

Assessment of E-learning Activity During COVID-19 Pandemic using Data Science Technique

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ABSTRACT

The emerging of COVID-19 pandemic has become a threat to humanity, many activities of higher education forced to use Learning Management System. This sudden transition significantly changed traditional face-to-face learning into fully online or blended learning environments, requiring both lecturers and students to quickly adapt to digital platforms and new methods of interaction. It provides various tools such as online quizzes, discussion forums, assignment submissions, and learning resources that can be accessed anytime and anywhere. Through these features, lecturers are able to distribute materials, monitor student participation, and evaluate learning outcomes more efficiently. The log records include information such as login frequency, access to learning materials, participation in discussion forums, quiz attempts, and assignment submissions. By applying data mining, statistical analysis, and data visualization methods, complex and unstructured log data can be transformed into meaningful insights. These visual representations help management identify trends, monitor student engagement, evaluate learning effectiveness, and support strategic decision-making in improving the quality of education. Processing log large data was optimized by the use of Graphics Processing Unit (GPU) and python programming language to extract, transform and load data (ETL) then convert the information to specific chart. By analyzing the result, we found some information regarded to student total activities by date, day, hour and also heatmap chart which represent total student activities by hour and day. Finally, the whole series of the processes are proposed as the assessment of e-learning activity on higher education.

INTRODUCTION

Covid-19 virus are enveloped, non-segmented, single-stranded, positive-sense RNA viruses that have a characteristic appearance on electron microscopy-negative staining (Guarner, 2020). The first case was reported at December 1, 2019 (Huang et al., 2020). On 31 December 2019, the WHO China Country Office was receive information of cases of pneumonia with unknown etiology (unknown cause) occur in Wuhan City, Hubei Province of China. The Clinical examination indicated a shared strain of pneumonia, which was named 2019-nCoV, or 2019 novel coronavirus (Huang dkk., 2020). Concurrently, the case has increase highly because the coronavirus outbreak that conduct the World Health Organization (WHO) to announce a Public Health Emergency of International Concern (Lai dkk., 2020).

The difficulty of predicting the stopping of this pandemic causes uncertainty and confusion in economic, social, and political institutions, as well as human interaction between others (Roman & Plopeanu, 2021). Education is one of the big aspects highlighted in the COVID-19 pandemic that will affect the quality of education that students get from school. On the 15th of May 2020, more than 1.2 billion student, about 70 percent of the total classroom member, from 158 countries, were forced to study at home by global lockdown (Guarner, 2020). Since the COVID-19 pandemic hit Indonesia, the government issued regulations on social activities on a large scale. One way to deal with the spread of this pandemic is to implement social restrictions, this results in the need for new ways of teaching and learning activities to ensure students do not miss learning and prevent the pandemic from spreading.

E-Learning is characterized by distance learning as all learning process virtualized through an electronic channel (medium), like the internet, for example, using learning management system (Wong dkk., 2020). E-education, distance learning, and online learning are all different kind of E-learning (Alqahtani & Rajkhan, 2020). E-learning has several nature, namely: 1) Stores and/or transport learning material on CD-ROM, local internal or external memory, or servers on the Internet or intranet; 2) Content related to particular course; 3) Deliver the content through media element such as picture and video; 4) A lot instructional methods such as best practice, tutorial and feedback; 5) Online class meeting (synchronous learning) lead by instructor or individual study through learning management system (asynchronous



learning); 6) Helps students acquiring new knowledge and skill according to their learning goal or increase organizational quality(Clark & Mayer, 2023).

In e-learning environments, student and teacher do not interact physically in order to teaching and learning process. This will lead to spatial and temporal gap that show kind of challenge for assessing students whether they can adapt with change and acquisition of skill and knowledge(Daradoumis dkk., 2013). The traditional face to face method were changed by e-learning when Covid-19 viruses spread around the world because it is known that interaction inside classroom become opportunity for virus to influence each other. E-learning is the best method available to prevent virus do not spread as it make social distancing despite of some challenge and learning model, which affected to student from this type of education.

