Differential Equations to Predict the Number of Students as a Basis for Accreditation Preparation Study Program Policy

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Kata Kunci	ABSTRAK
Persamaan Bernoulli, Memprediksi, Kebijakan Institusi	Pendidikan memiliki peran yang sangat penting dalam masyarakat. Melalui pendidikan, individu memiliki kesempatan untuk memperoleh pengetahuan, keterampilan, dan nilai-nilai yang diperlukan untuk menghadapi tantangan kehidupan. Ilmu pengetahuan alam adalah cabang ilmu yang membahas tentang pengetahuan yang berkaitan dengan alam dan fenomena-fenomena yang terjadi di dalamnya. Prodi Tadris Ilmu Pengetahuan Alam merupakan prodi tergolong baru, dimana SK berdirinya pada Tahun 2020. Oleh karena itu, peneliti melakukan penelitian dengan memprediksi jumlah mahasiswa Tadris IPA IAIN Kediri. Hasil persamaan logistik yang merupakan bentuk dari Persamaan Bernoulli menunjukkan kenaikan jumlah mahasiswa baru setiap tahunnya. Pada tahun 2020 , 2021, 2022, dan 2023 menunjukkan jumlah mahasiswa baru sebanyak 23, 48, 54, dan 62 mahasiswa. Seiring berkembangnya tahun, berkembang pula jumlah mahasiswa baru. Dengan perkembengan jumlah mahasiswa tentunya kebijakan institusi tentang layanan akademik, sarana prasarana dan lainnya juga dipenuhui dengan baik sesuai kebutuhan mahasiswa. Hal ini juga nantinya akan mendukung dalam visi keilmua prodi, yang targetnya di tahun 2030 nanti akan menjadi prodi yang unggul dalam pengembangan Pendidikan SAINS berbasis teknologi informasi dan pencetak tenaga pendidik IPA yang berkarakter islami pada tahun 2030.

Bernoulli Equation, Predicting, Institutional Policy

Education has a very important role in society. Through education, individuals have the opportunity to acquire the knowledge, skills, and values necessary to face life's challenges. Natural science is a branch of science that discusses knowledge related to nature and the phenomena that occur in it. The Natural Sciences Education Study Program is a relatively new study program, where the Decree was established in 2020. Therefore, researchers conducted research by predicting the number of Natural Sciences Education students at IAIN Kediri. The results of the logistic equation which is a form of the Bernoulli equation show an increase in the number of new students every year. In 2020, 2021, 2022, and 2023, the number of new students is 23, 48, 54, and 62. As the years progress, the number of new students also grows. With the increase in the number of students, of course institutional policies regarding academic services, infrastructure and other things are also well met according to student needs. This will also support the scientific vision of the study program, whose target is that in 2030 it will become a superior study program in developing information technology-based SCIENCE education and producing science educators with Islamic character by 2030.

INTRODUCTION

The role of education is very broad and cannot be underestimated. Education is the foundation for the development of individuals, society, and the country (Yulianto, 2016). By providing fair and quality access, education can encourage progress, equality, and prosperity for everyone (Indy et al., 2019). Therefore, it is important for all of us to support and prioritize education as the best investment we can make for a better future.

Education has a very important role in society. Through education, individuals have the opportunity to acquire the knowledge, skills, and values necessary to face life's challenges (Utari et al., 2014). The role of education is not only limited to transferring knowledge but also forming character, broadening horizons, and promoting holistic personal development (Fatimah, 2018). Education also encourages innovation, creativity, and critical thinking needed to encourage progress in the field of natural sciences (Bereki, 2022).

Natural science is a branch of science that discusses knowledge related to nature and the phenomena that occur in it (Kastawaningtyas & Martini, 2017). Through research and experimentation, natural science has provided a lot of important knowledge for humans. Natural science also provides knowledge about how nature works, such as the geological processes that form the earth and the vast sky that we see every night (Susilowati, 2014). With a better understanding of nature, we can develop solutions to global challenges such as climate change and environmental sustainability.

The development of educational facilities and infrastructure has a very important role in improving the quality of education so that it can meet the needs and demands of the times (Megasari, 2014). Facilities and infrastructure, also known as educational infrastructure, include adequate school buildings, comfortable classrooms, complete laboratory and library facilities, as well as fast and up-to-date internet access. By having adequate educational infrastructure, students can learn optimally and increase their potential optimally (Malau et al., 2022). Apart from that, the development of educational infrastructure also encourages students to

be more motivated and enthusiastic about learning, increases the effectiveness of the learning process, and creates a conducive environment for creating a generation that is competent and ready to face global competition (Nengsi & Muzakkir, 2022).

