum, which is the present curriculum, must also support the online mathematics learning process (Abidah et al., 2020).

Numerous locations have used online learning programs for mathematics education. Numerous scholars have conducted studies on the use of online learning in mathematics

education, including (Fadila et al., 2021; Faozi et al., 2020; Kusumaningrum & Wijayanto, 2020; Simanjuntak et al., 2021). Online learning at FKIP UHN Medan makes use of a variety of applications (Manik, 2021). Even though it has been extensively utilized, there are still a number of challenges that lecturers and students must overcome. For instance, the program frequently encounters system faults, the devices are not suitable or acceptable, and there are issues when sending a lot of material. There are 66.9% of students in the good category of understanding lecture material and 33.1% of students in the category of not understanding lecture material were found in a Vice.com survey of 3,353 students who participated in online learning offered by the UGM Center for Innovation and Academic Studies during the COVID-19 pandemic. This indicates that learners are not prepared to participate fully in the online learning environment; instructors' resources are not prepared to oversee remote instruction; policies pertaining to distance learning are not yet backed by suitable curricula; facilities and infrastructure are insufficiently supportive; and there are gaps in internet networks. adequate in certain situations.

Learning results are also impacted by human resources that are still not prepared for the use of distance learning. Instructors must also give high-quality online instruction while keeping in mind the needs of their students and their ability to access the course materials. Apart from issues concerning the execution of the online learning procedure, an additional challenge is the way in which student learning outcomes are affected following the introduction of online learning. Numerous investigations have been conducted concerning the challenges encountered by learners and the educational results attained subsequent to engaging in virtual education (Anim & Mapilindo, 2020; Fadila et al., 2021; Hutauruk, 2020; Iskandar et al., 2021; Manik, 2021). The impact of online learning on student learning outcomes, as demonstrated by multiple research, is a topic of great interest and curiosity (Kusumaningrum & Wijayanto, 2020; Syarifuddin et al., 2021).

Through educational evaluation of lecture results, students' learning outcomes after participating in a series of online courses in the subjects they took are assessed. The purpose of learning evaluation in online learning is to determine the degree to which the predefined learning objectives have been met by measuring the effectiveness of the use of online lectures. The learning objectives for every topic in the study program on mathematical education have been developed based on the program's determinations (Permendikbud Number 3 of 2020 about National Higher Education Standards of 2020). The mathematics education study program has four components to its learning outcomes: knowledge, attitude, general skills, and specific skills. Every topic indication in the study program includes a description of these four elements.

2. METHOD

An online survey was used to collect data for this study utilizing a quantitative methodology (Creswell, 2012; Gorard et al., 2001). Numerical data are gathered for this study using objective measures, which are then utilized to provide answers to predefined questions. A questionnaire was the research tool employed in this study. Information gathered through a Google form questionnaire for research purposes. Students received questionnaires through WhatsApp groups. In this study, descriptive analysis and confirmatory factor analysis (CFA) using AMOS SEM were utilized as data analytic techniques (Byrne, 2013). The purpose of this descriptive study is to characterize the standard deviation and answers provided by the students (Hidayat, Widodo, et al., 2023). The purpose of the CFA analysis in this study is to identify the strongest and weakest components within each indicator.

The research population was all students and lecturers affiliated with the UHN FKIP Mathematics Education Study Program. The sample consisted of 150 students for all courses in semesters two to six of the program, as well as 15 permanent instructors. The distribution table for these respondents is presented in Table 1.

Table 1. Distribution of respondent

Semester	Frequency	Percentage
3 (three)	52	34.67
5 (five)	48	32.00
7 (seven)	50	33.33
Total	150	100.00

Purposive sampling was used to identify 15 instructors and 150 students, with both groups taking part in online teaching. To describe the online learning process and determine its impact on student learning outcomes in the Mathematics Education Study Program FKIP UHN, a descriptive analysis was carried out. To ensure suitability, the instruments used in this investigation underwent initial validation by qualified validators. This research uses the Learning Management system used at HKBP Nommensen University and for online meetings uses common platforms such as Zoom, Cisco, Meet, and Whatsapp. The main page display for the LMS used is shown in Figure 1.