One way that can be used to accommodate online learning in order to support, facilitate distance studies runs well during pandemic is to use LMS (Learning Management System). LMS is one of an information technology as purposed to manage and support the distance learning asynchronously, provide learning material and enable corporation between teacher and student. Inside learning management system, student can take learning material given by lecturer, do some forum activity, module resources and assignment.

One of the popular learning management systems available on the internet is MOODLE (Modular Object-Oriented Dynamic Learning Environment). MOODLE is web based and open-source software designed for online based learning. The MOODLE LMS is created to support instructor in order to make online courses that enable students to participated in interactive and collaborative environment. The main purpose of this LMS is to provide the instructor a learning medium which effectively present the knowledge to the student. Moreover, it can help student to acquiring new knowledge, skill and experience(Hasan dkk., 2019).

However, in terms of using Moodle as a new main learning platform there are many challenges faced by lecturers when teaching in the classroom according to Qureshi, et. all (Qureshi, 2012)¹³who identified the challenges on implementing e-learning, the researchers found that biggest challenge was electricity failure and English proficiency. Another research that was conducted by Zboun & Farrah about the challenges and benefits of online learning during the pandemic revealed that the main challenges were the internet connection and lack of training from both lecturers and students when studying e-learning. Students get bored because there are no interactions in real-time, they prefer a traditional classroom where there is a face-to-face interaction between the lecturers and students. Data science can be used to analyze problems in e-learning and find out whether the implementation of e-learning has been effective or not.

During Covid-19 pandemic, e-learning considered as alternative solution to do studying activity inside higher education because of flexibility on time, location, and health issues. E-learning, especially by using Learning Management System improve the knowledge through the availability of massive data and increase collaboration. Although e-learning can increase the quality of education there is a question about what is the specific type of evaluation that can be made(Maatuk dkk., 2022). In other hand, Learning Management System also produce high load of the server. Importantly, data science project also plays important role as assessment-related data evidently reliable to extract important knowledge. Moreover, Data Science techniques have proved to give valuable information to make assessment process become more understandable(Lara et, al., 2020).

In recent years, the evaluation of Moodle-based e-learning has attracted considerable scholarly attention, particularly in relation to its effectiveness, usability, instructional value, and contribution to student learning outcomes. The literature published over the last five years suggests that Moodle continues to be recognized as one of the most widely adopted and pedagogically versatile learning management systems in both secondary and higher education contexts. Its popularity is largely attributed to its open-source nature, flexibility, and extensive range of features that support course organization, content delivery, communication, assessment, and learning monitoring (Gamage et al., 2022). At a general level, the existing body of research indicates that Moodle provides a strong technological foundation for online and blended learning environments; however, the success of its implementation depends not merely on the availability of the platform, but on how effectively it is designed, managed, and integrated into pedagogical practice (Gamage et al., 2022; Simon et al., 2025).

A recurring theme in the literature is that Moodle should not be evaluated solely as a technical platform, but rather as a learning environment shaped by instructional decisions and user interaction. Several studies have shown that Moodle is capable of supporting a wide range of educational activities, including content distribution, asynchronous discussion, online quizzes, formative and summative assessment, collaborative tasks, and learning analytics-based monitoring (Zainudin et al., 2024; Alvarez & Villamañe, 2024). These features make Moodle especially valuable in contexts where institutions seek to promote flexible learning, continuous assessment, and student-centered instructional approaches. At the same time, the literature also emphasizes that the pedagogical effectiveness of Moodle is not automatic. Rather, meaningful learning outcomes are more likely to emerge when course content is clearly structured, activities are purposefully designed, and students are provided with coherent guidance throughout the learning process.

