

IMPLEMENTATION OF ONLINE LEARNING AND ITS IMPACT ON LEARNING ACHIEVEMENTS OF MATHEMATICS EDUCATION STUDENTS

Simon M. Panjaitan, Agusmanto J. B. Hutauruk*, Christina Sitepu, Sanggam P. Gultom,
Parlindungan Sitorus, Melati Riani Marbun, Cahyana Hotmauli Sinaga
Universitas HKBP Nommensen, Indonesia

Article Info

Article history:

Received Jan 17, 2023
Revised Feb 21, 2023
Accepted Feb 26, 2023

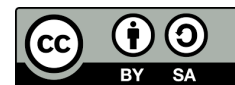
Keywords:

Learning Achievement,
Mathematics Education,
Online Learning

ABSTRACT

Implementing online learning in a higher education environment requires an analysis of learning outcomes and their impact on students, lecturers, and the institutions that administer the learning. The implementation of online learning shows that the learning process takes place and the readiness of lecturers and students to implement online learning. The impact given by online learning is in the form of GPA and student perceptions of the learning process they experience. Based on the research results, various findings were obtained, including that mastery of online learning LMS was not optimal, learning outcomes in the form of GPA were relatively high, students' perceptions of online learning were still low, especially in terms of lecturer readiness and students' confidence in their competence after participating in learning.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Agusmanto J. B. Hutauruk,
Department of Mathematics Education,
Universitas HKBP Nommensen
Jln. Sutomo No.4A, Perintis, Medan City, North Sumatra 20232, Indonesia.
Email: a7hutauruk@gmail.com

How to Cite:

Panjaitan, S. M., Hutauruk, A. J. B., Sitepu, C., Gultom, S. P., Sitorus, P., Marbun, M. R., & Sinaga, C. H. (2023). Implementation of online learning and its impact on learning achievements of mathematics education students. *Infinity*, 12(1), 41-54.

1. INTRODUCTION

Many studies show that it takes time to restore the various impacts caused by COVID-19 which takes about more than a decade to return to normal (Djalante et al., 2020). Interactions between humans are starting to be limited, a very large impact is felt in human life in various countries, including the Republic of Indonesia. This also has an impact on the education sector which is very broad ranging from learning at the elementary level to learning at the tertiary level. Various policies in the field of education were issued by the government, namely prevention and handling in the educational environment, prevention in education units, and education policies during an emergency period for the spread of the corona virus disease-19.

Learn from home has begun to be implemented in almost all regions in Indonesia. Online/online learning is implemented starting from the elementary level to higher education. All people involved in the education sector due to circumstances are forced to adapt and carry out the learning process from home, all schools and universities are prohibited from conducting direct or face-to-face learning, the learning process as a whole and simultaneously is required to carry out distance learning by utilizing technological advances (Faozi et al., 2020; Hidayat et al., 2023). Online and offline learning is a topic that is widely discussed. Many parties compare the two learning systems and look for the best learning. There are those who think online is better, but there are also those who think offline is the best. Both methods have their advantages and disadvantages.

During this pandemic, the face of education changed from face-to-face to online. This online learning is intended to prevent gathering and excessive interaction of students which can cause this cluster of COVID transmission to appear. Online learning is learning that is carried out by utilizing technology through virtual applications and using the internet, where the process of sending learning materials is not limited to time and place using various technologies in an open, flexible and distributed learning environment (Hidayat et al., 2022; Kusumaningrum & Wijayanto, 2020).

Online learning is expected to be able to overcome the limitations of space which has been a weakness of conventional learning models (Annur & Hermansyah, 2020). Online learning methods are divided into 2 types: synchronous and asynchronous. Synchronous learning is an interaction between educators and students directly with audio or video conferencing through learning media that is connected to a network, while asynchronous learning is an indirect learning interaction with the distribution of teaching materials by educators through online learning media so that students can access it anytime and anywhere (Fadila et al., 2021).

In the online learning process, of course, you have to pay attention to the whole learning dimension. There are six learning elements that must be present in online learning, namely (1) Connectivity makes it easier for students to communicate and interact with each other in the learning process; (2) Flexibility, meaning that learning can be done anywhere and anytime; (3) Interactive, where learning allows each participant to interact with each other; (4) Collaboration, online learning is supported by online communication and discussion facilities between learning participants; (5) Open, where student material and abilities can be accessed in various sources and mutually support the breadth of material, and (6) Motivation, where the online learning process is fun and can be enjoyed by students.

Like face-to-face learning, online mathematics learning must also have mathematics learning standards (Annur & Hermansyah, 2020) as (1) the teacher must bring up meaningful math assignments, (2) in discourse, the teacher must play a responsive role in asking, listening and observing, (3) the teacher facilitates students who are active and interactive in listening, responding, asking questions, exploring and discussing, (4) the teacher encourages students to use devices such as models, technological devices, writing tools, visual and oral (presentations), in the context of enhancing learning of mathematics, (5) the teacher must establish a learning atmosphere that fosters the development of mathematical power, (6) the involvement of the teacher in the analysis of teaching and learning processes. Online mathematics learning must also be supported by the current curriculum, which is known as Kurikulum Merdeka (Abidah et al., 2020).

