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IDENTIFICATION OF COVID-19 PATIENTS' EFFECT ON EDUCATION OUTCOMES IN ISLAM MAJORITY STUDENT USING SPATIAL ANALYSIS

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ABSTRACT
The COVID-19 epidemic has had an impact on the educational landscape, particularly the move to a remote learning model utilizing internet media. This system has so many issues that we need to do an extensive educational assessment of the subject. In order to create an educational map of the mathematics learning scores of the Islam Majority Student population during the COVID-19 epidemic in SMP Pekanbaru City, Indonesia, this study used spatial analysis. The distribution of the number of patients who tested positively was related to the geographical analysis of the learning score. The majority of the city's western and eastern regions had few patients and did not improve the score for mathematics education, according to a comparison of the two maps. On the other hand, a small percentage of the northern and western regions revealed that the few patients raised the Mathematics education score. A tiny portion of the southern region discovered that the score for mathematics education fell as the proportion of positive patients rose. Furthermore, the fewest patients are found in tree-lined, deserted locations, yet there are still few schools there. In Pekanbaru City, the majority of the schools are still located in urban areas devoid of pleasant open spaces.
Keywords: *Spatial Analysis, Positive COVID-19, Mathematics, COVID-19 Pandemic, Junior High School*

1. Introduction

The World Health Organization (WHO) issued a warning on January 30, 2020, declaring a state of urgency due to the Coronavirus illness 2019 (COVID-19) from China (Sohrabi, et al., 2020; Song & Karako, 2020; Talevi, et al., 2020). Various initiatives and tactics have been used by nations around the world to combat the rise in the number of infected patients. Utilizing isolation, which rigorously limits the physical distance between people when engaging in activities (Koh, et al., 2020; Marroquin, et al., 2020), is done to remedy this condition (Smith & Freedman, 2020). Nearly 300 million people, or 3.52% of the world's population, live in Indonesia (World Bank, 2020). The COVID-19 infectious pandemic was announced by the Indonesian Ministry of Health on February 4, 2020. The first two instances were confirmed by the government on March 2, 2020. By April 2, 2020, there were 1,790 confirmed cases, 1,508 people receiving treatment, 170 people passing away, and 112 people making a full recovery.

To stop the spread of COVID-19, the Indonesian government placed limits on activities performed outside the home, required people to wear masks, wash their hands, and keep physical and social distance. The Ministry of Education and Culture has also released a number of rules, such as the ban on national final exams and the policy on online education, to stop the virus from spreading. Nadiem Makarim, Minister of Education and Culture, gave technical instructions on how to stop the spread to all Education Units at all levels. The technical methods are divided into three groups based on risk: low, medium, and high. Since the first positive instance on March 9, 2020, this is valid for one week. Face-to-face instruction was quickly replaced with distance learning in all academic units from kindergarten through higher education. The principles of the learning process are combined with technology in this system (Cucu & Aprilinda, 2016). Numerous online tools that enable contact and engagement during learning at more flexible times and locations include video conferencing, zoom, and WhatsApp groups (Gunawan, et al., 2020; Zaharah, 2020).

Online and offline learning strategies can be used for distance learning. While this is going on, online learning can be conducted via a web network and an endless number of users (Dabbagh & Bannan-Ritland, 2007; Putria, 2020; Rigianti, 2020; Apriyansah et al., 2022). During the COVID-19 pandemic, this is regarded as suitable and comfortable for students. Using media like radio, television, or face-to-face systems, offline learning can be done without a network connection to the internet (Herliandry, 2020; Zhang, et al., 2020; Syaliman et al., 2022). Online media are becoming teachers' and lecturers' main areas of concentration in the classroom due to the trend toward home study. However, employing these medium for distance learning also has certain drawbacks. The growth of online media is currently outpacing the change in the way that knowledge is taught and learned. As a result of the learning process being divided among numerous benefits of cellphones, there is a decrease in both the quality and amount of the material delivered. Smartphones with high-speed internet connections can access this material. As a result, in addition to communication, it can also communicate images, audio, movies, and huge documents (Edosomwan, 2011; Kurniawan, 2022). It facilitates communication between individuals and disseminates video news, marketing materials, how-to guides, help, and even political campaigns. This is accomplished by offering a variety of capabilities that enable knowledge to be distributed to an infinite audience (Cohen, 2009).

