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Worksheet to Built Critical Thinking Skills for Prevalence Covid-19 in Indonesia on Limited Time: Curve Matching Modelling

To cite this article: Wawan Bunawan *et al* 2021 *J. Phys.: Conf. Ser.* **1819** 012064

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Worksheet to Built Critical Thinking Skills for Prevalence Covid-19 in Indonesia on Limited Time: Curve Matching Modelling

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Abstract. Data on the spread of covid 19 in Indonesia is usually displayed in the form of a bar chart and a graph of the function of the number of people versus time for cases of increase, death and recovery. Display data in the form of graphs and diagrams is quite adequate for use in television news shows or breaking news. The Covid 19 case can be used as a source of authentic learning data in the Data Processing Workshop course investigation. Curve matching based data modelling can be developed in the form of scientific worksheets. The challenge of developing worksheets is at what stages must be done in order for the mathematical model to match the distribution of the data. The development of worksheets has met the academic requirements in terms of pedagogy and knowledge content. The validity and reliability of the worksheets have met the requirements according to the validator's decision and evidence of empirical data analysis. Worksheets are developed based on excel, SPSS and Matlab with studies based on critical thinking skills. The scientific worksheets can improve critical thinking skills needed in the 21st century with several relevant indicators. The limitation of this study is that the prediction formula produced still does not meet the real data that occurs for cases of infection, recovery and death for a long time interval. The original research contained in the learning source data is authentic and continues to move during the pandemic. data is inputted into scientific worksheets that apply critical thinking skills in excel, spss and matlab presentation.

1. Introduction

Currently the Covid-19 pandemic in Indonesia is already at a very worrying stage in terms of its number and distribution cluster, even though in everyday life it has implemented WHO health standards. Based on the official institution confirmed positive 111,455. Being in care 37,244 (33.4%), recovered 68,975 (61.9%), died 5,236 (4.7%) of all confirmed cases. The number of cases of people infected with Covid-19 at this time when compared to sufferers in April 2020 has increased a lot[1]. Analysis of the number of cases of increase, recovery and death based on certain time intervals, whether the data trend is the same or slightly different, is certainly very interesting to observe.

Remuzzi, A., & Remuzzi, G describe cases of the spread of Covid-19 following an exponential trend between real data and simulation data. There are several interesting things that can be expressed in criticizing the relationship between real data and simulation data[2]. The first is what arguments can be given to test the accuracy of the curve matching method between simulation data and real data. Second, how the basic pattern is used to match the curve between the real data and the simulation data.

Third, how to make rational decisions and considerations against this mathematical model, and the fourth, how to develop problem-solving methods for similar cases.

Tuli et al [3] describe a framework for various possible analyzes of the COVID-19 pandemic concerning analytical activities, development of prediction machines, Covid data bases, patient care, specialized hospitals, government centers and other gateways (gateway devices). Analytical opportunities for the COVID-19 pandemic in the realm of education, especially as a source of authentic information or data for learning materials, are still not widely found in educational scientific journals. Data on the spread or increase of infected patients, the number of patients recovering and dying from Covid during a certain period of time can be used as a source of learning data by integrating it through scientific worksheets. Worksheets that have critical thinking characteristics are one of the right opportunities to improve student competence.

Scientific worksheets can be used to improve critical thinking skills in exploring the relationship between real data and simulation data. Scientific worksheets were developed to perform data analysis on the increase in the number of infected patients, the increase in cured cases and deaths. Scientific worksheets are developed based on critical thinking skills with the following domains: (1) the ability to argue effectively, (2) use systems thinking, (3) make considerations and decisions and (4) ability to solve problem[4].

The data processing workshop course aims to develop analytical skills and data-based critical thinking skills, the ability to predict and describe the data cases it handles[5]. The case of the Covid 19 pandemic in Indonesia is a source of real data that can be used as learning material in this course. Scientific worksheets are a means of learning activities that can be used to achieve effective and efficient learning goals. The main focus of the study is how to use scientific worksheets that can improve critical thinking skills by reviewing the data on the Covid-19 pandemic case in Indonesia within a certain period of time.

2. Literature Review

Several studies state that the growth of Covid-19 cases follows an exponential pattern[3,6]. Hasan claims that the accuracy of the linear model is slightly lower than the exponential and polynomial models in explaining the prediction of the spread of covid-19[7]. It is very interesting that the exponential and polynomial models have the same impact as in Table 1. It is interesting to study whether the spread is Covid-19 in Indonesia follows an exponential or polynomial model for a certain period of time.

Table 1. Comparison of impac various models of the spread of covid 19[3].