Implementation of online learning has been carried out in various places in learning mathematics. Studies regarding the implementation of online learning in mathematics learning were carried out by several researchers, including (Aini, 2021; Azhari & Fajri, 2022; Fadila et al., 2021; Kusumaningrum & Wijayanto, 2020; Nofriyandi & Andrian, 2022; Restian, 2020; Simanjuntak et al., 2021; Suripah & Susanti, 2022; Sutriyani, 2020;

Syarifuddin et al., 2021). In the learning process at several teaching and education faculties, online learning uses various applications (Aini, 2021; Manik, 2021). However, in practice, there are several obstacles faced by students and lecturers in the learning process, for example the applications used by lecturers often have problems or system errors occur, inadequate student devices, especially for materials with large capacity, lecturers who cannot directly deliver material so that many students do not understand the material, and so on (Annur & Hermansyah, 2020; Hutauruk, 2020; Iskandar et al., 2021).

Vice.com noted that a survey of 3,353 students who took part in online learning conducted by the UGM Center for Innovation and Academic Studies during the COVID-19 pandemic found that 66.9% of the research subject students showed a good category in understanding lecture material, and 33.1% of students in bad category (Azhari & Fajri, 2022; Nofriyandi & Andrian, 2022; Restian, 2020; Suripah & Susanti, 2022). This shows that students are not fully ready to take part in the online learning process, lecturer resources are not ready to manage distance learning, distance learning policies are not yet supported by an appropriate curriculum, facilities and infrastructure are not sufficiently supported, and internet networks are inadequate in some areas/ region.

The lack of readiness of human resources in distance learning will also affect learning outcomes. This requires lecturers to carry out quality online learning and remain oriented towards achieving the ultimate achievement/objective of the learning process by paying attention/considering the ability of students to access the lecture material provided. In addition to problems related to the implementation of online learning, another challenge is regarding student learning outcomes after the implementation of online learning. Several studies were conducted regarding the problems faced by students and the learning outcomes they got after participating in online learning (Anim & Mapilindo, 2020; Annur & Hermansyah, 2020; Fadila et al., 2021; Hutauruk, 2020; Iskandar et al., 2021; Manik, 2021; Simarmata, 2022; Sutriyani, 2020). This raised curiosity about the impact of online learning on student learning outcomes which was followed up through several studies (Kusumaningrum & Wijayanto, 2020; Manik, 2021; Syarifuddin et al., 2021).

Student learning outcomes are learning outcomes obtained by students after participating in a series of learning in the courses they take (Widodo et al., 2020). Learning outcomes can be carried out through evaluation of lecture results (Hendriana et al., 2022). In online learning, evaluation of online lectures is carried out to determine the level of effectiveness of implementing online lectures or in other words to find out the extent to which predetermined learning objectives have been achieved. The learning outcomes for each subject in the mathematics education study program are arranged in accordance with the learning outcomes that have been determined by the study program. There are four aspects of learning outcomes in the mathematics education study program, namely learning outcomes from the aspects of attitude, knowledge, general skills and specific skills. These four aspects of learning achievement are described in each learning achievement per subject in the study program.

The measurement of learning achievement is used to measure the learning achievement of graduates, which is an indicator of the success of the learning process that is expected from the implementation of the educational curriculum. Fulfillment of learning outcomes can be measured to evaluate the process and results of meeting expected competency standards as well as evaluating the learning process of students, lecturers, and study programs. Measurement of graduate learning outcomes carried out at the end of the study can provide information on the fulfillment of learning outcomes for students during their study period as well as an evaluation of graduate learning achievements. In this study, student learning outcomes were measured by learning achievement indicators for each subject that had been prepared by the lecturer concerned. In addition, it will also measure

how students perceive online learning and the learning achievements they have obtained in these courses. Studies on student perceptions of online learning and the difficulties faced by students have been carried out before (Anim & Mapilindo, 2020; Annur & Hermansyah, 2020; Manik, 2021; Siregar et al., 2021).

Based on the problems mentioned, the researchers are interested in conducting research on the topic of implementing online learning and its impact on student learning outcomes in mathematics education study programs.

2. METHOD

This research is a quantitative descriptive research, to explain how online learning is implemented in the mathematics education department of FKIP UHN. Quantitative descriptive analysis also measures the impact that the implementation of online learning has on student learning outcomes in the mathematics education department of FKIP UHN. The population of this study were all students and lecturers of the mathematics education department of FKIP UHN, with the sample consisting of 15 permanent lecturers and 100 active students from various subjects in the mathematics education department of FKIP UHN. The selection of 15 lecturers and 100 students was carried out by purposive sampling, where the lecturers and students were lecturers and students participating in online learning.

Descriptive data analysis techniques were used in this study to explain how online learning is implemented and its impact on student learning outcomes in the mathematics education department of FKIP UHN. There are several research instruments used in this research that are used to collect data related to the implementation of online learning and its impact on student learning outcomes. Before the research instrument is used, the research instrument validation has been carried out to the instrument validator to ensure the feasibility of the research instrument.

Instruments for implementing online learning include:

- a. Questionnaire, contains several statements that measure how the implementation of online learning is carried out by lecturers and students of mathematics education study programs. Questionnaire statements are prepared based on the realities that occur in the field, which will explain how the online learning process occurs. This questionnaire will be filled in by lecturers and students;
- b. The Observation Sheet, which is an observation sheet for the lesson plan, will see the suitability between the results of the questionnaire and the lesson plan that has been prepared;
- c. Interviews are confirmation activities for lecturers and students regarding the implementation of online learning that is taking place.