Face-to-face interactions as a means of instructor control over students will also become increasingly shaky and infrequent. The usage of internet media in the sphere of education will lead to a large classroom. In this broad area, people with various objectives and even fictitious identities are frequently observed (Hartshorn, 2010). Due to the scale of the virtual classroom provided by online media, the use of online media in learning and teaching frequently causes delays in the teacher's reaction. Online media is a communication system or channel as a result, which makes it difficult to get the right reaction or answer in line with expectations (Badell, 2010). The interaction between students will be reduced by distance learning that prioritizes online media because students would get bored more rapidly (Nurkholis, 2020).

2. Literature Review

Results of online distance learning during the epidemic should be properly assessed in a particular area. This will generate data on the particular subject areas most impacted by distance learning, highlighting the poor level of comprehension reflected in the lesson's lower ratings. It can also be used as a starting point for a regional leader to develop plans to counteract the pandemic's detrimental effects on the standard of regional education that he oversees. The number of positive patients is also directly tied to the pandemic in a certain area. In contrast to the learning outcomes, the distribution map created through spatial analysis will be useful. The areas most impacted by this distribution are determined by its impact on the learning evaluation. Additionally, it details the qualities that make highly good school settings with the least chance of being negatively impacted. The impact on numerous events has drawn significant attention using geographical analysis. The Indonesian Government is concentrating on regions that are stable in producing rice during the pandemic season as a result of mapping of rice sales during the COVID-19 pandemic season (Nasir, et al., 2021). Spatial analysis was used to examine the impact on the environment and was displayed on a map of the Beijing region (Han, et al., 2021). The COVID-19 epidemic caused numerous socio-demographic changes in the Brazilian region as well. Spatial analysis in Brazil was used to confirm this information (Raymundo, et al., 2021).

The total number of positive patients in the Pekanbaru region as well as all Mathematics learning scores were obtained using the universal kriging interpolation approach. These scores will be analyzed using surfing software. The distribution map of patients in the Pekanbaru City region and a mathematics learning score will be used in the display. The two will be compared as a result, and the results will aid in addressing the study's goals.

Education has made extensive use of spatial analysis. A genuine advantage of spatial analysis is the ability to select a good school based on a location that fosters high-quality learning

(Lebienski & Dougherty, 2009). By applying a spatial analysis-generated map of the educational institutions in a given area, evaluation of educational services may be carried out (Hisham, 2016). One of the key applications of spatial analysis is the mapping of comparisons of different variables to demonstrate the links between these variables. A breakthrough in demonstrating the relationship between the two factors may be seen, for instance, in the comparison of the mapping of gender and lesson score variables to indicate the influence in understanding particular subjects (Murhayati, et al., 2019).

Distinguishing regions with low admittance to testing and high case the trouble is important to figure out risk and distribute assets in the Coronavirus pandemic (Marizal, 2022). Cordes, & Castro, (2020) looked at testing rates, positivity rates, and the proportion of students who were positive using zip code-level data for New York City. Clusters with high and low testing rates, high positivity rates, and a high proportion of positives were discovered using a spatial scan statistic. Pearson correlations and boxplots were used to find connections between outcomes, clusters, and contextual factors (Kwok, et al., 2021; Marizal & Nurmita, 2021). Bunches with less testing and low extent positive tests had higher pay, training, and white populace, while groups with high testing rates and high extent positive tests were lopsidedly dark and without medical coverage. White race, education, and income had negative correlations with the proportion of positive tests, while black race, Hispanic ethnicity, and poverty had positive correlations. We suggest testing and medical care assets be coordinated to eastern Brooklyn, which has low testing and high extent up-sides.

Data

The provincial capital of Riau, Pekanbaru, is located in a tropical region. There are about 2 million people living there, and the majority of this diverse population are private sector employees. In this city, the majority of junior high schools (SMP) are Islamic, and they are frequently located near heavily populated residential areas.