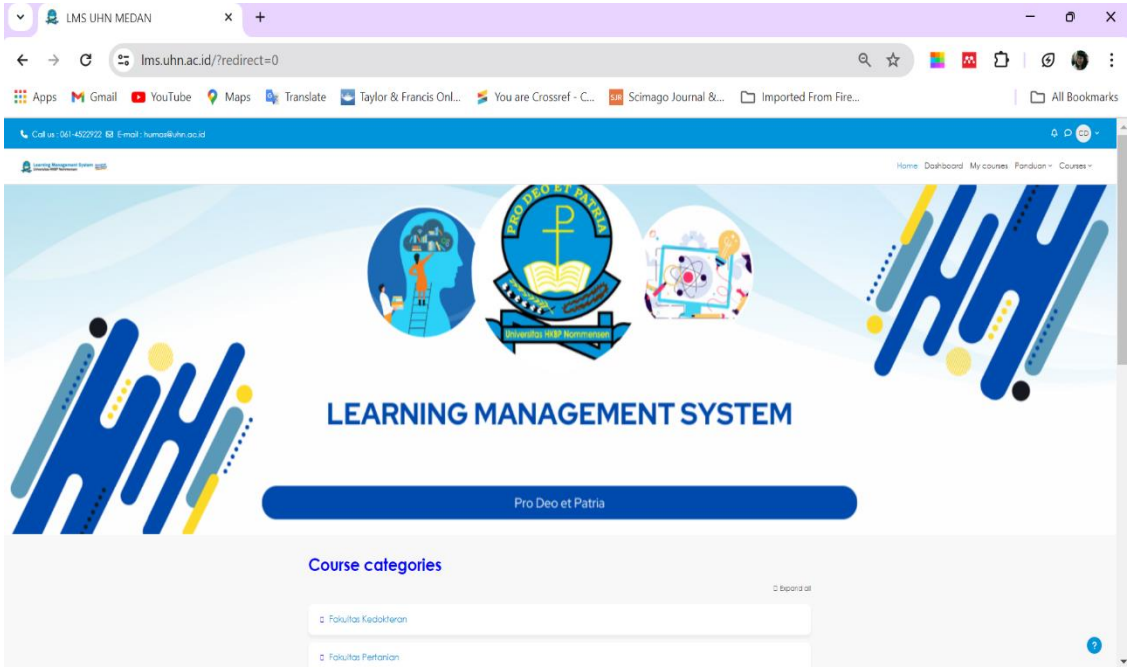

Figure 1. Learning management system for online learning

Based on conditions in the field, a questionnaire was used to measure how teachers and students in mathematics education study programs experience online learning. The questions in this questionnaire can also provide insight into the mechanisms involved in online learning. Filling out this questionnaire is also to see the effect of using the LMS from several aspects, namely usage aspects, presentation aspects, display aspects and implementation aspects. The questionnaire is filled in by lecturers and students. Several indicators and statements conveyed in the questionnaire are in Table 2.

Table 2. Statement in the questionnaire

Aspects	No	Statement
Aspects of Use	1	Presence activities in the LMS are easy to use
	2	LMS can be used without having to have IT expertise
	4	I feel happy when using LMS to carry out lectures
	5	Discussion activities in the LMS are difficult to use
	6	How to use activities to collect task descriptions is difficult to access
	7	LMS can only be used by people who have expertise in the IT field
	8	Learning using LMS becomes chaotic
	9	I feel uncomfortable using LMS for learning
	10	Quiz-taking activities are easy to access
Presentation Aspect	11	LMS has forum facilities for asking questions or discussing
	12	Modules, videos and practice questions uploaded to the LMS are easy to understand
	13	The language used in the LMS is easy to understand
	14	The language used in the LMS is less communicative
	15	There is no forum available to ask questions or discuss the LMS
	16	Modules, videos and practice questions uploaded to the LMS confuse users
Display Aspect	17	Images and videos on the LMS look clear
	18	The use of LMS theme colors is attractive and does not clutter the appearance
	19	The LMS design for each meeting is consistent (the same).
	20	LMS has an attractive appearance
	21	Images and videos on the LMS look blurry
	22	The LMS design for each meeting is different so it makes me confused about finding materials for each meeting
	23	The use of LMS theme colors is boring
	24	LMS has an unattractive appearance
Implementation Aspects	25	Learning using LMS at each meeting can be carried out
	26	Learning to use the LMS at each meeting is hampered