Another research focuses on the usability of Moodle, which has become a central criterion in contemporary evaluations of e-learning systems. Usability studies consistently report that while Moodle is functionally rich, users do not always experience the platform as intuitive or easy to navigate. Common issues identified in the literature include complex menu structures, inconsistent course layouts, cognitive overload caused by poorly organized content, and

interface designs that may not be equally accessible to all learners (Agjei, R., & Jimoh, 2023). These findings suggest that the technical completeness of an LMS does not necessarily translate into a positive learning experience. In fact, when the platform is poorly designed from the user's perspective, it may create barriers that reduce learner engagement and satisfaction. This concern is further reinforced by research adopting the Universal Design for Learning perspective, which argues that Moodle evaluation should also consider inclusivity, accessibility, and the extent to which the platform accommodates diverse student needs (Liliana et al., 2024).

Student and teacher perceptions also play an important role in the literature on Moodle evaluation. Recent empirical studies reveal that users' experiences with Moodle are shaped not only by the platform's technical affordances, but also by the quality of course design and instructional facilitation. From the student perspective, positive perceptions tend to emerge when Moodle courses are visually clear, logically sequenced, easy to access, and aligned with learning objectives (Al-Fraihat, 2025). Conversely, negative perceptions often arise when students encounter disorganized resources, unclear instructions, or an excessive number of tasks without sufficient pedagogical coherence. From the teacher perspective, the literature indicates that Moodle can serve as an effective platform for monitoring participation and supporting teaching decisions, particularly when instructors are able to interpret learner data and engagement patterns through analytics tools (Agjei, 2023). Nevertheless, this also implies that successful Moodle implementation depends heavily on instructors' digital competence, their understanding of online pedagogy, and their ability to transform platform features into meaningful learning experiences.

In addition to usability and perception, recent studies have increasingly expanded the scope of Moodle evaluation by incorporating learning analytics and quality assurance dimensions. This marks an important shift in the literature, as evaluation is no longer confined to questions of access and technical performance, but now includes broader concerns such as service quality, interaction quality, learner behavior, and academic achievement. For example, studies on digital learning traces in Moodle have demonstrated that student activity data can provide useful insights into patterns of participation and their association with academic success (Dalia et al, 2025). Similarly, broader evaluations of e-learning quality in higher education highlight the importance of usability, reliability, responsiveness, and overall user satisfaction as essential indicators of system quality (Wolniak & Stecula, 2024). Such findings suggest that Moodle evaluation is increasingly becoming multidimensional, combining technical, pedagogical, behavioral, and institutional perspectives in order to provide a more comprehensive understanding of e-learning effectiveness.

The literature also points to the importance of assessment practices within Moodle-based environments. Moodle is often praised for its capacity to facilitate not only conventional testing but also more complex forms of assessment, including continuous assessment, feedback-oriented evaluation, and structured learning tasks supported by digital tools (Alvarez & Villamañe, 2024). This reinforces the view that Moodle can contribute substantially to the development of meaningful assessment ecosystems when used strategically. However, the effectiveness of such assessment practices is contingent upon careful planning, appropriate task design, and alignment between assessment activities and intended learning outcomes. In this regard, the platform functions best not as a substitute for pedagogy, but as a tool that can enhance pedagogical intent when used with clarity and purpose.

Overall, the literature reviewed demonstrates that Moodle remains a significant and relevant platform for e-learning implementation, yet its quality and effectiveness cannot be assumed simply because the system is available. The evidence consistently shows that Moodle-based e-learning is most successful when evaluation encompasses multiple dimensions, including usability, instructional design, accessibility, user experience, interaction quality, learning analytics, and academic outcomes. Therefore, the current scholarly conversation increasingly positions Moodle not merely as a technological infrastructure, but as a pedagogical environment whose value depends on the quality of its educational design and implementation (Gamage et al., 2022; Simon et al., 2025). In this sense, evaluating Moodle-based e-learning requires a holistic perspective that recognizes the interdependence of technology, pedagogy, and user experience in shaping effective digital learning environments especially during covid-19 pandemic.