The relationship between the number of students and the infrastructure in higher education cannot be denied. The more students who join an educational institution, the higher the demand for adequate infrastructure (Suranto et al., 2022). Students need access to a complete library, adequate lecture halls, adequate laboratories, adequate sports facilities, and other facilities to meet their various academic and non-academic needs. Therefore, educational institutions need to adapt to the increasing number of students to ensure that existing infrastructure can meet their needs effectively and efficiently (Aprilia et al., 2021).

In the world of education, predicting the number of students is very important when planning and managing educational institutions (Syamsudin, 2022). One method used to predict the number of students is by using differential equations (Nuraeni, 2017). Differential equations are mathematical equations that relate changes in a variable to time or other

variables (Nuraini et al., 2018). In this context, differential equations can be used to model growth and changes in student numbers over time. Differential equations can help in predicting how student numbers will grow in the future.

One commonly used method is the logistic model. The logistic model uses differential equations to model population growth by considering factors such as birth rates, deaths, and migration rates (Nuraini et al., 2018). However, population predictions using differential equations have limitations (Pratiwi, 2020). These models are based on assumptions that may not always reflect the actual situation, and other factors not included in the models may influence population growth. Therefore, population prediction results need to be confirmed and compared with valid empirical data to verify their accuracy.

Previous research shows that the population growth model obtained is accurate for estimating the population of Surabaya City using a logistic model (Kurniawan et al., 2017). The logistic equation produces the population of West Kalimantan province, equipped with the MAPE size (Putri et al., 2023). Population growth projections in Sumenep Regency on Madura Island use a logistic growth model (Nurmadhani & Faisol, 2022). These

studies are only limited to determining the population using differential equations, and some are accompanied by MAPE. However, this research also conveys the next steps that need to be taken by policymakers (or suggestions) after knowing the population in the coming year.

METHOD

The method used in this research is a qualitative library research method (Hadi, 2022). The required data is obtained from the activities of reviewing and tracing data originating from the relevant agencies, namely the IAIN Kediri Tarbiyah Faculty Tadris Science Study Program, supported by data sourced on the official government website pddikti.com, as well as other articles that can provide appropriate information to meet the needs of researchers.

The data source used in this research is secondary and does not use primary data. Secondary data sources, namely sources that help existing primary sources (Ali, 2002; Ridwan, 2001), are supporting data that are used as tools in analyzing existing problems. In relation to this, the secondary source that the author uses is data obtained from IAIN Kediri staff in the Tadris Natural Sciences Study

Program (TIPA) regarding the number of students in the last three years.

The data collection technique used is to look for data related to the number of students and institutional policies that can provide information according to the researcher's needs. After the data is collected, a systematic review is carried out in relation to the problem being studied so that data and information can be obtained for research material. The data analysis carried out is adjusted to the type of research carried out and the type of data collected (Tim, 2009), namely using a content analysis method that is an in-depth discussion of the content of written or printed information in the mass media (Afifuddin & Saebani, 2009). Content analysis is a research technique for drawing replicable and valid data conclusions by paying attention to the context (Mukhtar, 2013).

Apart from using the content analysis method, this data analysis also uses a hermeneutical analysis approach, which means interpreting (Mahfudz, 2013). The operational targets of hermeneutics are actually always related to the processes of understanding, interpretation, and translation. Therefore, basically, the area that can be approached with hermeneutics is written texts (Mahfudz, 2013).

RESULTS AND DISCUSSION
Tadris IPA IAIN Kediri

The Tadris Science Study Program, Faculty of Tarbiyah IAIN Kediri, is one of the new study programs at the Faculty of Tarbiyah and began operating in July 2020 with a decree permitting the establishment of a new study program number 197 of 2020 dated March 9, 2020. The Faculty of Tarbiyah IAIN Kediri and especially the Tadris Science Study Program have a vision, mission, goals, and objectives that are expected to be able to meet the demands of graduate users in accordance with specified academic standards. The Tarbiyah Faculty's vision is to become a superior, competitive, and professional faculty at the Southeast Asian level in the fields of tarbiyah and teaching by integrating science, Islam, and Indonesianism by 2033. Meanwhile, the vision of the Tadris IPA Study Program is "to become a superior study program in the development of science-based education information technology and producing science teaching staff with Islamic character by 2030." In order to achieve this vision, the Faculty of Tarbiyah and the Tadris Science

study program have developed a strategy that is expected to facilitate the achievement of the ideals of the Tadris Science study program, which are based on devotion to Allah Subhanallahu Wa Ta'ala and good morals (TIPA, 2020).