Next, the observation sheet, which is accompanied by a learning plan, allows someone to assess the harmony between the questionnaire findings and the learning plan that has been prepared. Furthermore, it is hoped that there will be positive experiences regarding the use of online learning by instructors and students included in the interviews. For the learning outcomes instrument, it is seen from the Student Learning Achievement Index which is documented in the form of a report. Observation sheets are also used to find out whether the test findings and learning objectives are in accordance with the learning plan, while in the context of online learning, interviews are conducted with lecturers and students which serves to validate the implementation of ongoing learning.

3. RESULT AND DISCUSSION

The research sample consisted of 150 students and 15 mathematics education study program lecturers who took and completed online courses at FKIP UHN in semesters two to six. The research was carried out in the even semester of the 2022–2023 academic year. FKIP UHN uses various online learning tools, such as Zoom, Google Meet, Cisco Webex, and Whatsapp. Based on responses from the interview questionnaire, as many as 51% used Google Classroom, 45% used Zoom and 4% used Cisco Webex which was utilized in the online learning process for the FKIP UHN mathematics education study program. The results of these responses can be seen in Figure 2.

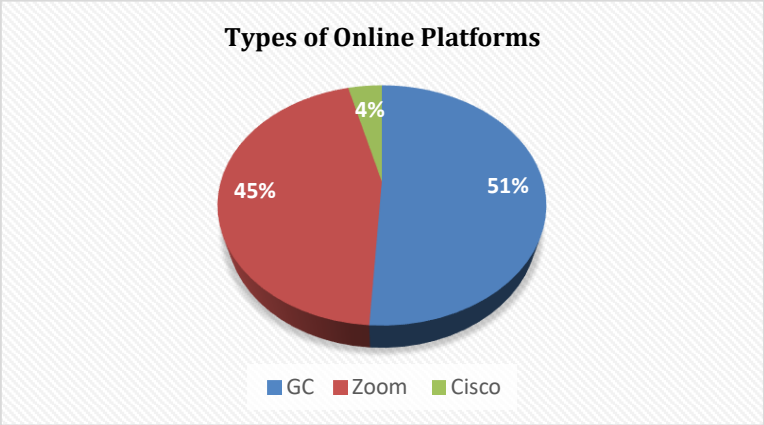

Figure 2. The types of online platforms

This study is focused on two variables: the online learning process and the online learning outcomes. Lesson planning, learning execution, and learning evaluation are the three primary components of the online learning process. The creation of learning contracts, the distribution of lesson plans, and the explanation of lesson plans are all included in learning planning. The process of putting learning into practice involves delivering educational materials and learning tools, completing assignments, explaining subject both synchronously and asynchronously, and becoming proficient at recording attendance. Exam administration is one aspect of learning evaluation that happens concurrently with the usage of learning apps and learning management systems (LMS). A Likert scale with five response categories—Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree—was employed in this study tool. The variable of online learning outcomes is examined from two angles: (1) the degree to which students have met learning objectives for each subject as measured by their grade point average (IP) following online learning; and (2) the degree to which students believe they have met these objectives.

3.1. Learning of Planning

The four criteria used in planning online learning are: creating a learning contract, uploading the learning contract to the learning management system (LMS), outlining the lesson plan at the beginning of the semester, and placing the lesson plan in the LMS. In Table 3, the conclusions of lecturers' responses in carrying out the four criteria above are presented.

Table 3. Plan of learning dimension

Criteria	Average	SD	Category
Ability to upload RPS in LMS (X_1)	4.12	0.993	High
Ability to explain lesson plans at the beginning of the semester (X_2)	4.28	0.991	High
Ability to create learning contracts (X_3)	4.25	0.986)	High
Ability to upload learning contracts in the LMS (X_4)	3.42	0.891	Moderate
Total	4.01		High

From the Table 3, it can be explained that the learning planning preparations carried out by lecturers in planning online learning are in the high category, namely (average response: 4.01 on a 5 point scale). Among these four criteria, the lecturer's ability to upload learning plans in the LMS had the lowest response (mean value = 3.42, standard deviation (SD) = 0.891). From the average calculation results, almost all criteria are in the high category, so it can be concluded that the data is not biased and is in the good category.