Data science is an interdisciplinary field that uses scientific methods, processes, algorithms, and systems to extract knowledge and insights from noisy, structured, and unstructured data and apply knowledge from data across a broad range of application domains. Data science is related to data mining, machine learning, and big data. It understands the phenomenon of the data. It employs techniques and theories drawn from many fields within the context of mathematics, statistics, computer science, and information science. In the method of using data science, many execution methods are used to process the data, one of which is using the Python programming language. It is high-level, interpreted, and acts as a general-purpose programming language. Python designed its philosophy to emphasize code readability with the use of significant indentation. Python also provides a large set of comprehensive standard libraries which is extensible. The main features of Python are Simple and easy to learn, Freeware and open source, High-level, Simple and easy to learn, Freeware and open source, High-level programming language, Platform independent, Portability, Dynamically typed, Both procedure-oriented and Object-oriented, Interpreted, Extensible, Embedded, Extensive Library.

Python is preferred over other data science tools. The reason is Python's Features which make it a generous choice for data science. Python Features are: Easy to learn, Scalable, and Variety of Libraries, its Ecosystem, and Visualization. Python's biggest power for data science lies in the great Python libraries and modules available for data

science. This research was made to carry out Data science techniques on Big Data Moodle as a form of evaluation of e-learning activities during covid 19. The evaluation was carried out to answer the following questions: 1) What days are the most active users?; 2) What time is the most active user?; 3) How many activities per date?; 4) Comparison of hours and days.

METHOD

The type of this research is Descriptive Research. This research is conducted to provide specific information about a phenomenon related to e-learning activity inside Widyatama University. We describe how much student and teacher spend their time during study in certain course. In the initial step, we already have MySQL admin access to the Moodle database and dump whole log table which called logstore_standard_log table into csv flat file. Second, change csv format with python programming language, pandas library, and GPU processing into parquet file due to optimize the processing of large file. Third, use the data science technique to slicing parquet dataset into regular student only. Selecting the dataset based on userid, only 2000 userid of regular student selected as parameter from parquet into csv format. Fourth, csv format as final dataset already to be processed for further step. The next involves implementation data science technique to make some reporting such Daily activity, total activity by hour, total activity by name of day and heatmap which represent correlation between day and hour.

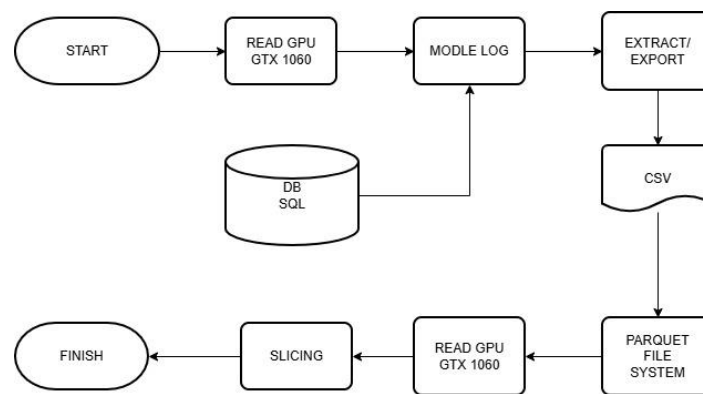


Figure 1. Moodle log operation flow

This study implemented a multi-stage data pipeline to acquire, store, transform, and preprocess GPU monitoring data from an NVIDIA GeForce GTX 1060 shown by figure 1. Initially, the system was started and GPU parameters were captured through a dedicated reading process. The acquired measurements were forwarded to a Moodle log, which interfaced with an SQL database for persistent and structured data storage. The logged records were then extracted from the database environment and exported in CSV format as an intermediate data representation. To enhance storage performance and support efficient downstream processing, the CSV files were converted into a Parquet-based file system. The transformed data were subsequently reloaded from the Parquet repository and subjected to a slicing procedure using data science technique in python programming language. The dataset was segmented into relevant subsets according to the processing requirements. This end-to-end procedure enabled efficient handling of GPU monitoring data from raw acquisition to analysis-ready output related to measurement of elearning activity.