Learning achievement instrument include:

- a. Student Achievement Index (IP) reports which are the results during the online learning process;
- b. The Observation Sheet, Observation Sheet, containing observation sheets on test results, to see the suitability between the test results and the learning outcomes in the lesson plan;
- c. Interviews are confirmation activity to lecturers and students regarding student learning outcomes.

3. RESULT AND DISCUSSION

The research was carried out in the even semester of 2021/2022, with the research sample consisting of 120 students and 15 lecturers from the mathematics education department who attended and carried out online learning at FKIP UHN. There are two variables that are the focus of the study in this study, namely online learning and learning outcomes. The indicators for studying the implementation of online learning in this research will be seen from two aspects, namely (1) the external aspect consists of the type and mastery of the learning application/LMS used, and (2) the internal aspect consists of ongoing learning practices and the readiness of students and lecturers in implementing online learning. Indicators of student learning achievement will be reviewed from two aspects (1) achievement of learning achievement for each subject obtained through student achievement index (IP) scores after participating in online learning, and (2) student perceptions of learning achievement that have been obtained after participating in online learning.

3.1. Implementation of Online Learning

Online learning at FKIP UHN uses the virtual meeting method using various applications including Zoom, Google Meet and Whatsapp. This learning is integrated in one Learning Management System, namely Google Classroom. Based on the results of the questionnaire, 100% of the LMS types used in online learning in the mathematics education department of FKIP UHN use Google Classroom (see [Figure 1](#)).

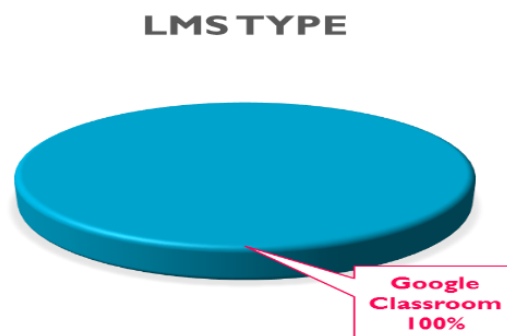


Figure 1. Type of LMS

Data related to LMS mastery was measured using a questionnaire containing several statements related to LMS operating mastery, including (1) LMS login and logout, (2) uploading and downloading documents on the LMS, and (3) knowing and operating the various features available on the LMS. In terms of LMS mastery, of the 15 lecturers, only 6 lecturers had LMS operational mastery above the average mastery, while 9 other lecturers had LMS mastery below the average mastery. Then for students, out of 100 students, 44 students have LMS operational mastery above the average mastery, and 56 students have LMS mastery below the average mastery (see [Figure 2](#)).

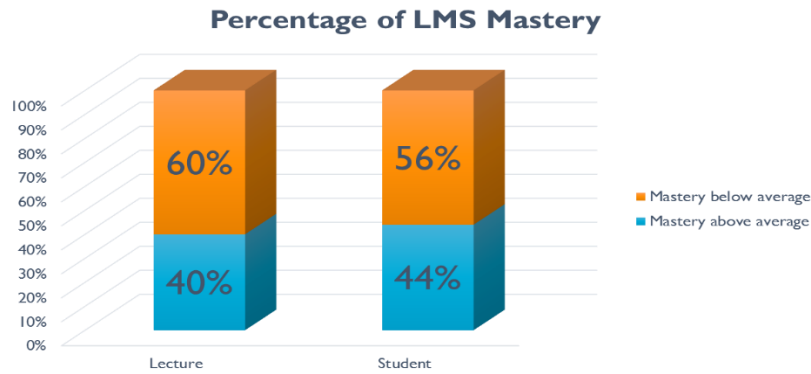


Figure 2. Percentage of LMS mastery

The percentage of using LMS in online learning for lecturers and students is described in detail according to the indicators for measuring LMS mastery shown in the Figure 3.

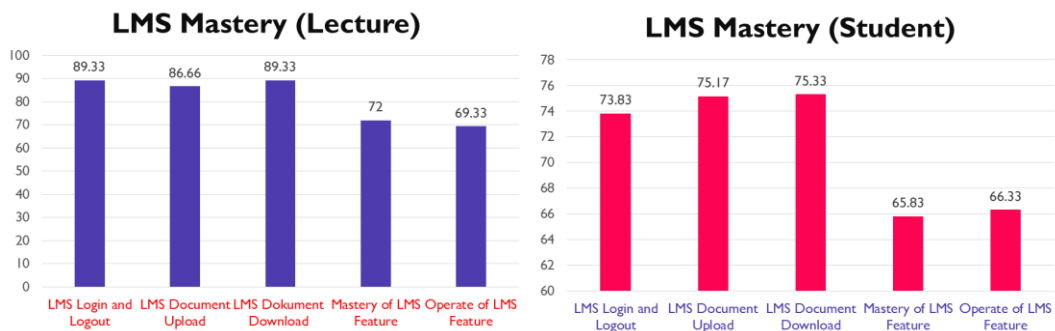


Figure 3. Mastery of LMS according to indicators on lecturers and students

Based on Figure 3, it can be seen that there is 89.33% mastery of LMS login and logout for lecturers, while only 79.83% for students. Furthermore, for lecturers, 86.66% mastery is for uploading documents and 89.33% mastery is for downloading documents on the LMS. While for students, 75.17% mastery for uploading documents and 75.33% mastery for downloading documents on the LMS. Regarding mastery of recognizing features in the LMS, lecturers mastered the introduction of LMS features by 72%, while students mastered the introduction of LMS features by 65.83%. And in operating the LMS, lecturers have mastery of 69.33% in operating the features on the LMS, and students have mastery of 66.33% in operating the features on the LMS.