The profile of graduates of the Tadris Science Study Program with a focus on information technology includes the ability to integrate Islamic knowledge, science education knowledge, and mastery of technology. Technology in this case is highly emphasized so that graduates can follow the developments of the times. In this place, graduates are able to follow developments in science and learning with mastery of information technology. Technology plays a crucial role in changing the educational landscape, enhancing the learning experience, and expanding access to knowledge. One aspect of technology integration in the education sector is the use of technology in learning. Research shows that the integration of digital technology in learning can increase the effectiveness of the teaching and learning process in the Industrial Era 4.0 (Khomarudin, 2020).

The natural sciences study program is one of the most important fields of study in the academic world. This program discusses the understanding and exploration of the universe and the phenomena that exist in it (Prakoso, 2020). In this study program, students will study various scientific disciplines, such as physics, chemistry, biology, geology, and astronomy (Fatimah, 2018). One of the interesting things about the natural sciences study program is the close connection between theory and practice. Students will be given the opportunity to carry out research and experiments in the laboratory, as well as apply the knowledge they have learned in real-world situations. They will also be invited to participate in research projects aimed at developing an understanding of the natural world and finding solutions to the challenges they face.

One of the interesting things about the natural sciences study program is the close connection between theory and practice (Setyabudi & Sudarso, 2021). Students will be given the opportunity to carry out research and experiments in the laboratory, as well as apply the knowledge they have learned in real-world situations. They will also be invited to participate in research projects aimed at developing an understanding of the natural world and finding solutions to the challenges they face.

After completing this study program, natural science graduates have various promising career opportunities. They can work in educational institutions as educators according to their main graduate profile, in addition to research, energy companies, the pharmaceutical industry, forensic laboratories, and many more. In addition, the analytical, problem-solving, and scientific thinking skills they develop during their studies will be very valuable and can be applied in various other professional fields. The natural sciences study program provides a strong foundation for understanding the world around us and developing innovative knowledge.

Facilities and infrastructure

The Natural Sciences or Natural Sciences study program is one of the study programs that requires adequate infrastructure (sarpras) to support learning and research activities (Rahayu & Haq, 2021). The infrastructure required by the science study program includes laboratories, libraries, and classrooms (Hayati, 2020), which are equipped with appropriate equipment and learning media. The laboratory is a very important piece of infrastructure for the science study program. This laboratory is used to carry out practicums and experiments in the field of natural sciences. A laboratory complete with adequate chemical and biological equipment and materials will enable students to carry out more in-depth research and experiments.

Apart from laboratories, the science study program also requires a complete library with a collection of books and scientific journals related to the natural sciences. This library is the main reference source (Iztihana & Arfa, 2020) for students to increase their knowledge and insight. The availability of the latest books and journals will make it easier for students to access the information needed to support research and learning. Classrooms that are equipped with appropriate equipment and learning media are also the infrastructure needed by the science study program. Equipment such as computers, projectors, and multimedia devices will help in delivering more interactive and interesting learning material. With adequate infrastructure, the science study program can provide a better learning experience for students and encourage their interest in exploring the world of natural sciences.

Facilities and infrastructure have a significant influence on the learning

process. Research shows that adequate infrastructure conditions can facilitate smooth and easy learning (Inayah et al., 2021; Miski, 2015). Factors that can be influenced by the condition of the infrastructure include:

- Learning Outcomes: Research at Vocational School Wikrama Bogor shows that facilities and infrastructure have an influence on student learning outcomes (Miski, 2015).

- Teaching and Learning Process: Adequate facilities and infrastructure are absolutely necessary to maintain a smooth teaching and learning process (Novita, 2017).

- Quality of Learning: Good management of facilities and infrastructure can improve the quality of student learning.

- Learning Motivation: Adequate facilities and infrastructure also play a role in supporting the smoothness and ease of the learning process, increasing students' learning motivation (Nengsi & Muzakkir, 2022).

Number of science study program students

The number of students at a university is an important parameter that reflects the educational population and the level of educational participation. The number of students can also be an important measure for educational institutions (Agwil et al., 2020) in evaluating their success and determining the resource needs that must be provided. An increase in student numbers is often considered a positive sign because it reflects a strong interest in higher education and the possibility of intellectual prominence in society. However, increasing student numbers can also pose challenges, such as limited capacity, inadequate infrastructure, and the provision of adequate educational resources.

The number of students can also have significant economic implications (Ridha et al., 2023). The more students who pursue higher education, the greater the demand for educational facilities, such as universities, colleges, and faculties. This can create new job opportunities in the education sector and make a positive contribution to economic growth. Apart from that, the significant number of students can also have an impact on the housing sector, transportation, and other community needs. Therefore, it is important for governments and

educational institutions to understand and manage student numbers wisely so as to achieve the right balance between demand

and capacity. The following is the number of students in the IAIN Kediri Tadris Science Study Program from 2020 to 2022.