ANN Performance Comparison Analysis with some Traditional Statistical Analysis				
		MSE	**R-Squared**	**Significance**
Regression Analysis	Linear	6.59e+05	0.8146	<0.0001
	Exponential	2.87e+05	0.9646	<0.0001
	Polynomial	1.44e+05	0.9912	<0.0001
Moving Average	Linear	2.36e+09	0.9990	<0.0001
	Exponential	0.024238	0.9957	<0.0001
	Polynomial	1.87e+08	0.9999	<0.0001
EEMD-ANN	Training	**6.42E-06**	**0.99997**	<0.0001
	Validation	**8.72E-05**	**0.99981**	<0.0001
	Testing	**3.763-05**	**0.99982**	<0.0001

The increase in cases infected with the Covid-19 virus in Italy from February 19 to March 10, 2020 is expressed in exponential form as in Table 1[2]. The graph in Figure 1 shows the number of infected patients and simulated cases of increasing the number of patients in Italy in 20 day intervals. Plotting real data on the addition of infected cases does not involve critical analysis steps, why is that, because

it only shows the distribution of data. On the other hand, plotting simulation data requires critical steps such as curve matching, whether the curve can provide accurate predictions for longer time intervals, whether the curve formula meets the statistical test requirements. Whether a simulation data model like this is suitable for the increase in cases of Covid 19 infection in Indonesia, still requires further analysis.
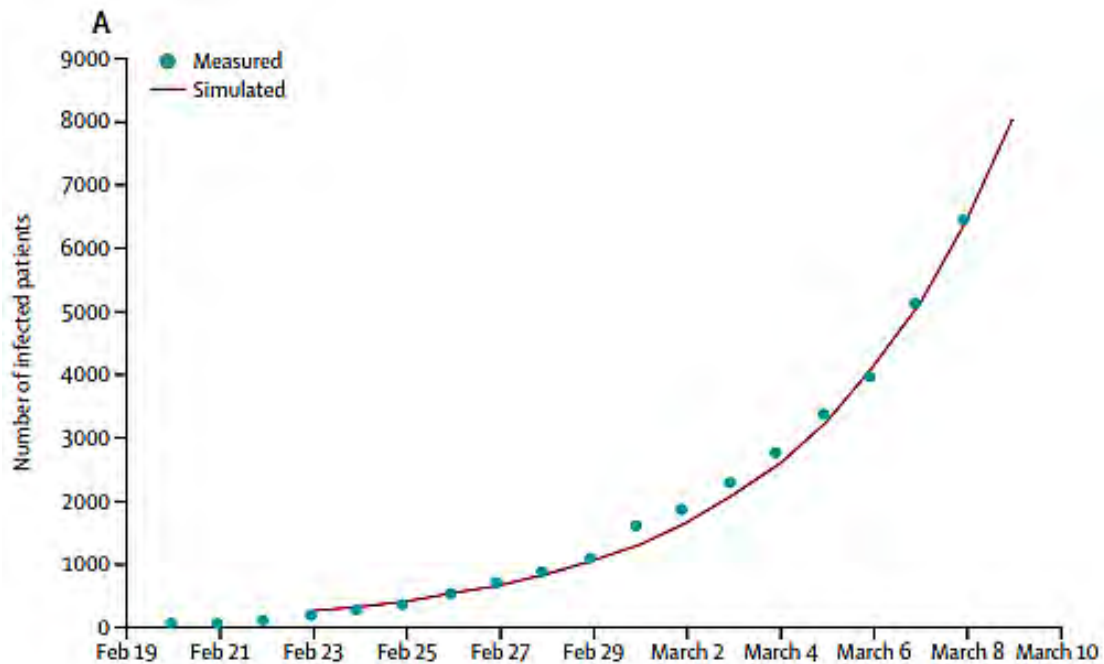

Figure 1. Measured and predicted number of patients reported to be infected in Italy using an exponential curve [2]

One of the objectives of the competence developed in the data processing workshop course is to be able to improve critical thinking skills based on the results of data analysis. The ability to think critically is an active, sustainable thinking activity with careful consideration of his beliefs, knowledge, and background that supports him to provide conclusions that accompany it. In the context of learning at universities, critical thinking appears in many activities such as (1) increasing the quality of questions and the emergence of various problems as well as clear and precise formulations, (2) collecting and evaluating relevant information, (3) achieving proper explanations in providing conclusions and assessments that exceed existing criteria and standards. (4) open in considering other systems of thought or other points of view, (5) communicate effectively with solutions and other analyzes related to problems and questions.