Table 1 - Coordinate and NEM for Junior High School in Pekanbaru

Junior High School	Average score	Latitude	Longitude
SMP NEGERI 1 PEKANBARU	69.62	0.526278	101.4537
SMP NEGERI 2 PEKANBARU	46.24	0.532261	101.442
SMP NEGERI 3 PEKANBARU	52.40	0.524268	101.432
SMP NEGERI 4 PEKANBARU	81.44	0.526206	101.4563
SMP NEGERI 5 PEKANBARU	61.31	0.526947	101.4537
SMP NEGERI 6 PEKANBARU	55.24	0.572081	101.4372
SMP NEGERI 7 PEKANBARU	32.01	0.535894	101.4654
SMP NEGERI 8 PEKANBARU	68.22	0.462326	101.4345
SMP NEGERI 9 PEKANBARU	49.13	0.494018	101.4871

Table 2 - Coordinate, Number of COVID-19 Positive Case for Village in Pekanbaru

Village	Latitude	Longitude	Number of COVID-19 Positive Case
Palas Village	0.571453	101.3854	22
Umban Sari Village	0.579684	101.3981	33
Lembah Damai Village	0.575813	101.4429	17
Lembah Sari Village	0.571151	101.4516	22
Limbungan Village	0.567135	101.4463	55
Limbungan Baru Village	0.567162	101.4398	22
Tampan Village	0.540647	101.419	12
Kampung Baru Village	0.537666	101.4337	17
Meranti Pandak Village	0.571453	101.3854	22

The COVID-19 epidemic at selected junior high schools in Pekanbaru City or the Mathematics course grade during distance learning were taken into consideration when conducting the study. Data on the grades for the junior high school topics are shown in Table 1 in some cases. Figure 1 displays the latitude and longitude position coordinates. Table 2 and Figure 2 show data and coordinates for a few villages. The locations selected are evenly distributed over the majority of Pekanbaru, as seen in Figures 1 and 2. As a result, it is possible to effectively apply the universal kriging method to acquire scores for all coordinates. However, the majority of SMP and villages are still few in the eastern section because there are fewer people living there.