Table 1.
Number of TIPA IAIN Kediri Study Program Students 2020-2022

Year	2020	2021	2022
Number of students	23	71	125

2023 is related to the study program's 2030 vision.

In 2023, the Tadris IPA study program will carry out accreditation because the first accreditation will be in 2022. 2023 was chosen based on the vision of the study program being superior in 2030, and 2023 is the first step after the study program is accredited. This study program has advantages that differentiate it from other study programs. These advantages can be in the form of complete and modern facilities, qualified and experienced teaching staff, a curriculum that is relevant and in line with industrial developments, as well as good connections and collaboration with the industrial world.

A superior study program includes a high level of academic achievement, such as good accreditation, numerous and high-quality research publications, and the best student achievements. Apart from that, superior study programs may also have soft

skills development programs and good internship or practical work opportunities to prepare students to face the world of work with adequate competence. A superior study program is one that has superiority and high competitiveness compared to similar study programs at other institutions or campuses. These advantages can be seen in various aspects, such as facilities, teaching staff, curriculum, industry connections, level of academic achievement, and soft skills development.

Prediction of the number of students in the Tadris Science Study Program in 2023

The Logistic Equation is a study in mathematics that is a form of the Bernoulli Equation. Bernoulli's equation is one of the studies in the field of mathematics within the scope of differential equations. This logistic equation is used to predict the number of students using available data on the number of students.

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The logistic equation used is

$$\frac{dP}{dt} = kP, \; k > 0,$$

$P(t) = population \; at \; time \; t(time)$

The population indicated by P is the result of the change in the number of students over time. For example, if the number of students in the first year is 200, and in the second year it is 245, then the size of P is 45 people, which comes from 245 to 200. This equation includes exponential growth, relative growth, or specific growth rates. Apart from human populations in an area, the logistic equation can also be used to model animal populations in limited spaces. Next, it will be processed to produce $f(P)$ because it adjusts to the population function.

$$\frac{dP}{dt} = kP \quad [Eq \; 1]$$

$$\frac{dP/dt}{P} = k \, f(P)$$

$$\frac{dP}{dt} = k \, P \, f(P) \quad [Eq \; 2]$$

K: individuals in an area, and capacity

$$f(K) = 0; \; f(0) = r$$

$$f(P) = c_1 P + c_2$$

$$c_1 = -\left(\frac{r}{K}\right); \; c_2 = r$$

So that

$$f(P) = c_1 P + c_2 = -\left(\frac{r}{K}\right)P + r$$

From Eq (2)

$$\frac{dP}{dt} = k \, P \, f(P)$$

$$= k \, P \left(-\left(\frac{r}{K}\right)P + r\right)$$

$$= k \, P \left(r - \left(\frac{r}{K}\right)P\right)$$

example $a = kr$, $b = k\left(\frac{r}{K}\right)$, so

$$\frac{dP}{dt} = P(a - bP) \quad [Eq \; 3]$$

$$\frac{dP}{dt} = P(a - bP)$$

$$\frac{dP}{P(a - bP)} = dt$$

$$P(t) = \frac{ac_3}{e^{-at} + bc_3} \quad [Eq \; 4]$$

$$P(t) = \frac{ac_3}{e^{-at} + bc_3}$$

$$t = 0 \Rightarrow P(0) = P_0 = \frac{ac_3}{e^{-a.0} + bc_3}$$

$$P_0(1 + bc_3) = ac_3 \Rightarrow P_0 = ac_3 - P_0 bc_3$$

Eq (4) becomes

$$P(t) = \frac{ac_3}{e^{-at} + bc_3}$$

$$P(t) = \frac{aP_0}{((a - P_0 b)e^{-at} + bP_0)}$$

$$P = \frac{a}{b + [e^{-at}]ac} \quad [Eq \; 5]$$

Equation 5 is what will be used to predict the number of students. The data used in equation 5 is from table 2.

Table 2.
Number of TIPA IAIN Kediri Study Program Students 2020-2022

Year	2020	2021	2022	2023
Number of students	23	71	125	?
t	-	0	1	2
P	23	48	54	???