Several standards of thought in providing an evaluation of the ability to think critically in developing scientific worksheets are (1) clarity (easy to understand and free from confusion and ambiguity), (2) accuracy (free from errors, distortion, error (3) precision (accurate, definite and exact) (4) significant (important relative to others) (5) deep (meets complexity) (6) broad (7) logical (true reasoning with system principles, concepts and assumptions based on scientific disciplines, (8) fairness (considering all the possibilities that have a role to something being considered).

## 3. Methods

3.1 Participant.

The implementation of scientific worksheet development is carried out for the Data Processing Workshop course in the odd semester of 2020 for two classes of the Physics Education study program. Classes with a smaller number of students (24 students) are used to provide input on the development of worksheets with unique treatment in improving the quality of the worksheets. Classes with more students (40 students) as a place for implementing the worksheets that have been produced previously.

3.2 Data Sources

In Indonesia, the Covid-19 pandemic is handled by an institution known as a task force, one of its tasks is to provide various information via official institution site[1]. Data on the number of infected cases, the number of patients recovered and died in the form of graphs and diagrams from a certain period of time are always available. The data source used to develop scientific worksheets is real data originating from the official government website with a display as shown in Figure 2. The next process is that students are asked to perform critical analysis based on the worksheet to transform graphic data into table data using the excel program, followed by SPSS and Matlab.
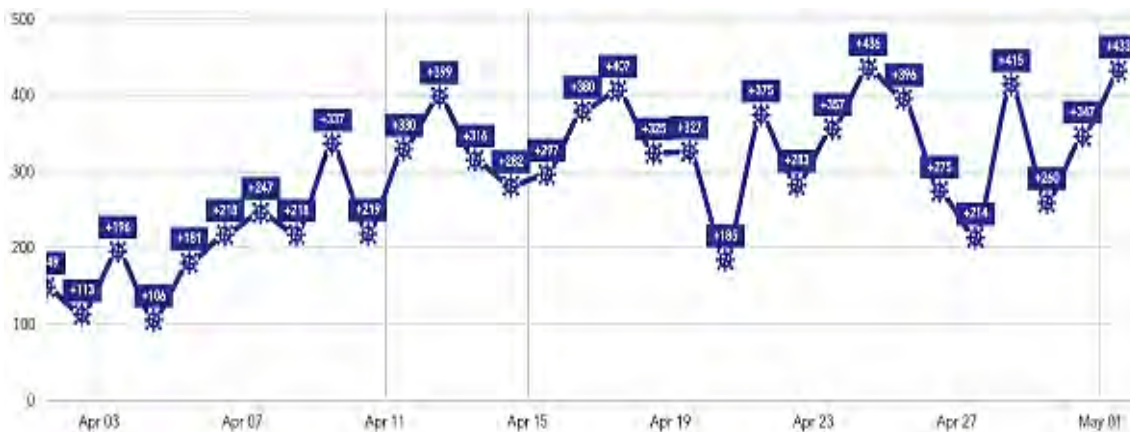
(a)
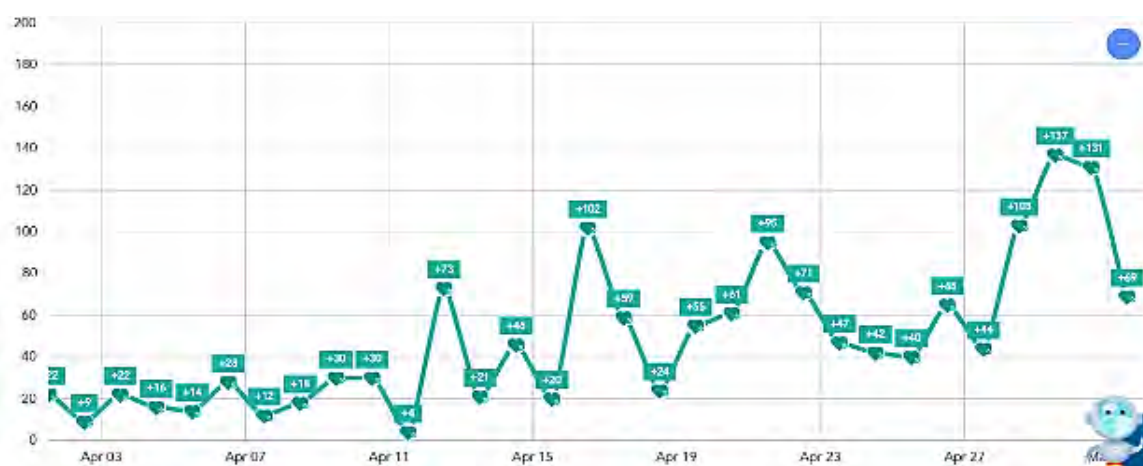
(b)
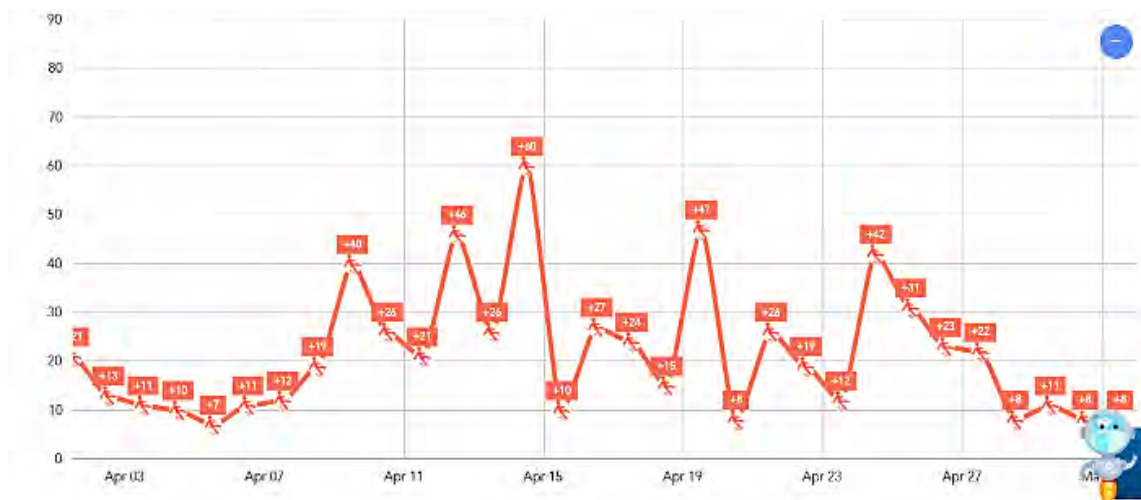
(c)