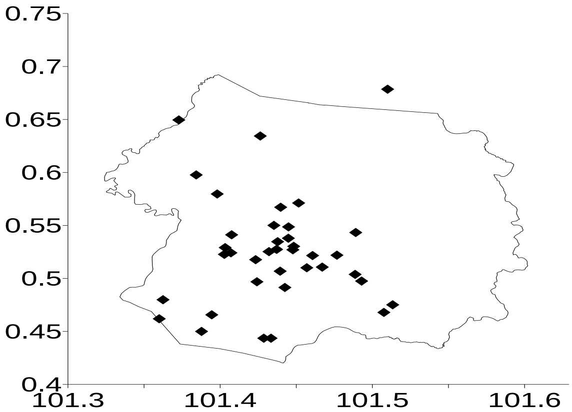

Fig. 1. Village Coordinates and Locations in Pekanbaru

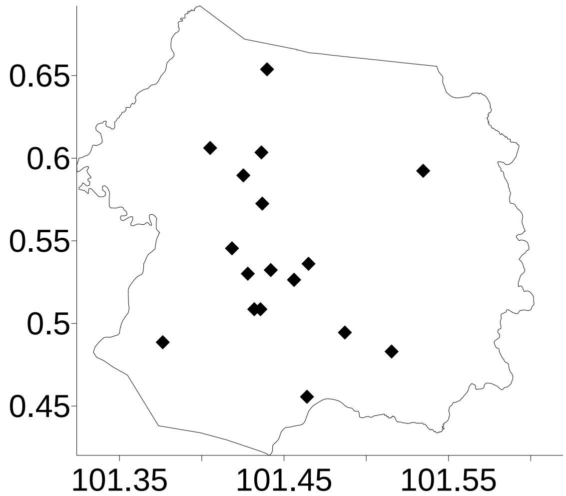

Fig. 2. Location and Coordinates of Junior High School in Pekanbaru

3. Research Methods

Kriging Spatial Analysis and Interpolation

The primary element of mapping that is used to study a *phenomena* is spatial data. Its primary properties are latitude and longitude geographical coordinates. In stations, schools, and monitoring centers with particular coordinates, for instance, phenomena like rainfall scores, wind speed, educational scores, and the score of the number of COVID-19 positive patients were recorded (latitude and longitude). For each coordinate point position mapped into an area, a score should be produced. However, a challenging mathematical formulation is needed to create phenomenon ratings for all coordinate positions. The phenomenon score is created using the interpolation approach (Fotheringham, et al., 2000). There are several benefits and drawbacks to the interpolation techniques that can be used to retrieve all of the scores at coordinates for an area. Kriging is one of the interpolation techniques used in this geographical study. The Kriging method is thoroughly explained in a number of papers (Amri, et al., 2016; Amri, et al., 2017).

Kriging is a technique for estimating a phenomenon's score when spatial data is available. A number of mathematical equations will be used to generate the phenomenon scores at sites where measurements have not been made (Wackernagel, 1994). There are various types of Kriging calculations, including Co-Kriging, Ordinary Point Kriging, Ordinary Block Kriging, and Universal Kriging (Olea, 1999). Additionally, Universal Kriging shows a striking propensity to trend (Kambhammettu, et al., 2011). It can also be seen as an evaluation technique to address the issue of sample data non-stationarity, which can assist with issues in practical situations. Software has been developed that allows interpolation to be done while also automatically converting the results into visual maps. An area on a map can be interpolated and visualized using surfing software, for instance. Demography, epidemiology, political science, and sociology are just a few of the fields that have used these methods.

Universal Kriging and Semivarogram

In this study, the universal kriging interpolation technique will generate all scores for the phenomenon of the Mathematics exam for Junior High Schools and the number of positive COVID-19 patients in Pekanbaru City. In addition, Universal Kriging can be determined by specifying the general form of the semivariogram as in the following equation:

$$\hat{\gamma}(h) = \frac{1}{2N(h)} \sum_{i-1}^{N(h)} \left[\left(Z(x_i + h) - m(x) \right) - \left(Z(x_i) - m(x) \right) \right]^2$$

with

$\hat{\gamma}(h)$: experimental semivariogram score with distance *h*
$Z(x_i)$: the score of observations in x_i
$Z(x_i + h)$: the score of observations in $x_i + h$
$m(x)$: trend (drift) equation
$N(h)$: number of point pairs within *h*

As indicated in table 3, the three mathematical models and variables sill (c), range (a), and distance (h) can be used to calculate the semivariogram's score. Prior to 2004, utilizing mathematical solutions, the solution was quite challenging. However, in 2004, a mathematical package in the R programming language was made available, expressly for tackling issues brought on by the three mathematical equations in table 3, making it much simpler to complete the model. To address spatial analysis issues, the package converts mathematical equations into a computer programming language (Bivand, et al., 2013). As a result, the GStat R Program can be used to assess the Universal Kriging Method.

Table 3 - Models for Estimates Semivariogram

Mathematical model	Model equation
Spherical model	$\gamma(h) = \begin{cases} c\left[\frac{3}{2}\left(\frac{h}{a}\right) - \frac{1}{2}\left(\frac{h}{a}\right)^2\right], & h < a \\ c. & h \geq a \end{cases}$
Gaussian model	$\gamma(h) = \begin{cases} c\left[1 - exp\left(\frac{-3h^2}{a^2}\right)\right], & h < a \\ c, & h \geq a \end{cases}$
Exponential model	$\gamma(h) = \begin{cases} c\left[1 - exp\left(\frac{-3h}{a}\right)\right], & h < a \\ c, & h \geq a \end{cases}$