From table 1, it was changed to table 2 by adding one edition of the previous academic year, namely 2020 as the amount for obtaining P in 2021, 2022, and 2023 as the year in which the number of students was sought. t starts in 2021 with $t = 0$, 2022 with $t = 1$, and 2023 with t = 2. A minimum of three t is needed because of the need to find the values of equation 5. Then 2023 is the year in which the number of students will be searched using $t = 2$. Initial predictions depart from equation 5.

$$P = \frac{a}{b + [e^{-at}]ac} \quad \textcolor{red}{[Eq\ 5]}$$

Information:
$$r = 71$$
$$K = 125$$
$$a = rk = 71k$$
$$b = k$$
$$P(0) = 48$$

- r is the capacity of an area. The number of students cannot be predicted as to the region's capacity, so the latest number of students, namely 2021, is used as the region's capacity.

- K is the number of individuals in an area; in this case, we are also using the number of students in the last year, namely 2022.

- a is obtained by multiplying r by k, so that a = r.k.

- b is obtained from the same as k.

- $P(0)$ is obtained from table 2, namely the growth in the number of students from 2020 to 2021, and is used to determine the value of c.

$$P = \frac{a}{b + [e^{-at}]ac}$$

$$P(0) = 48 = \frac{71\,k}{k + [e^{-a.0}]71k\,c}$$

$$= \frac{71}{1 + 71\,c}$$

$$1 + 71c = \frac{71}{48} = 1,5$$

$$c = \frac{0,5}{71}$$

After the c value is obtained, the next step is to find the e^{-a} value using the value $t = 1$.

$$P = \frac{a}{b + [e^{-at}]ac}$$

$$P(1) = 54 = \frac{71k}{k + [e^{-a.1}]71\,k\left(\frac{0,5}{71}\right)}$$

$$54 = \frac{71}{1 + [e^{-a}]0,5}$$

$$1 + [e^{-a}]0,5 = \frac{71}{54} = 1,3$$

$$[e^{-a}] = \frac{0,3}{0,5} = 0,6$$

After obtaining the values of c and e^{-a}, look for the value when $t = 2$ to find out P in 2023.

$$P = \frac{a}{b + [e^{-at}]ac}$$

$$P(2) = \frac{71\,k}{k + [0,6^2]71k\left(\frac{0,5}{71}\right)}$$

$$P(2) = \frac{71}{1 + (0,36)0,5}$$

$$P(2) = \frac{71}{1,18} = 60,169 \approx 62$$

From the calculation above, the result is $P(2)$ = 62. This means that from 2022 to 2023, the number of students will increase by 62, so the predicted number of students in 2023 is 187. Table 2 is complete with the number of students in 2023, which is shown in Table 3 below.

Table 3.
Number of TIPA IAIN Kediri Study Program Students 2020-2023

Year	2020	2021	2022	2023
Number of students	23	71	125	187
t	-	0	1	2
P	23	48	54	62

Now that we have entered the 2023–2024 academic year, the number of students in 2023 is already known, namely 55. Regarding the prediction results, you can find the percentage accuracy of the equation that has been obtained, namely by using the MAPE (*mean absolute percentage error*) formula.

$$MAPE = \frac{1}{N}\sum_{t=1}^{N}\left|\frac{P_t - \widetilde{P_t}}{P_t}\right| \times 100\%$$

Information:

$P_t = actual\ population$

$\breve{P}_t = predicted\ population$

$N = number\ of\ observations$

$$MAPE = \frac{1}{N}\sum_{t=1}^{N}\left|\frac{P_t - \breve{P}_t}{P_t}\right| \times 100\%$$

$$MAPE = \frac{1}{1}\sum_{t=1}^{1}\left|\frac{55-62}{62}\right| \times 100\%$$

$$= \left|\frac{55-62}{62}\right| \times 100\%$$

$$\approx 0{,}113 \times 100\% = 11{,}3\%$$

So the error rate of this equation is 11.3%. Next, the number of students in 2024 will be predicted using the equation obtained with t = 3, namely

$$P(t) = \frac{a}{b + [e^{-at}]ac}$$

$$P(3) = \frac{71\,k}{k + [0{,}6^3]71k\left(\frac{0{,}5}{71}\right)}$$

$$= \frac{71}{1 + (0{,}216)0{,}5}$$

$$= \frac{71}{1{,}108} = 64{,}1 \approx 63$$

So, in 2024, the number of students is predicted to increase by 63. These results were then checked for accuracy using the MAPE percentage, thus obtained

$$63 \times 11{,}3\% = 7{,}119 \approx 8$$

This means that in 2024 there will be an addition of at least $63 - 8 = 55$ students, or a maximum of $63 + 8 = 71$ students. Thus, table 3 is completed into table 4 as follows:

Table 4.
Number of TIPA IAIN Kediri Study Program Students in 2020-2024

Year	Tahun	2020	2021	2022	2023	2024	
Number of students	Jumlah	23	71	125	180	235	251
t	t	-	0	1	2	3	
P	P	23	48	54	55	55	71

Based on table 4, information is obtained that the number of students in 2024 will increase by 55– 71, or an increase of 31%– 40% from the previous number of students, so that the number of students in that year will be in the range of 242– 258.