Figure 2. The increase in infected cases (a), cured cases (b), and death cases (c) starting from 01 April-01 May 2020 [1]

3.3 Research Analysis
The steps taken to measure critical thinking skills using scientific worksheets are: (1) downloading data on the increase in cases of infection, recovery and death from the covid-19.go.id site in a scatter plotting view as in Figure 2. (2) doing transforming initial data into table data in excel, (3) translating table data into scatter plotting, (4) predicting data or simulation data using the trend data formula in step 3, (5) conducting statistical tests using SPSS to test validity and reliability of simulation data and real data, (6) to improve critical thinking skills, the next step is to simulate data trend equations using the Matlab program (m-file) (7) to predict and analyze cases using the M-file program in Matlab and plotting data.

4. Results and Discussion
Scientific worksheets that are built to be able to provide data descriptions and analysis of cases of the increase in the number of Covid-19 infected in Indonesia during a certain period of time, cases of recovery and death can be seen in Figure 3. Critical thinking skills adopted from 21st century thinking skills are developed based on suitable indicators a synthesis was carried out with data from the COVID-19 pandemic in Indonesia to become a source of learning in the form of scientific worksheets. Scientific worksheets are developed to guide students to analyze and critique raw data from the original source. Manipulating the data by substituting the empiric data into a trend data equation with curve matching equation models that are considered relevant. Organize with descriptive and predictive views.
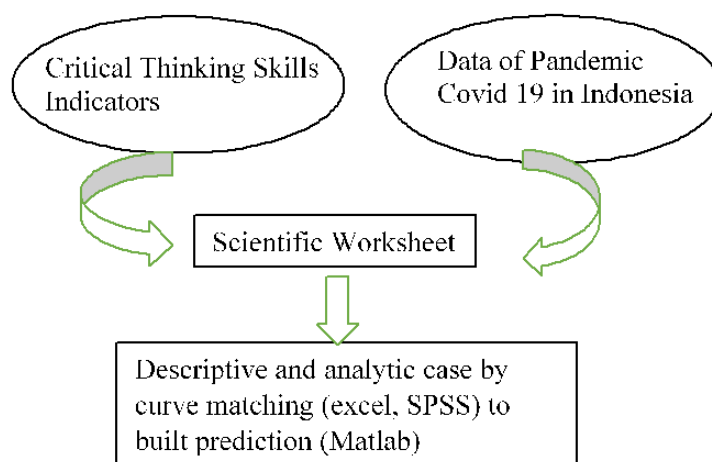
Figure 3. The working mechanism of the scientific worksheet

Scientific worksheets that have been produced related to critical thinking can be seen in Table 2. The critical thinking skills needed in the 4.0 era are the ability to give reasons effectively. This capability is integrated into worksheets using the Matlab program in order to test synthetic data formulas. Formula analysis uses arguments inductively or deductively. The findings obtained by implementing this scientific worksheet are that the ability to provide scientific arguments is related to synthetic data formulas in predicting the number of cases of infection, recovery and death. The prediction formula for death cases is still not satisfactory. This fact shows that the method used needs to be revised by using other methods that have better accuracy. Additional cases of infected and cured had a good predictive rate using the polynomial equations model in scientific worksheets.