In this research, we use Moodle log data from daily activity of elearning inside Widyatama University from 11 February 2022 until 27 July 2022. Teacher on each course upload some resources such as modul, forum, quiz and assignment during semester. Not whole column inside logstore_standard_log table used in this research, the dump SQL data only on id, eventname, action, target, edulevel, contextid, contextinstanceid, userid, courseid and 'timecreated. There are is a reason why limiting column user. The table column represent certain information, this research tried to answer research question related to user, time and activity dimension. Therefore, this is enough to fulfil the top level management requirement and the purpose of this research.

RESULT

Figure 2 shows total activity from 11 February 2022 until 27 July 2022. The pattern represent the most active day when elearning visited by student. From the experiment result, we analyze that the student login to elearning website and doing some learning process sometime it takes high level of activity within each week. It is happened due to in particular date, student gathered and doing the most studying activities. For example on 21 February, 2 March, 7 March, 14 March, 21 March, 28 March, 4 April, 11 April, and 18 April the bar reach its peak. Lower activities are conducted by student on Saturday and Sunday, this is reasonable because on the weekend there are less activities on elearning. In the other hand, this is interesting because even though weekend there are still activity among student by learning on certain course. The other benefit from this level activity is server administrator can monitor when the server load reaches its peak and how system handle this. As long as server is not down and could handle users requests, admin doesn't have to

worry. Then server administrator could make prediction and evaluate server performance to make better service quality to elearning users.