Institutional policy forms a response to the growth in student numbers.

This is in accordance with (Hapsari & Hascaryani, 2012), who argue that higher

education institutions respond to the growth in student numbers with careful policies. First, there is awareness of the excess demand for higher education studies, which is reflected in the difference between the number of applicants and the number of students admitted. Response policies include:

- Capacity Building: Institutions can expand infrastructure and resources to accommodate more students.
- Increased Selectivity: Improve selection criteria to ensure admission of students who meet institutional standards.
- Online Program Development: Implement online programs to reach more students without burdening physical facilities.
- Collaboration with Industry: Establish partnerships with industry to provide practical educational opportunities and work placements after graduation.

CONCLUSION

The natural sciences Tadris study program is a field of study that discusses the understanding and exploration of the universe and the phenomena within it, so it is necessary to implement appropriate policies. Determining institutional policies related to infrastructure and quality of education for Tadris Natural Sciences students using logistic equations, which are used to determine or predict the number of Natural Sciences students each year. The result is that it is predicted that the number of students in the following year will increase by 31% to 40% from the current number of students. With the growth in the number of students, of course, institutional policies regarding academic services, infrastructure, and other things are also well met according to student needs. This will also support the scientific vision of the study program, whose target is that in 2030 it will become a superior study program in developing information technology-based science education and producing science educators with Islamic character.

REFERENCE

Afifuddin, & Saebani, B. A. (2009). *Metodologi Penelitian Kualitatif* (Qualitative Research Methodology). CV. Pustaka Setia.

Agwil, W., Fransiska, H., & Hidayati, N. (2020). Analisis ketepatan waktu lulus mahasiswa dengan menggunakan bagging cart (*Analysis of student graduation timeliness using a bagging cart. Journal of Mathematics and Mathematics Education*). *Jurnal Pendidikan Matematika Dan Matematika*, *6*(2), 155–166. https://doi.org/https://dx.doi.org/10.24853/fbc.6.2.155-166

Ali, S. (2002). *Metodologi Penelitian Agama* (Religion Research Methodology). PT Raja Grafindo Persada.

Aprilia, R. N., Sugiyanto, & Prihadi, S. (2021). Kajian Ketersediaan Sarana dan Prasarana Pendidikan Dasar (SD / MI) dan Menengah Pertama (SMP / MTS) di Kecamatan Sambong Kabupaten Blora Tahun 2020 (Implementasi Dalam Pembelajaran Geografi Kelas XI Pada Materi Kualitas Penduduk dan Indeks Pembangun (*Study of the Availability of Basic (SD/MI) and Junior Secondary (SMP/MTS) Education Facilities and Infrastructure in Sambong District, Blora Regency in 2020 (Implementation in Class XI Geography Learning on Population Quality and Development Index Material*). *Geadidaktika : Jurnal Geografi*, *1*(1), 87–103.

Bereki, L. S. I. (2022). Inovasi Pembelajaran Ipa Pada Masa Pandemi Covid-19 (*Science Learning Innovations During the Covid-19 Pandemic*). *Jurnal Pendidikan Sang Surya*, *8*(2), 37–42. https://doi.org/https://doi.org/10.569 59/jpss.v8i2.82

Fatimah, N. (2018). Pembentukan Karakter Dalam Pendidikan (*Character Formation in Education*). *Jurnal Tribakti: Jurnal Pemikiran Keislaman*, *29*(2), 369–387. https://doi.org/https://doi.org/10.333 67/tribakti.v29i2.602

Hadi, S. (2022). *Metodologi Research Jilid I*. Andioffset.

Hapsari, M. ., & Hascaryani, T. . (2012). Kajian Respon Permintaan Pendidikan Tinggi Terhadap Kenaikan Biaya Kuliah Dan Pendapatan Masyarakat Di Kota Malang (Studi Kasus Pada Universitas Brawijaya Dan Universitas Negeri Malang) (*Study of The Response of Demand For Higher Education To Increasing Tuition Costs And Community Income In Malang City (Case Study At Brawijaya University And Malang State University*)). *Jurnal Ilmiah Mahasiswa FEB*, *1*(1).

Hayati, A. (2020). Evaluasi Standar Sarana dan Prasarana Laboratorium IPA Di Sekolah Model SMA Negeri 7 Bengkulu Selatan (*Evaluation of Standards for Science Laboratory Facilities and Infrastructure at The Model School of SMA Negeri 7 Selatan Bengkulu*). *Jurnal Manajer Pendiidkan*, *14*(2), 60–67.