4. Results and Discussions

Every State Junior High School in Pekanbaru provided information on math test results during the COVID-19 pandemic, particularly six months after the first positive case was found there. The number of virus-infected people in each Pekanbaru sub-district will also be analyzed using geographical analysis. Descriptive statistics will be used to present the basic information for the two categories of data, as shown in Table 4. The number of COVID-19 positive patients has a data variation of 275.23, which is a considerable difference between the two types of currently available data. The statistically significant difference suggests that the subject scores and the number of positive patients for the Pekanbaru region are fairly diverse. At the start of this episode, the average was still somewhat low (18.65). With a variation score of 161.93, the data ranges from 1 to 66 individuals dispersed around the region. The mathematics score similarly varies substantially. This variation further demonstrates the wide range of early-onset student skills. The average ability to learn mathematics is 45.32, which means that in order to improve their ability to understand mathematics, difficulties must be predicted rapidly. Only a few few children in a select few schools are capable of mastering Mathematics at the start of the epidemic, as seen by the large differences and low averages. This conclusion is further supported by the wide range or difference between the minimum and highest data of 52.34, which shows that there is a sizable disparity in the comprehension of mathematics among the pupils in each Pekanbaru school.

Table 4 - Descriptive Statistics for Mathematics Scores and Number of COVID-19 Positive Patients

Statistics	Mathematics Score	Number of COVID-19 Positive Patients
Min	29.10	1
1sr Qu	35.13	6.00
Median	44.48	14.00
Mean	45.32	18.65
3rd Qu	51.99	26.00
Max	81.44	66.00
Var	161.93	275.23

By visualizing the data as a map of Pekanbaru City, as seen in Figure 3, spatial analysis will be used to conduct an overall study of the number of positive patients. This number showed that there are different numbers of patients in Pekanbaru City. According to the numbers on the scale, the more blue there is, the more COVID-19 patients there are. In Pekanbaru, the majority of the southern region and a tiny portion of the northern region have the greatest proportion of positive patients. This is in line with the fact that there are many residential settlements in these locations, which is a common reality in the neighborhood. The locations are also crowded with Pekanbaru City's commercial, educational, and office hubs. On the other hand, in the majority of the eastern regions and a small portion of the western region in Pekanbaru City, the results are different. In these places, the number of positive patients is relatively low. This is because they are far from the city center, have low population distribution, and have many places planted with green trees (Prabowo, 2018; Basuony, et al., 2021; Budiarti, et al., 2021).

The distribution of arithmetic test scores for Pekanbaru City junior high school pupils is indirectly impacted by the aforementioned spatial study. As a result, an extensive analysis of these scores is also done for every area of Pekanbaru. Figure 4 illustrates the distribution of scores for junior high school mathematics as a result. One interpretation is that a better mathematics score corresponds to a darker blue tint. The image demonstrates that despite the fact that there are still a few COVID-19 positive patients, the majority of the eastern region and a small portion of the western region have low scores in mathematics. These findings also show that online media remote learning tactics are ineffective (Muttaqin, et al., 2020; Awais, et al., 2020; Khan, et al., 2022). The Pekanbaru government will likely find this information invaluable as it assesses the local educational system.

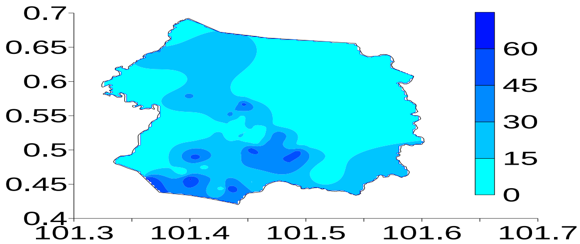

Fig. 3. Distribution Map for the Number of COVID-19 Positive Patients in Pekanbaru

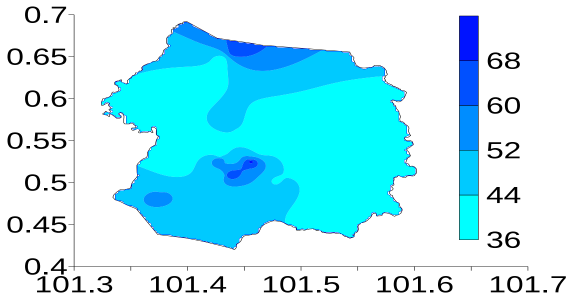

Fig. 4. Distribution Map of Junior High School Mathematics Scores in Pekanbaru

The Pekanbaru City education office needs to find the best approach to raise this area's low score in mathematics. The community's data also demonstrate that residents in this area still have lower-middle income levels, which contributes to the poor Mathematics score during the epidemic by making it impossible for them to purchase smartphones and internet credit. Therefore, the government should look for free or inexpensive internet credit packages and give junior high school pupils in the area access to old or reasonably priced smartphones (Pranzo, et al., 2023).