The second indicator related to the implementation of online learning in the mathematics education department can be seen from ongoing online learning practices and the readiness of students and lecturers to carry out online learning. This indicator was measured using a questionnaire and interviews conducted with 15 lecturers and 100 students as respondents. The questionnaires and interviews conducted were guided by several sub-indicators, namely (1) the availability of lesson plans for courses, (2) the suitability of the number of lecture meetings, namely 16 meetings including UTS and UAS, (3) the completeness of lecture material for each subject, (4) the accuracy of study duration according to the course credit load, with the rule that the duration of lectures is 50 minutes per credit, (5) there is learning in the form of assignments or projects, (6) UTS and UAS are implemented in each subject and (7) available course assessment rubrics.

The data obtained from the questionnaire regarding the practice and readiness of online learning is described as follows (see [Figure 4](#)).

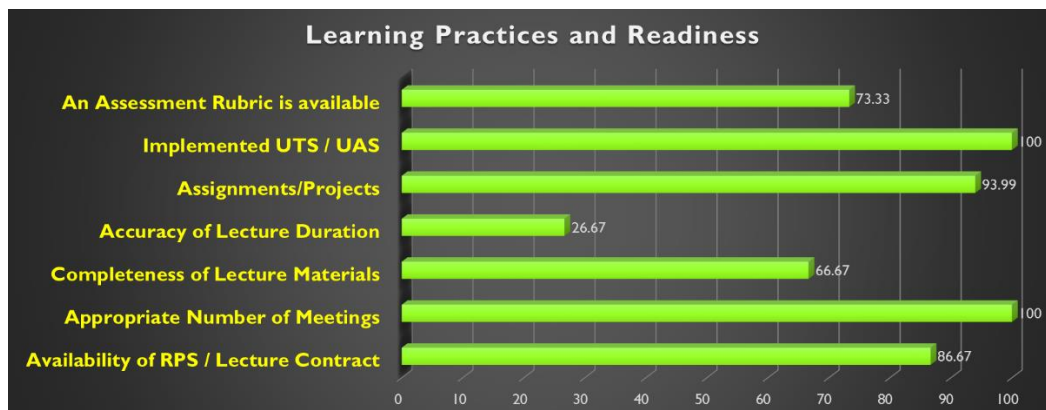


Figure 4. Online learning practice and readiness

Based on [Figure 4](#), it can be explained that in the sub-indicator of availability of RPS and lecture contracts, out of 15 subject lecturers who carry out online learning, only 86.67% have RPS and lecture contracts in the courses they teach. In the sub-indicator of suitability for the number of meetings, all lecturers (100%) carry out online lectures according to the specified number of meetings, namely 16 meetings including UTS and UAS. In the sub-indicator of the completeness of lecture material, it was found that only 66.67% of the completeness of lecture material in online learning could be completed.

Furthermore, the sub-indicator for the accuracy of lecture duration obtained the lowest results, namely only 26.67% of online learning lectures were carried out in accordance with the specified lecture duration. Then in the assignment/project sub-indicator, 93.99% of online learning lectures apply task-based learning or lecture projects. Regarding the implementation of UTS/UAS, all online learning courses (100%) carry out UTS and UAS, and on the sub-indicator of the availability of an assessment rubric, there are 73.33% of courses that have an online learning lecture assessment rubric that is implemented.

3.2. Student Learning Outcomes

One indicator of the student learning achievement variable for the implementation of online learning at the mathematics education department is the student achievement index after participating in online learning. The student achievement index in this study is the student achievement index for the 2020 and 2021 batches who have participated in online learning since the beginning of their studies at the mathematics education department. Student achievement index data is obtained from an academic information system that displays student achievement indexes for all courses attended during online learning. The data is described as follows (see [Figure 5](#)).

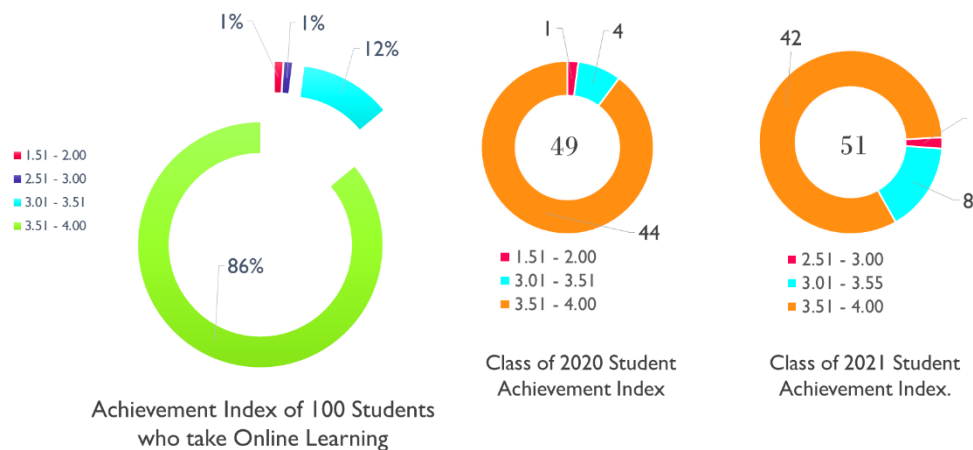


Figure 5. Achievement index for online learning students

Based on the achievement index data of students participating in online learning (see [Figure 5](#)), overall out of 100 students, 81% have a grade point average between 3.51 to 4.00, 12% have a grade point index 3.01 to 3.51, and 1% respectively for grade point average 2.51 to 3.00 and grade point average between 1.51 to 2.00. Separately, there are 49 students in class 2020, 44 of whom have a GPA of 3.51 to 4.00, there are 4 students who have an GPA of 3.10 to 3.50 and 1 person who has an GPA of 1.51 to 2.00. There are 51 students in class 2021, 42 of whom have a GPA of 3.51 to 4.00, 8 people have an GPA of 3.01 to 3.50 and 1 person has an GPA of 2.50 to 3.00.