Inayah, C. F. A., E., M., S., Ni'mah, L., & Amalia, V. (2021). Pengaruh Sarana Prasarana Dalam Menunjang Prestasi Belajar Siswa Sd Di Sekolah Indonesia Den Haag (*The Influence of Infrastructure in Supporting Primary Student Learning Achievement In Indonesian Schools In The Den Haag*). *MODELING : Jurnal Program Studi PGMI*, *8*(1), 52–63. https://doi.org/https://doi.org/https:/ /doi.org/10.36835/modeling.v8i1.686

Indy, R., Waani, Fonny, J., & Kanowangko, N. (2019). Peran Pendidikan Dalam Proses Perubahan Sosial Di Desa Tumaluntung Kecamatan Kauditan Kabupaten Minahasa Utara (*The Role of Education in the Process of Social Change in Tumaluntung Village, Kauditan District, North Minahasa Regency*). *HOLISTIK, Journal Of Social and Culture*, *12*(4), 1–18.

Iztihana, A., & Arfa, M. (2020). Peran Pustakawan MTs N 1 Jepara Dalam Upaya Mengembangkan Minat Kunjungan Siswa Pada Perpustakaan

(*The Role of MTs N 1 Jepara Librarians in Efforts to Develop Students' Interest in Visiting the Library*). *Jurnal Ilmu Perpustakaan*, *9*(1), 93–103.

Kastawaningtyas, A., & Martini. (2017). Peningkatan Keterampilan Proses Sains Siswa Melalui Model (*Improving Students' Science Processing Skills Through Models*). *Jurnal Penelitian Pendidikan IPA*, *2*(2), 45–52. https://doi.org/https://doi.org/10.267 40/jppipa.v2n2.p45-52

Khomarudin, N. (2020). Integrasi Teknologi Dalam Pembelajaran Implementasi Pembelajaran Ilmu Teknologi Dan Masyarakat (*Integration of Technology in Learning Implementation Of Learning Science Technology And Society*). *Jurna; Edueksos*, *IX*(2), 67–79.

Kurniawan, A., Holisin, I., & Kristanti, F. (2017). Aplikasi Persamaan Deferensial Biasa Model Eksponensial Dan Logistik Pada Pertumbuhan Penduduk Kota Surabaya (*Application of Ordinary Deferential Equations Exponential and Logistic Models in Population Growth In The City Of Surabaya*). *MUST: Journal of Mathematics Education, Science and Technology*, *2*(1), 129–141. https://doi.org/https://www.doi.org/1 0.30651/must.v2i1.529

Mahfudz, M. (2013). Hermeneutika: Pendekatan Alternatif Dalam Pembacaan Teks (*Hermeneutics: Alternative Approaches to Reading Texts*). *Al-Fikr*, *2*(2).

Malau, T. F., Harianja, K. N., Simarmata, Y., & Turnip, H. (2022). Pentingnya Administrasi Sarana dan Prasaran Pendidikan (*The Importance of Administration of Educational*

Facilities and Infrastructure). *Dewantara : Jurnal Pendidikan Sosial Humaniora*, *1*(4), 186–195. https://doi.org/DOI: https://doi.org/10.30640/dewantara.v 1i4.462

Megasari, R. (2014). Pendidikan Untuk Meningkatan Kualitas (*Education to Improve Quality*). *Jurna Administrasi Pendidikan*, *2*(1), 636–648. https://doi.org/https://doi.org/10.240 36/bmp.v2i1.3808

Miski, R. (2015). Pengaruh Sarana dan Prasarana terhadap Hasil belajar Siswa (*The Influence of Facilities and Infrastructure on Student Learning Outcomes*). *Ta'dibi*, *4*(2), 69–73. https://doi.org/https://doi.org/10.309 97/jtm.v4i2.341

Mukhtar. (2013). *Metode Praktis Penelitian Deskriptif Kualitatif* (Practical Methods of Qualitative Descriptive Research). GP Press Group.

Nengsi, N., & Muzakkir. (2022). Belajar Terhadap Hasil Belajar Fiqih Siswa Kelas VII 9 MTs Negeri 1 Enrekang (*Studying on The Fiqih Learning Outcomes of Class VII 9 Mts Negeri 1 Enrekang Students*). *Dialektika : Jurnal Pendidian Agama Islam*, *1*(1), 47–58.

Novita, M. (2017). Sarana Dan Prasarana Yang Baik Menjadi Bagian Ujung Tombak Keberhasilan Lembaga Pendidikan Islam (*Good Facilities and Infrastructure Are Part of The Spear of The Success Of Islamic Educational Institutions*). *NUR EL-ISLAM : Jurnal Pendidikan Dan Sosial Keagamaan*, *4*(2), 97–129.