Subsequent findings Scientific worksheets succeeded in building a thinking system for analyzing data tables into graphs as a function of the number of cases versus time. Likewise, the worksheet has succeeded in building a test of a coefficient from the equation or data trend formula whether it meets the statistical test requirements using SPSS.

Another finding is that scientific worksheets have succeeded in building critical thinking skills to make decisions and consider whether the distribution of data meets the wrong mathematical model of data trends for various Covid 19 cases over a certain period of time. One of the shortcomings of scientific worksheets is that they are still unable to generate critical thinking skills to predict the number of cases increasing, dying or recovering, this is because it requires specific knowledge of how to write an M-file program in Matlab. The ability to predict using formulas that are built into the M-file Matlab can only be done by a few students, but if you use Excel, the ability is very adequate.

Table 2. Implementation of the dimensions of critical thinking skills to the worksheet

21 st Century Thinking Skills	Worksheet On Excel	Worksheet On SPSS	Worksheet In Matlab
REASON EFFECTIVELY Use various types of reasoning (inductive & deductive)			Exam the synthetic data
USE SYSTEM THINKING Analyze how parts of whole interact with each other to produce overall outcomes in complex	Analyze table data to create relevant graphs	Test the validity of a data trend equation	
MAKE JUDGEMENT AND DECICIONS			

|			
Effectively analyze and evaluate evidence, arguments, claims and beliefs. Analyze and evaluate major alternative points of view. Synthetize and make connection between information and argument. Interpret information and draw conclusions based on the best analysis. Reflect critically on learning experience and processes **SOLVE PROBLEMS**	Choose a data trend equation model that matches the actual data	Provide a decision whether the data trend equation meets the inferential statistical rules	
Solve different kinds of non familiar problems in both conventional and innovative way. Identify and ask significance question that clarify various point of view and lead to better solution		Perform case predictions using the M-file program	
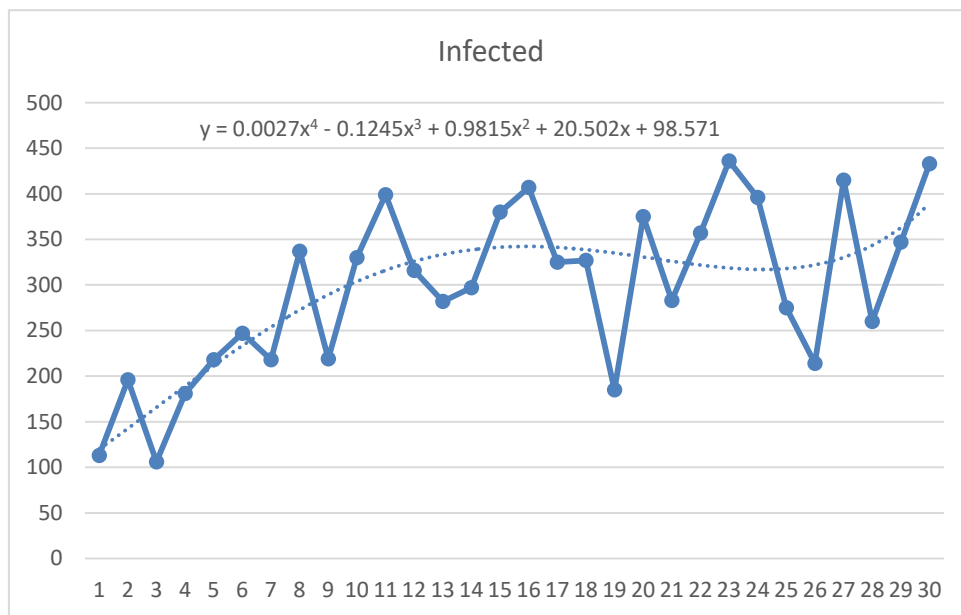
Figure 4. (a) Graph of data trends in COVID-19 infection in April