Student perceptions of the process and achievements of online learning were obtained using questionnaires and questionnaires, and were strengthened by the results of interviews with respondents from several students. Student perceptions of the online learning process are measured based on nine sub-indicators, namely (1) achievement of understanding of course material, (2) smooth learning process, (3) time efficiency during the learning process, (4) interactions during the learning process, (5) the lecturer's attention to student needs/questions, (6) fees for online learning, (7) the level of obstacles encountered, (8) quantity of online learning assignments/projects and (9) the quality of online learning assignments/projects. Meanwhile, students' perceptions of online learning achievements consist of three sub-indicators, namely (1) the final score describes competence, (2) confidence in the competencies possessed, and (3) the success of online learning. Student perceptions of the online learning process are described as follows (see [Figure 6](#)).

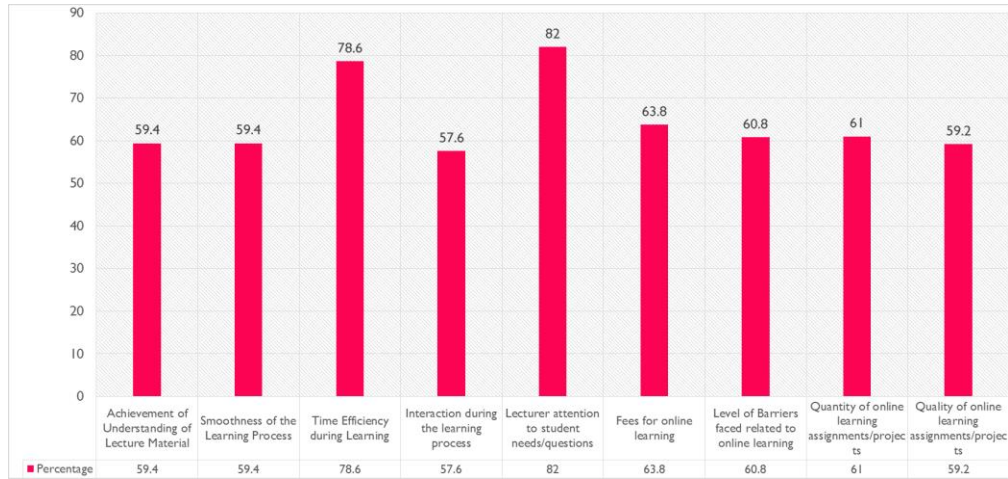


Figure 6. Student perceptions of the online learning

Based on Figure 6, it is explained that students have a perception of achieving understanding of the course material they are following during online learning only at 59.4%, and the smoothness of the online learning process they are participating at is also 59.4%. Regarding time efficiency during learning, students stated an efficiency of 78.6%. Regarding the interaction that was built between students and lecturers during online learning, students had a view regarding the interactions that occurred at 57.6%, and the attention given by lecturers to students' needs and questions during learning was at 82%. Regarding the costs and obstacles experienced by students in participating in the online learning process, data was obtained that the costs for the learning process were 63.8%, as well as the level of obstacles experienced by students when learning online was 60.8%. Finally, regarding assignments or projects during online learning, data on the quantity of assignments/projects during online learning was obtained by 61% and the quality of assignments/projects was 59.2%. Student perceptions of online learning outcomes are described as follows (see Figure 7).

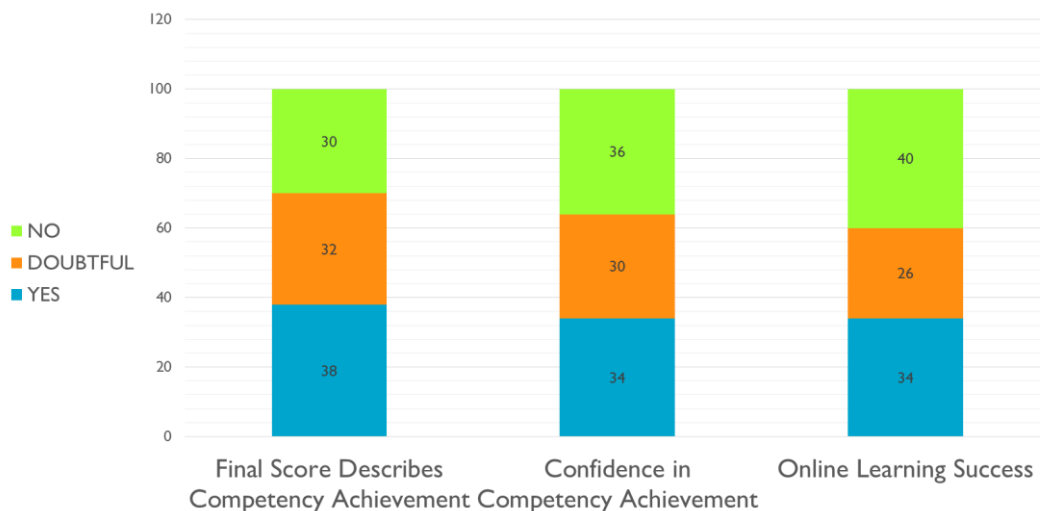


Figure 7. Student perceptions of online learning outcomes

Regarding the achievement of the final score whether the final score describes the competencies possessed by students, 38% of students believe that the final score describes