3.2. Process of Online Learning

The process of online learning taking place well can be seen from several criteria, namely the use of LMS for student attendance, the use of applications outside the LMS such as Cisco Webex, Zoom, and Google meet for synchronous, the use of LMS for asynchronous activities, the use of Google Classroom, WhatsApp and Telegram for activities. Asynchronous, making assignments and submitting assignments, using LMS to upload teaching materials (PDF, PPT, Documents, Videos, etc), analysis data for the online learning process can be seen from Table 4.

Table 4. Process of online learning

Criteria	Average	SD	Category
The use of LMS for student attendance (Y_1)	3.55	1.074	High
The use of applications outside of online latform such as Cisco Webex, Zoom, and Google meet for synchronous (Y_2)	3.32	1.078	Moderate
The use of LMS for asynchronous activity (Y_3)	3.15	1.066	Moderate
The use of WhatsApp and telegram for asynchronous activity (Y_4)	4.38	1.081	High
Making assignment and delivery of assignments (Y_5)	3.58	1.023	High
The use of LMS to upload teaching materials, (PDF, PPT, Documents, Videos, etc.) (Y_6)	3.17	1.012	Moderate
Total	3.52		High

From the analysis of the data in Table 4, it was found that the average total response of respondents to the six online learning processes was 3.52, this shows that the process of implementing online learning is in the high category, namely for the following reasons: a) the standard deviation shows nothing exceeds the average limit, this shows that the data distribution is not biased and is in the good (normal) category; b) the use of WhatsApp and Telegram for asynchronous activities places the process in the top group; the average

response rate was 4.38; c) the use of LMS for student attendance is in the medium category with an average score of 3.55; d) with an average score of 3.15, lecturers' use of the Omline platform for synchronous activities is included in the medium group. d) With an average of 3.58, the use of LMS for creating and collecting assignments is included in the high category; and e) the use of LMS to upload learning materials for online learning in the form of PDF, PPT, Documents, Audio, Video and other formats is included in the medium category with an average of 3.17.

Based on the data analysis above, it can be concluded that lecturers like and use online platforms such as Cisco Webex, Zoom, and Google Meet to support the implementation of online learning. With an average comparison of 4.38 > 3.52, the use of Google Classroom and WhatsApp is more than the use of UHN LMS. However, the use of LMS by lecturers to explain content connected to links is still not ideal (the response is in the medium range).

3.3. Evaluation of Student Learning Outcomes

Evaluation of student learning outcomes can be seen from the three criteria contained in Table 5, namely the final score which describes student competence, self-confidence in competence, and success in online learning. Table 5 shows the average score for the three criteria for determining evaluation of student learning outcomes.

Table 5. Evaluation of learning

Criteria	Average	SD	Category
Final score that describes student competence (Z_1)	3.05	1.202	Moderate
confidence in competence (Z_2)	4.78	1.014	High
success of online learning (Z_3)	4.97	1.142	High
Total	4.26		High

Table 5 describe that; a) the standard deviation value shows that there is no SD value that is more than the average, this shows that the data distribution is not biased and is in a good range; b) the data found that the students' final score had an average score of 3.05 and this score was in the medium category, which means this score describes the competencies obtained by students after participating in online learning; c) comfort in participating in online learning has an average value of 4.78, this figure shows that students are comfortable with implementing online learning; and d) from this table it can also be stated that the average confidence to complete online learning is very high, namely 4.97, which means students are confident that they will complete the learning well.