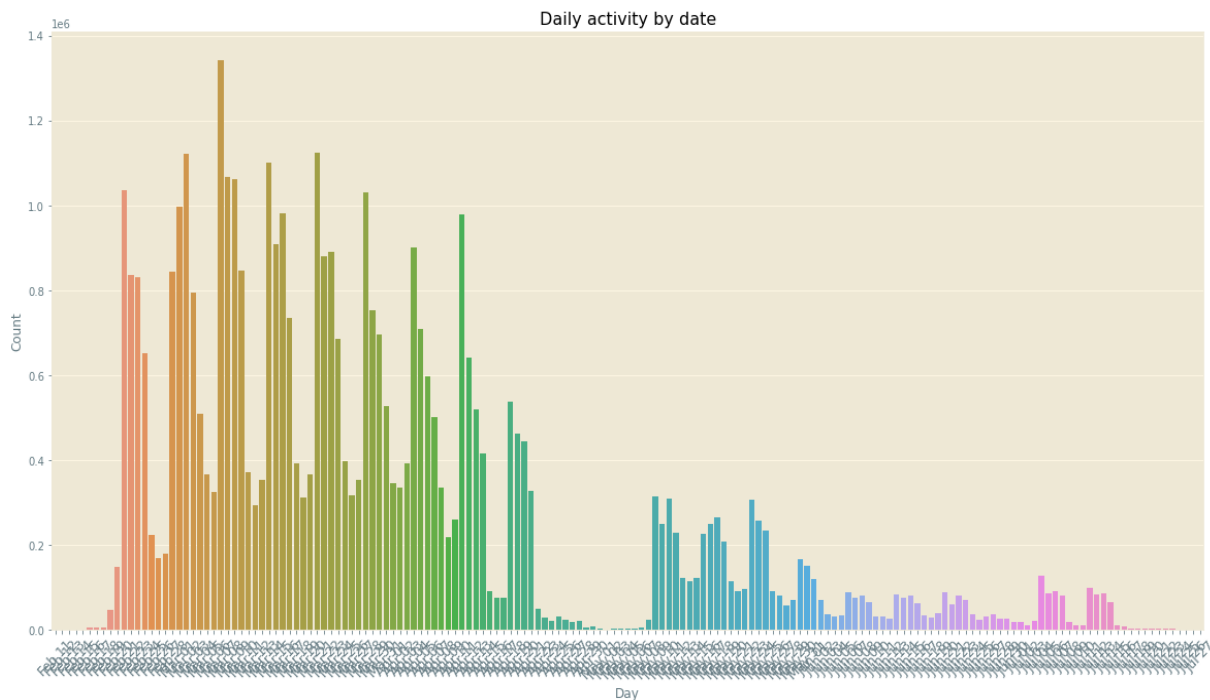


Figure 2. Daily Student Activity

Figure 3 is result of the experiment to answer the question about what the most active hour during the period. Student participate learning activity inside Moodle course with specific pattern. Within 24 hours, total activity could be sorted from highest into lowest. The experiment result shown by figure represent that the highest student activity is at 8 until 9 am, about 7.9%. Around 7% from total activity on 9 until 10 am and 11 until 1 pm. There are some activities at evening, above 4%. This means, regular students even though the class schedule start from 7 am until 6 pm, they still study at evening whether opening course module, doing assignment and another action inside elearning. The experiment result shown by figure 3 represent that the highest student activity is at 8 until 9 am, about 7.9%. Around 7% from total activity on 9 until 10 am and 11 until 1 pm. There are some activities at evening, above 4%. This means, regular students even though the class schedule start from 7 am until 6 pm, they still study at evening whether opening course module, doing assignment and another action inside elearning.

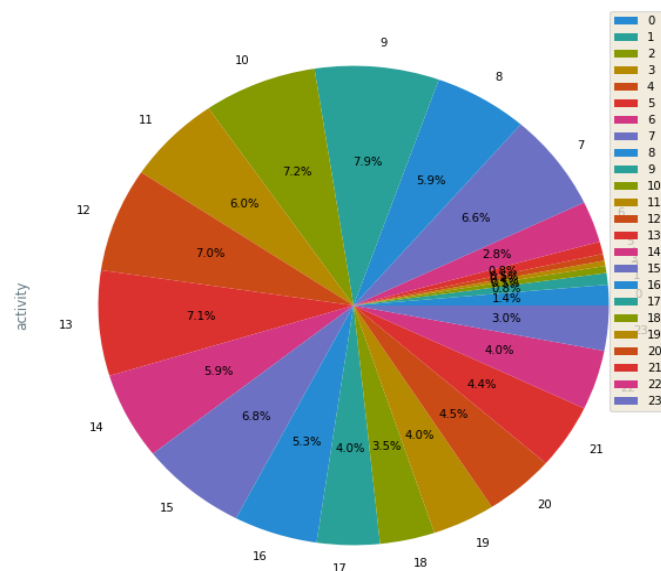


Figure 3. Student elearning activity by hour

Figure 4 represents the most activity by regular student based on specific day. Monday become the day which student doing elearning activity at most, its about 24.4% followed by Tuesday, Wednesday and Thursday above 10%. It is interesting that Sunday shows activities although holiday, student still active and do some learning inside elearning website. It is caused by some possible result, one of them is student tried to complete some course assignment or quiz and because of assignment deadline on the next day. This information also useful to measure learning quality, and some assessment can be conducted based on the finding result.

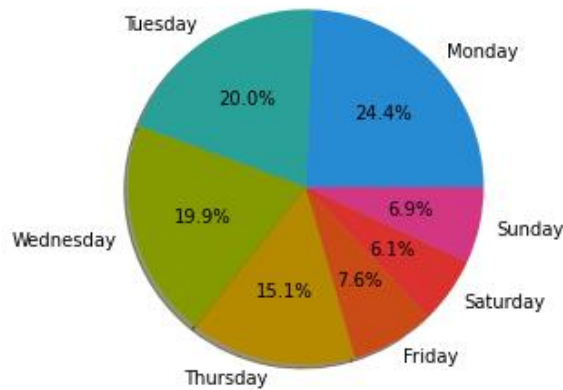


Figure 4. Student elearning activity by day

Figure 5 shows the correlation between day and hour within the context of total activity. Darker color represents highest activity count based on y axis as hour and x axis as day. Therefore, this image can conclude what time which student most active between days of week. Around Monday, Tuesday, Wednesday and Thursday show darker color due to of high activity by student. Friday until the end of week, activity become lower. It is interesting that Friday had lower activity, although there are still learning schedule on that day. Student tends to take a rest early and doing less activity inside some course resources.