the competencies possessed, 32% of students doubt that their final score describes the competencies they have, and 30% of students are not sure that the final score describe their competence. Furthermore, regarding confidence in competence, 34% of students are confident in the quality of the competencies they have, 30% are unsure of the quality of the competencies they have, and 36% are unsure of the quality of the competencies they have after participating in online learning. Regarding their opinion on the success of online learning that they have gone through, 34% of students think that online learning has been successful, 26% of students have doubts about the success of online learning, and 40% of students think that online learning is not successful.

Based on the research results that have been obtained, the implementation of online learning requires an LMS that can be accessed and understood by users, both lecturers and students both in use and assessment (Dahlstrom et al., 2014; Sahin et al., 2021; Watson & Watson, 2007). The pandemic has caused higher education to be able to adapt in the learning process using IT and LMS that support online teaching and learning activities (García-Morales et al., 2021; Mishra et al., 2020). Identifying obstacles in using all LMS features and considering readiness to take part in online learning is one of the important factors to support smooth online learning, so that it becomes one of the aspects of LMS selection and organizing online learning (Hidayat et al., 2022; Irfan et al., 2020; Octaberlina & Muslimin, 2020; Tang et al., 2021). In addition, pedagogical competence in learning also needs to be a concern in organizing online learning (Zhao et al., 2021).

Regarding student perceptions of online learning and online learning outcomes, students consider that careful preparation is needed to ensure that online learning produces satisfactory outcomes according to learning objectives (Adnan & Anwar, 2020; Almusharraf & Khahro, 2020; Bestiantono et al., 2020). It is necessary to pay attention to the control and evaluation of learning in order to maintain the quality and outputs and outcomes of ongoing online learning (Elmunsyah et al., 2020; Giatman et al., 2020; Mishra et al., 2020; Pertiwi et al., 2021; Szopiński & Bachnik, 2022).

4. CONCLUSION

Based on the results of this study, the following conclusions were obtained: (1) Online learning for mathematics education study programs uses Google Classroom as the only LMS used; (2) Mastery of the LMS used by the majority is still below average, both for lecturers and students, with the level of mastery of lecturers being higher than that of students; (3) The lowest lecturer mastery of LMS is the use of features in the LMS. The lowest student LMS mastery is an introduction to the features of the LMS; (4) Regarding the practice and readiness of lecturers' learning for online learning, the accuracy of lecture duration is the lowest, while the highest is the implementation of the number of meetings and the implementation of UTS/UAS; (5) Learning achievement as seen from the student achievement index, the majority of students have GPA above 3.51; (6) Regarding student perceptions of the online learning process, the lowest score relates to the interaction between lecturers and students during the learning process, while the highest score is the lecturer's attention to student needs and questions during the learning process; (7) Regarding students' perceptions of online learning achievements, students are not fully convinced of the success of learning and competency achievements obtained from online learning; and (8) There is no significant effect of the implementation of online learning on learning outcomes, and there is a very weak close relationship between the implementation of online learning and learning outcomes.

REFERENCES

- Abidah, A., Hidaayatullaah, H. N., Simamora, R. M., Fehabutar, D., & Mutakinati, L. (2020). The impact of COVID-19 to Indonesian education and its relation to the philosophy of “merdeka belajar”. *Studies in Philosophy of Science and Education*, 1(1), 38-49. <https://doi.org/10.46627/sipose.v1i1.9>
- Adnan, M., & Anwar, K. (2020). Online learning amid the COVID-19 pandemic: Students' perspectives. *Journal of Pedagogical Sociology and Psychology*, 2(1), 45-51. <https://doi.org/10.33902/JPSP.2020261309>
- Aini, K. (2021). Analisis proses pembelajaran daring pada masa pandemi COVID-19 [Analysis of the online learning process during the COVID-19 pandemic]. *Jurnal Studi Guru Dan Pembelajaran*, 4(1), 218-228. <https://doi.org/10.30605/jsgp.4.1.2021.585>
- Almusharraf, N., & Khahro, S. (2020). Students satisfaction with online learning experiences during the COVID-19 pandemic. *International Journal of Emerging Technologies in Learning (iJET)*, 15(21), 246-267. <https://doi.org/10.3991/ijet.v15i21.15647>
- Anim, A., & Mapilindo, M. (2020). Persepsi mahasiswa pendidikan matematika tentang pembelajaran daring selama masa learn from home (LFH) pandemic COVID-19 [Perceptions of mathematics education students about online learning during the learn from home (LFH) pandemic COVID-19]. *Jurnal Mathematic Paedagogic*, 5(1), 72-80.
- Annur, M. F., & Hermansyah, H. (2020). Analisis kesulitan mahasiswa pendidikan matematika dalam pembelajaran daring pada masa pandemi COVID-19 [Analysis of the difficulties of mathematics education students in online learning during the COVID-19 pandemic]. *Paedagoria: Jurnal Kajian, Penelitian dan Pengembangan Kependidikan*, 11(2), 195-201.
- Azhari, B., & Fajri, I. (2022). Distance learning during the COVID-19 pandemic: School closure in Indonesia. *International Journal of Mathematical Education in Science and Technology*, 53(7), 1934-1954. <https://doi.org/10.1080/0020739X.2021.1875072>
- Bestiantono, D. S., Agustina, P. Z. R., & Cheng, T.-H. (2020). How students' perspectives about online learning amid the COVID-19 pandemic? *Studies in Learning and Teaching*, 1(3), 133-139. <https://doi.org/10.46627/silet.v1i3.46>
- Dahlstrom, E., Brooks, D. C., & Bichsel, J. (2014). *The current ecosystem of learning management systems in higher education: Student, faculty, and IT perspectives*. Louisville, CO: ECAR. <https://doi.org/10.13140/RG.2.1.3751.6005>
- Djalante, R., Lassa, J., Setiamarga, D., Sudjatma, A., Indrawan, M., Haryanto, B., Mahfud, C., Sinapoy, M. S., Djalante, S., Rafliana, I., Gunawan, L. A., Surtiari, G. A. K., & Warsilah, H. (2020). Review and analysis of current responses to COVID-19 in Indonesia: Period of January to March 2020. *Progress in Disaster Science*, 6, 100091. <https://doi.org/10.1016/j.pdisas.2020.100091>
- Elmunyah, H., Hidayat, W. N., Ulfa, S., Surakhman, E., & Wakhidah, R. (2020). Measuring user experience on personalized online training system to support online learning. *IOP Conference Series: Materials Science and Engineering*, 732(1), 012115. <https://doi.org/10.1088/1757-899X/732/1/012115>