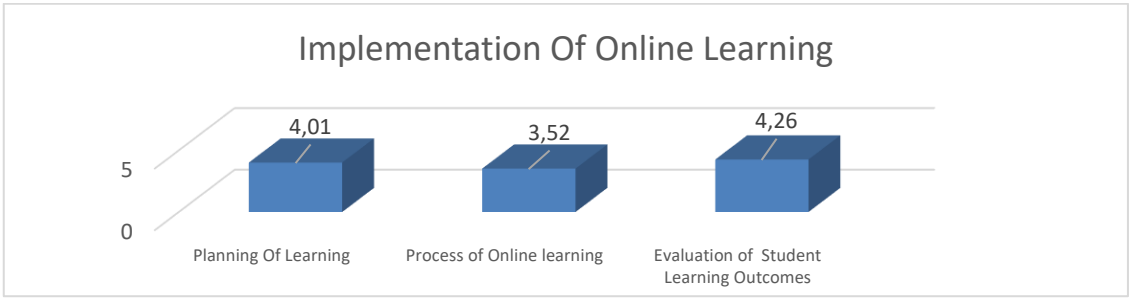

Figure 3. Description of online learning implementation

Figure 3 the evaluation results of the implementation of online learning have the highest average response when compared with the other two dimensions, based on descriptive analysis of the three main dimensions of implementing online learning, namely learning planning, the process of implementing online learning, and evaluation of results. learning, as seen in the picture above, it can be concluded that the planning and learning process dimensions are included in the medium category, so it can be concluded that these two dimensions have not been utilized optimally.

3.4. Factor Analysis of Online Learning Management

Table 6 the KMO value is 0.678, meaning the KMO value is greater than 0.5 so the data is suitable for factor analysis. Bartlett's Test of chi-square value is 3159.726 with a significant value <0.001 less than the real level (α) 0.05, this means there is a correlation in each variable. This means there is a correlation in each variable.

Table 6. KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequasi.	0.678
Bartlett's Test of Sphericity Approx. Chi-Square	3159.726
Df	78
Sig.	<0.001

The results of the KMO and Bartlett tests used to assess the data were 0.678 > 0.5, which indicates that confirmatory factor analysis can be carried out. Because the KMO value must be more than 0.5 for confirmatory factor analysis to be carried out. Because the data that has been analyzed using KMO is suitable for confirmatory factor analysis, Figure 4 is a picture of the results of the confirmatory factor analysis that has been carried out.

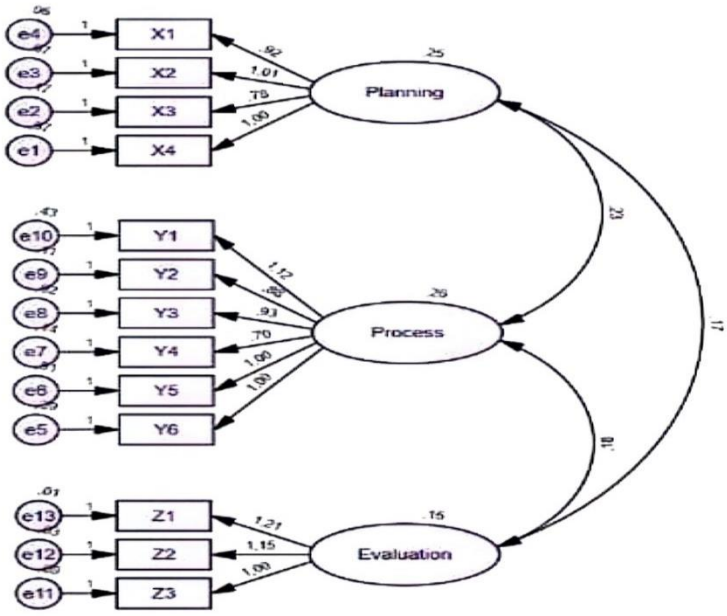

Figure 4. Confirmatory factor analysis (CFA) implementation of online learning

Planning, process and evaluation of learning outcomes in particular have latent variables (dimensions). Figure 4 shows that what is observed is the entire indicator, because it has a factor loading weight exceeding 0.50, meaning that all indicators are able to explain all dimensions significantly. The best indicator is Y4, namely the average activity of using

WhatsApp and Telegram in asynchronous activities. Likewise for synchronous use of Zoom, Google Meet, and Cisco Webex and asynchronous use of WhatsApp and Telegram.