Real data released by the government for the month of April as a reference source is translated using the instructions in the worksheet so that the trend of data on infected cases is generated as in Figure 4. (a) with the formula:

$$y = 0.0027\,x^4 - 0.1245x^3 + 0.9815x^2 + 20.502x + 98.571 \tag{1}$$

with χ is the day. This worksheet is done using excel data processing base. After completing the data processing, testing is carried out using SPSS to provide justification whether the equation coefficient and the mathematical model meet the statistical requirements. Figure 4 (b) is a prediction graph developed using the M Matlab file for the same month.
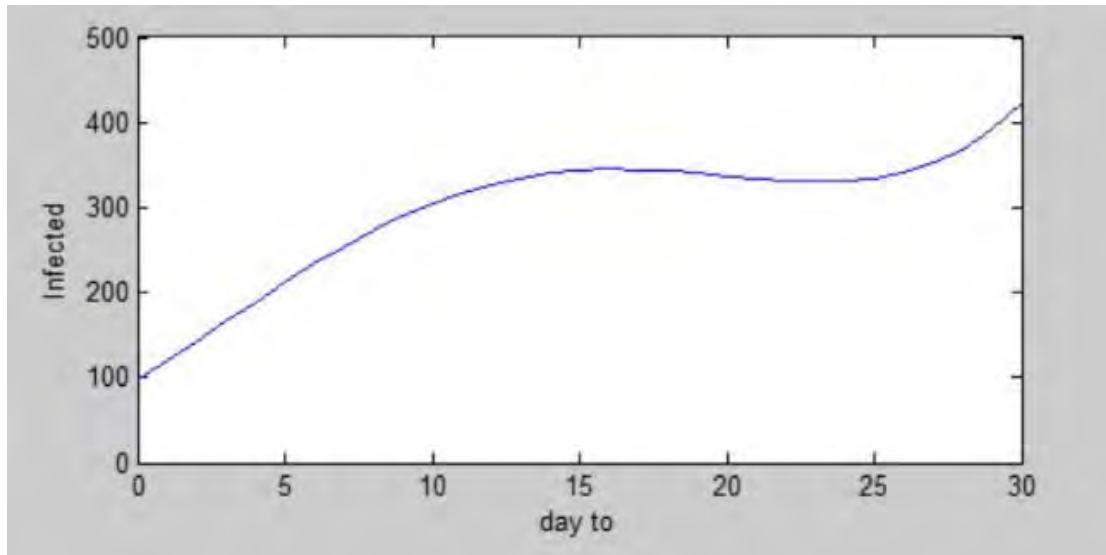

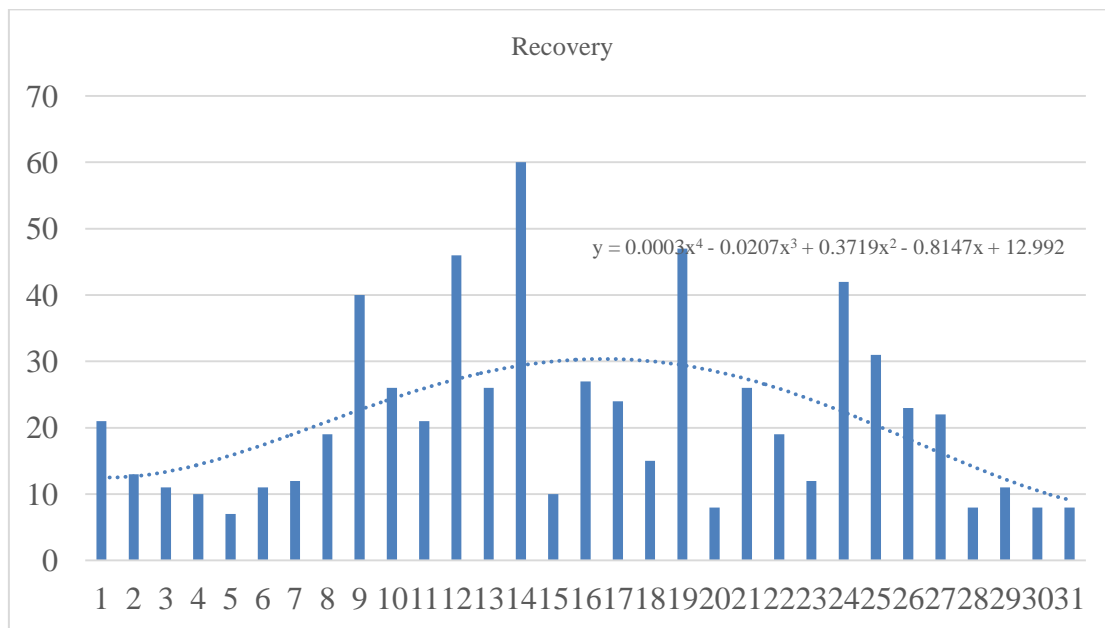**Figure 4. (b)** Graph model prediction for April infected cases