- Fadila, R. N., Nadiroh, T. A., Juliana, R., Zulfa, P. Z. H., & Ibrahim, I. (2021). Kemandirian belajar secara daring sebagai prediktor hasil belajar mahasiswa pendidikan matematika UIN Sunan Kalijaga [Independent learning online as a predictor of learning outcomes for students of mathematics education at UIN Sunan Kalijaga]. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(2), 880-891. <https://doi.org/10.31004/cendekia.v5i2.457>
- Faozi, A. K. A., Hobri, Fatekurohman, M., Aini, K., & Yuniar, D. (2020). Student's problem solving abilities in project based learning (PjBL) based on learning community (LC). *Journal of Physics: Conference Series*, 1538(1), 012070. <https://doi.org/10.1088/1742-6596/1538/1/012070>
- García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario. *Frontiers in psychology*, 12, 616059. <https://doi.org/10.3389/fpsyg.2021.616059>
- Giatman, M., Siswati, S., & Basri, I. Y. (2020). Online learning quality control in the pandemic COVID-19 era in Indonesia. *Journal of Nonformal Education*, 6(2), 168-175.
- Hendriana, H., Prahmana, R. C. I., Ristiana, M. G., Rohaeti, E. E., & Hidayat, W. (2022). The theoretical framework on humanist ethno-metaphorical mathematics learning model: An impactful insight in learning mathematics. *Frontiers in Education*, 7. <https://doi.org/10.3389/feduc.2022.1030471>
- Hidayat, W., Rohaeti, E. E., Ginanjar, A., & Putri, R. I. I. (2022). An ePub learning module and students' mathematical reasoning ability: A development study. *Journal on Mathematics Education*, 13(1), 103-118. <https://doi.org/10.22342/jme.v13i1.pp103-118>
- Hidayat, W., Rohaeti, E. E., Hamidah, I., & Putri, R. I. I. (2023). How can android-based trigonometry learning improve the math learning process? *Frontiers in Education*, 7, 1016. <https://doi.org/10.3389/feduc.2022.1101161>
- Hutauruk, A. J. (2020). Kendala pembelajaran daring selama masa pandemi di kalangan mahasiswa pendidikan matematika: Kajian kualitatif deskriptif [Barriers to online learning during the pandemic among mathematics education students: A descriptive qualitative study]. *Sepren*, 2(1), 45-45. <https://doi.org/10.36655/sepren.v2i1.364>
- Irfan, M., Kusumaningrum, B., Yulia, Y., & Widodo, S. A. (2020). Challenges during the pandemic: Use of e-learning in mathematics learning in higher education. *Infinity Journal*, 9(2), 147-158. <https://doi.org/10.22460/infinity.v9i2.p147-158>
- Iskandar, B. A., Zulparis, Z., & Mubarak, M. (2021). Kendala perkuliahan praktik pembelajaran matematika secara daring bagi mahasiswa selama pandemi COVID-19 (Studi Fenomenologi) [Obstacles to online mathematics learning practice for students during the COVID-19 pandemic (Phenomenological Study)]. *Edu Cendekia: Jurnal Ilmiah Kependidikan*, 1(3), 81-87. <https://doi.org/10.47709/educendekia.v1i3.1076>
- Kusumaningrum, B., & Wijayanto, Z. (2020). Apakah pembelajaran matematika secara daring efektif? (studi kasus pada pembelajaran selama masa pandemi COVID-19) [Is learning mathematics online effective? (case study on learning during the COVID-