The junior high schools in the area may receive new or used cellphones from the Pekanbaru City Government. Additionally, a tiny portion of the northern region highlighted in Figure 5 demonstrates that regions with the fewest COVID-19 positive patients had the highest subject scores, like the regions ringed in Figure 6. One can infer that these regions have successfully implemented a remote learning system employing internet media. The intriguing findings demonstrate that the junior high school pupils in the region are not overly affected by the pandemic because Pekanbaru City has the fewest positive patients overall this is in line with research Zuhri, et al., (2020), and Supriyanto, et al., (2021). Low scores in mathematics will follow regions with a high proportion of positive patients, such as a tiny portion of the southern region, as seen in Figures 5 and 6. The distribution of the number of COVID-19 positive patients has a significant impact on the Mathematics scores in a number of Pekanbaru locations (Darwis, et al., 2022).

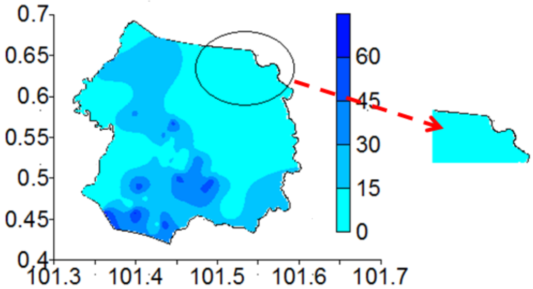

Fig. 5. Partial Distribution of Regions with the Lowest Number of COVID-19 Positive Patients

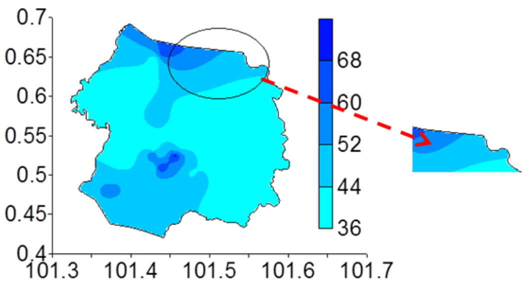

Fig. 6. Partial Distribution of the Regions with the Highest Mathematics Scores

Furthermore, a fascinating result is that some locations with specific coordinates in a small part of the northern region in Pekanbaru with the smallest number of COVID-19 patients are inhabited by a less dense population. For example, figure 7 shows several locations far from the crowds, and there are still many green plants. However, the area still has very few junior high schools

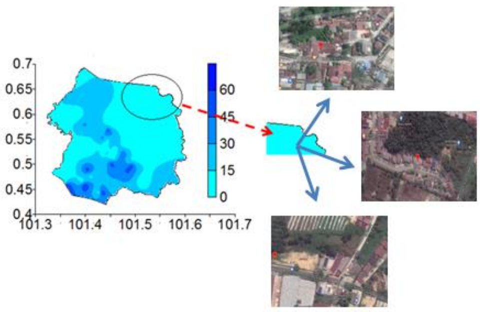

Fig. 7. Environmental Situation at Certain Coordinate Locations

5. Conclusion

This study used online media for distant learning and applied map comparison to illustrate the findings of spatial analysis for mathematics score data. The number of positive patients' data can also provide the government with crucial data for assessing this distance learning system. First, the government needs to set aside a specific amount of money to help communities that are unable to implement this distant learning procedure with affordable internet and smartphone facilities. Second, in areas where COVID-19 positive patients are most prevalent, strong health protocols should be implemented and closely followed. This study demonstrates that a higher percentage of COVID-19 positive patients can lower math test scores. Third, setting up a distance learning system in densely populated areas is inappropriate. To create junior high schools in sparsely populated areas, pertinent information should be made available. This area should be removed from the bustle of the city and have flora that will be important in the future.

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