Figure 5. (a) Data trend graph recovered from covid 19 in April
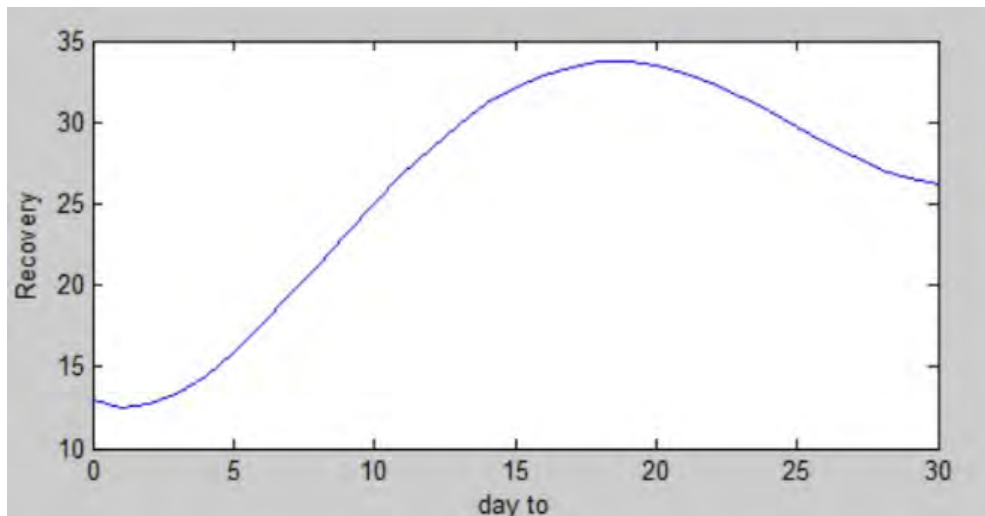
Figure 5. (b) Graph model prediction for cases recovered in April

The same phases of analysis work were developed in order to generate critical thinking for cases recovered from infection in April as can be seen in Figures 5 (a) and 5 (b) with the equation for the trend of recovery data:

$$y = 0.0003x^4 - 0.0207x^3 + 0.3719x^2 - 0.8147x + 12.992 \qquad (2)$$

with y the number of cured and x is the day.

Death cases due to Covid 19 in Indonesia for April have a data trend formula as in equation (3), with a trend graph in Figure 6 (a). Figure 6 (b) shows the predicted data for the period in April.

$$y = 0.00003x^4 - 0.0008x^3 - 0.1326x^2 + 3.8907x + 2.0454 \qquad (3)$$
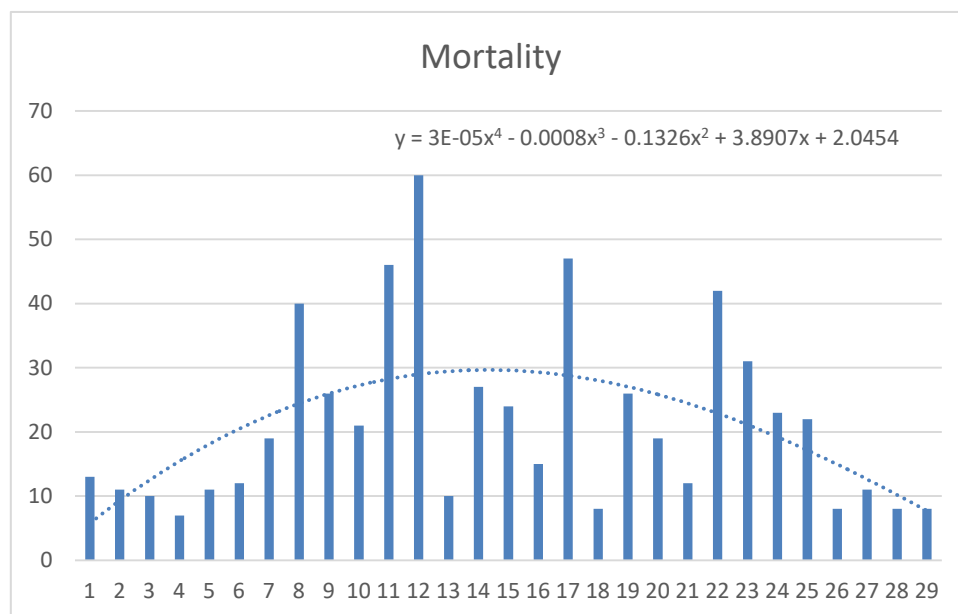