- 19 pandemic)]. *Kreano, Jurnal Matematika Kreatif-Inovatif*, 11(2), 136-142. <https://doi.org/10.15294/kreano.v11i2.25029>
- Manik, E. (2021). Menimbang kompetensi calon guru matematika dalam penyelenggaraan pembelajaran daring [Considering the competence of prospective mathematics teachers in implementing online learning]. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 5(1), 13-22. <https://doi.org/10.33603/jnpm.v5i1.4806>
- Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *International Journal of Educational Research Open*, 1, 100012. <https://doi.org/10.1016/j.ijedro.2020.100012>
- Nofriyandi, N., & Andrian, D. (2022). Factors that affect students' mathematics performance at higher education in Riau province during the COVID-19 pandemic. *Infinity Journal*, 11(2), 367-380. <https://doi.org/10.22460/infinity.v11i2.p367-380>
- Octoberlina, L. R., & Muslimin, A. I. (2020). EFL students perspective towards online learning barriers and alternatives using Moodle/Google Classroom during COVID-19 pandemic. *International Journal of Higher Education*, 9(6), 1-9. <https://doi.org/10.5430/ijhe.v9n6p1>
- Pertiwi, C. M., Rohaeti, E. E., & Hidayat, W. (2021). The students' mathematical problem-solving abilities, self-regulated learning, and VBA Microsoft word in new normal: A development of teaching materials. *Infinity Journal*, 10(1), 17-30. <https://doi.org/10.22460/infinity.v10i1.p17-30>
- Restian, A. (2020). Freedom of learning in the " elementary arts and culture" subject the character-based covid-19 pandemic. *Journal for the Interdisciplinary Art and Education*, 1(1), 55-62. <https://doi.org/10.29228/jiae.5>
- Sahin, M., Aydın, F., Sulak, S., Müftüoğlu, C. T., Tepgeç, M., Yılmaz, G. K., Yılmaz, R., & Yurdugül, H. (2021). Using adaptive mastery testing in assessment management systems. In 18th International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2021). https://doi.org/10.33965/celda2021_2021081025
- Simanjuntak, J., Sihombing, S., Purba, T. N., Hutaaruk, A., & Panjaitan, S. (2021). Analisis kegiatan pembelajaran pendidikan matematika pada masa Pandemi COVID-19 di negara asia (Indonesia, Jepang dan Filipina) [Analysis of mathematics education learning activities during the COVID-19 Pandemic in Asian countries (Indonesia, Japan and the Philippines)]. *Sepren: Journal of Mathematics Education and Applied*, 2(2), 47-55.
- Simarmata, R. J. (2022). Dampak pembelajaran hybrid learning pada kemampuan matematis siswa SMP Kalam Kudus Medan [The impact of hybrid learning on the mathematical abilities of SMP Kalam Kudus Medan students]. *Edumaspul: Jurnal Pendidikan*, 6(1), 456-461. <https://doi.org/10.33487/edumaspul.v6i1.3107>
- Siregar, H. M., Siregar, S. N., & Solfitri, T. (2021). Persepsi mahasiswa pendidikan matematika terhadap pelaksanaan perkuliahan online di masa pandemi COVID-19 [Perceptions of mathematics education students towards the implementation of online lectures during the COVID-19 pandemic]. *SAP (Susunan Artikel Pendidikan)*, 6(2). <https://doi.org/10.30998/sap.v6i2.9855>

- Suripah, S., & Susanti, W. D. (2022). Alternative learning during a pandemic: Use of the website as a mathematics learning media for student motivation. *Infinity Journal*, *11*(1), 17-32. <https://doi.org/10.22460/infinity.v11i1.p17-32>
- Sutriyani, W. (2020). Studi pengaruh daring learning terhadap minat dan hasil belajar matematika mahasiswa PGSD era pandemi COVID-19 [Study of the effect of online learning on the interest and learning outcomes of PGSD students in the COVID-19 pandemic era]. *Tunas Nusantara*, *2*(1), 155-165.
- Syarifuddin, S., Basri, H., Ilham, M., & Fauziah, A. F. (2021). Efektifitas pembelajaran daring mahasiswa pendidikan matematika ditengah pandemi COVID-19 [The effectiveness of online learning for mathematics education students amid the COVID-19 pandemic]. *JagoMIPA: Jurnal Pendidikan Matematika dan IPA*, *1*(1), 1-8. <https://doi.org/10.53299/jagomipa.v1i1.16>
- Szopiński, T., & Bachnik, K. (2022). Student evaluation of online learning during the COVID-19 pandemic. *Technological Forecasting and Social Change*, *174*, 121203. <https://doi.org/10.1016/j.techfore.2021.121203>
- Tang, Y. M., Chen, P. C., Law, K. M. Y., Wu, C. H., Lau, Y.-y., Guan, J., He, D., & Ho, G. T. S. (2021). Comparative analysis of Student's live online learning readiness during the coronavirus (COVID-19) pandemic in the higher education sector. *Computers & Education*, *168*, 104211. <https://doi.org/10.1016/j.compedu.2021.104211>
- Watson, W. R., & Watson, S. L. (2007). An argument for clarity: What are learning management systems, what are they not, and what should they become? *TechTrends*, *51*(2), 28-34. <https://doi.org/10.1007/s11528-007-0023-y>
- Widodo, S. A., Irfan, M., Trisniawati, T., Hidayat, W., Perbowo, K. S., Noto, M. S., & Prahmana, R. C. I. (2020). Process of algebra problem-solving in formal student. *Journal of Physics: Conference Series*, *1657*(1), 012092. <https://doi.org/10.1088/1742-6596/1657/1/012092>
- Zhao, Y., Pinto Llorente, A. M., & Sánchez Gómez, M. C. (2021). Digital competence in higher education research: A systematic literature review. *Computers & Education*, *168*, 104212. <https://doi.org/10.1016/j.compedu.2021.104212>