Table 7. The data regression weights

	Estimate	S.E.	C.R.	P Label
X4 <---- Planning	1.000			
X3 <---- Planning	0.777	0.123	6.334	Par_1
X2 <---- Planning	1.008	0.139	7.244	Par_2
X1 <---- Planning	0.916	0.127	7.216	Par_3
Y6 <---- Process	1.000			
Y5 <---- Process	1.004	0.157	6.381	Par_4
Y4 <---- Process	0.703	0.095	7.407	Par_5
Y3 <---- Process	0.929	0.099	9.403	Par_6
Y2 <---- Process	0.879	0.106	8.299	Par_7
Y1 <---- Process	1.118	0.159	7.044	Par_8
Z3 <---- Evaluation	1.000			
Z2 <---- Evaluation	1.150	0.083	13.917	Par_9
Z1 <---- Evaluation	1.208	0.081	14.885	Par_10

There isn't an indicator in the variable process of applying online learning whose loading factor (λ) is less than 0.50 (see Table 7). This indicates that in order to facilitate the execution of the online learning process, lecturers frequently employ additional programs like Google Classroom, WhatsApp, and Telegram. The assignment-based online learning assessment variable has a loading factor value greater than 0.50. This indicates that the elements of learning evaluation have been explained by this indicator. For students who use the LMS, the indicator for gathering assignments is 4.26.

We can deduce that virtually all of the tasks that professors assign to their students are gathered online. The management of online learning was not executed as well as it could have been, according to the study's findings, particularly when it came to the online learning process' implementation variable. The ability of educators and lecturers, as well as the availability of infrastructure, dependable technology, sufficient bandwidth, and implementation management systems, all influence the process of conducting an optimal online learning environment (Zhao et al., 2021). When utilizing external applications like Zoom, Google Meet, and Cisco WebEx for synchronous learning, the process is more extensive than when utilizing internal tools. This is because the LMS only has a small number of functionalities. Consequently, the system plays a critical role in optimizing the efficacy of the introduction of online learning in higher education. Qualified features, such as trustworthy administration, tracking, reporting, and automation, must be accessible for the deployment of online learning (Naz & Khan, 2018). When three criteria were considered—online learning, judgments of the quality of their learning, and technological capabilities—it was discovered that postgraduate students preferred online lectures with specific applications over undergraduate students (Miller et al., 2020; Widodo et al., 2020)

According to study by Richardson et al., from the perspective of the teacher, it's also important to consider how students' short- and long-term comprehension of using online learning apps is shaped (Panjaitan et al., 2023; Szopiński & Bachnik, 2022). According to the learning management system theory proposed by Naz and Khan (2018), everyone

involved must be digitally literate and informed for the purposes of administration, tracking, reporting, automation, and documentation. Universities need to be able to offer simple, convenient access so that both instructors and students can take advantage of online learning opportunities. Digital literacy in the usage of learning management systems will increase as a result of institutions' roles in giving users access to vast amounts of information and suitable rules. The success of the online learning process is significantly influenced by students' attitudes and opinions about it (Suripah & Susanti, 2022). According to other research, students desire high-quality interactions with their instructors and the online learning tools they employ. According to this study, higher education establishments ought to motivate instructors to keep using online learning resources into their classes. Furthermore, because it can boost student engagement and satisfaction with learning, the use of interactive videos in online learning—for instance, by integrating YouTube links in online learning applications—is a crucial component (Nagy, 2018).

4. CONCLUSION

After the COVID-19 Pandemic has brought new habits and culture in the management of Higher Education learning around the world. The use of digital applications such as managing online learning is becoming a new habit. This research shows that the management of online learning is not optimal, especially in the process of implementing online learning and evaluating learning. The implementation and assessment of learning are the two areas where the learning management process is found to be deficient in this study. In the online learning process, several important things are obtained, namely: (1) For synchronous lecturers use many supporting applications to carry out learning optimally, namely Zoom, Cisco Webex and Google Meet. This happens because it is supported by the ability of users, both lecturers and students, the facilities available, and the quality of the existing system; (2) It is necessary to improve LMS facilities at universities to be more adequate so that there is no need to use auxiliary applications with limited time, both from the user system and large storage space so that evaluation of student assignments can take place properly; (3) In this study, the mastery of using the LMS in general was still on average, both lecturers and students. For lecturers what is lacking is mastery over the use of features in the LMS when the learning process takes place; (4) Evaluation results of online learning with an average student having a cumulative grade point average above the average of 3.50; (5) There is less interaction between lecturers and students with this online learning process, there is no face-to-face meeting which is also a need for students to be able to directly interact with those who help them in learning; and (6) There is a significant relationship between the implementation of the online learning process and student learning outcomes.

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