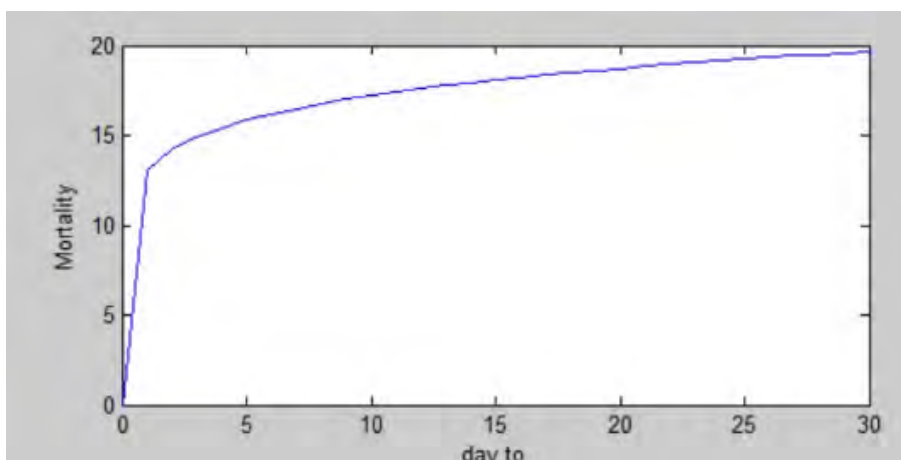**Figure 6. (a)** Graph of data on mortality cases in April

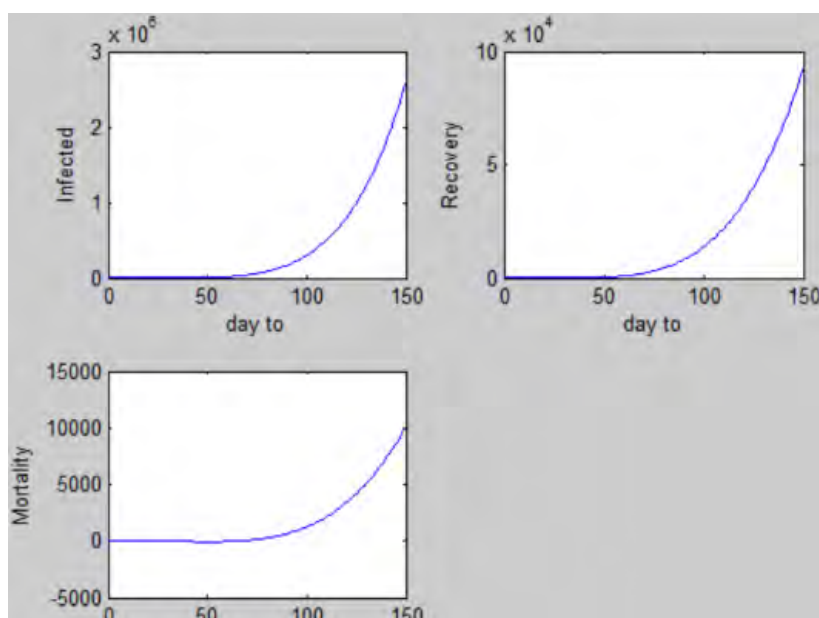**Figure 6. (b)** Graph of prediction of death cases in April.

Figure 7. Prediction graph based on the Matlab program for cases of infection, recovery and death for 150 days

The scientific worksheet built to predict the number of cases of infection increase after 150 days in Figure 6 is around 300,000 above real data of 257,388, recovered 100,000 under real data 187,958 and 10,000 died above real data 9,977 (https://covid19.go.id/peta -sebaran, 24/09/20). The success rate of prediction data accuracy built based on the cases in April matches quite well with real data in September with time intervals of 5 months or an average of 150 days.

5. Conclusion and Further Research

Scientific worksheets built by synthesizing 21st century thinking skills with several relevant indicators combined with real data on the COVID-19 pandemic in Indonesia for cases of increase, recovery and death provide an increase in students' critical thinking skills in the data processing workshop course. The ability to think that is meant is the ability to provide scientific arguments, the ability to use a thinking system, the ability to make considerations and decisions, and the ability to solve problems. This capability is used to build a mathematical model based on matching the real data curve of the

Covid 19 pandemic in Indonesia over a certain period of time and providing predictions outside the real time data interval.

The data model for the spread of infected, recovered and dead cases for cases in April follows the trend of polynomial data rank four, while for cases prediction built using the equation in that month are able to provide very good accuracy of the number of cases after the Covid 19 pandemic in Indonesia for five months.

Further research can continue to be developed for prediction using other approaches, for example based on a certain mathematical series which can be packaged using another, more accurate worksheet.

Acknowledgment

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