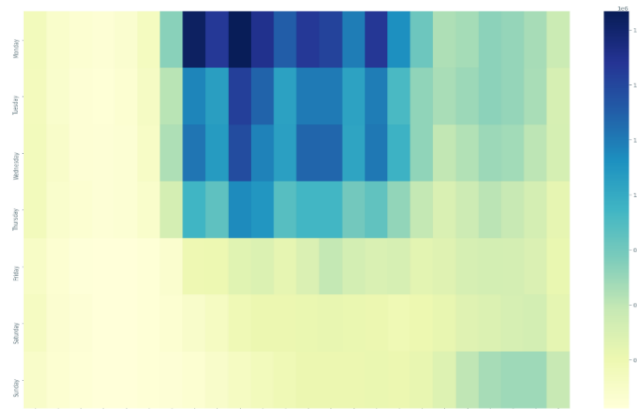


Figure 5. heatmap e-learning activities based on hours and days

There are many other things can be done as further finding from Moodle log analysis. Skill and creativity in data science is the key point when trying to extract information from raw log data, in other hand top level management support also influencing what kind of information that to be collected. Top level management have a vision and certain point of which can be communicated to data scientist as requirement for next target of information.

DISCUSSION

Based on the result of this study, the data science technique was able to reveal contained information inside raw data. Another research uses Moodle log data as evaluation method but limited only on user based on training course with smaller size of dataset. For more size of large elearning dataset, especially Moodle usage inside Higher Education needs better technique to handle some evaluation requirements. In this research, we use Python programming language and some library such as Pandas which is well known as tool to do some data analytic. Furthermore, the analytics itself is speed up using GPU processing, it is made easier with the support of python programming language and Pandas to do some task related to execute code which fully use of GPU processing.

Data science skill become important, especially inside higher education. A person with data science skill can convert raw data into specific information in order to improve quality of education particularly during covid-19 pandemic. Online study through asynchronous tool like Moodle need more monitoring schema as evaluation.



Implementation of data science technique like slicing of large data, making some plot or graph and code algorithm into log data can make better understanding about real condition of online learning. Hence, management or faculty can make better decision based on the experiment result in order to improve quality of education.

The experiments are represented as graphic as purpose to be more readable by non IT member especially top management level. Generally, Figure 1 show total activity within 1 semester, if looked more deeper, there is subtraction activity at the half end of the graph. This will be sign of evaluation to Teacher and major of student to keep activity up and stable until the end of semester. Figure 2 can be use by lecturer to see the most active hour when student studying on particular course. Event though, Figure 2 can be more analyzed per course, it is not difficult by a data scientist to modify and improve the code. Total activity by day are shown on Figure 3, it is useful for IT unit when predicting server load. High server load or scalability issue has make heavy load of the elearning server (Maatuk et al., 2022). Statistic result shown by Figure 3 can help IT unit to plan usage strategy or some policy in order to prevent server down. Correlation between day and hour represented by Figure 4, this information also useful IT unit inside Widyatama University because of more detailed information contained on it. For example, it is known that Monday at 9 am until 10 am elearning server reach high load condition because of a lot of student activity on that hour. Some policy can make by management to divide user to equally divide their activities inside elearning, so that the activities not stack into one time.

CONCLUSION

Based on the results of the result and discussion, it can be concluded that: 1) Processing of Moodle log data is important as most of studies are held in online learning. Especially during Covid19 pandemic, monitoring system through learning management system is needed constantly to keep the good quality of education. 2) Python programming language and optimized the process through GPU processing made some important information like graphic bar of total activity count during certain periods. From the information, it is known that the total activities are decrease from May until the end of semester. Hence, agement can make certain policy to keep activities remain stable at the next semester. IT unit also can pay more attention at Monday, because the peak traffic occurs on Monday morning around 9 am. Some mitigation plan can be made to minimizing the impact of down server. This study prove that Moodle log data can represent specific type of collective evaluation for higher education in order to improve the quality of education. Data science technique also proved to give important information for assessment process online learning in higher education especially in asynchronous learning through Moodle learning management system. The results of the study provide suggestions for practitioners to pay attention to Moodle log Data, especially as data science provide some method to extract important information about activities inside elearning.

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