Nuraeni, Z. (2017). Aplikasi Persamaan Diferensial dalam Estimasi Jumlah Populasi (*Application of Differential Equations in Population Size Estimation*). *Delta: Jurnal Ilmiah*

Pendidikan Matematika, *5*(1), 9. https://doi.org/10.31941/delta.v5i1.384

Nuraini, Mujib, & Suherman. (2018). Aplikasi Persamaan Diferensial Model Populasi Eksponensial Dalam Estimasi Penduduk Di Kota Bandar Lampung (*Application of Exponential Population Model Differential Equations in Population Estimation in Bandar Lampung City*). *Seminar Nasional Matematika Dan Pendidikan Matematika*, 401–405.

Nurmadhani, N., & Faisol. (2022). Penerapan Model Pertumbuhan Logistik Dalam Memproyeksikan Jumlah Penduduk Di Kabupaten Sumenep (*Application of The Logistic Growth Model in Projecting the Number of Population in Sumenep District*). *JES-MAT*, *8*(2), 181–192. https://doi.org/https://doi.org/10.25134/jes-mat.v8i2.5436

Prakoso, T. J. (2020). Al- Qur'an dan Kosmologi: Kronologis penciptaan dan kepunahan Alam Kosmos (*Al-Qur'an and Cosmology: Chronology of the creation and extinction of the Cosmos*). *MAGHZA : Jurnal Ilmu Al-Qur'an Dan Tafsir*, *5*(1), 17–35. https://doi.org/10.24090/maghza.v5i1.

Pratiwi, C. D. (2020). Application Of Differential Equation Of Logistic Population Model To Estimate Population In Balikpapan. *AdMathEdu : Jurnal Ilmiah Pendidikan Matematika, Ilmu Matematika Dan Matematika Terapan*, *10*(1), 63–76. https://doi.org/https://dx.doi.org/10.12928/admathedu.v10i1.15941

Putri, S. R., Noviani, E., & Yudhi. (2023). Prediksi Jumlah Penduduk Dengan Persamaan Logistik Menggunakan Metode Adams-Bashforth-Moulton (*Prediction of Population with Logistic Equations Using the Adams-Bashforth-Moulton Method*). *Buletin Ilmiah Mat. Stat Dan Terapannya*, *11*(1), 159–166. https://doi.org/https://dx.doi.org/10.26418/bbimst.v11i1.52200

Rahayu, A. D., & Haq, M. S. (2021). Sarana Dan Prasarana Dalam Mendukung Pembelajaran Daring Pada Masa Pandemi Covid-19 (*Facilities and Infrastructure to Support Online Learning During the Covid-19 Pandemic*). *Jurnal Inspirasi Manajemen Pendidikan*, *9*(1), 186–199.

Ridha, A., Nirzalin, & Mursyidin. (2023). Implikasi Sosial Ekonomi Keberadaan Mahasiswa Pendatang Terhadap Masyarakat Sekitar Kampus Universitas Teuku Umar (*The Socio-Economic Implications of The Presence of Immigrant Students on The Community Around the Teuku Umar University Campus*). *Jurnal Agama Dan Sosial Humaniora*, *11*(1), 49–64.

Ridwan, M. D. (2001). *Tradisi Baru Penelitian Agama Islam; Tinjauan Antara Disiplin Ilmu* (New Traditions of Islamic Religious Research; Interdisciplinary Review). Nuansa.

Setyabudi, A. D., & Sudarso. (2021). Hubungan Hasil Belajar Teori Dengan Hasil Belajar Praktik Pada Pembelajaran Passing Sepakbola (*The Relationship of Theoretical Learning Outcomes With Practical Learning Outcomes In Learning Football Passing*). *Jurnal Pendidikan Sains*, *9*(1), 63–67.

Suranto, D. I., Annur, S., Ibrahim, & Alfiyanto, A. (2022). The Importance

Of Facilities And Infrastructure Management In Improing The Quality Of Education. *Jurnal Kiprah Pendidikan*, *1*(April), 59–66. https://doi.org/https://doi.org/10.335 78/kpd.v1i2.26

Susilowati. (2014). Pembelajaran IPA pada Kurikulum 2013. *Pembelajaran IPA Pada Kurikulum 2013," in Program Pengabdian Pada Masyarakat (PPM)* (Science Learning in the 2013 Curriculum. Science Learning in the 2013 Curriculum," in Community Service Program (PPM)).

Syamsudin, A. (2022). Development of Priority Determination System for Revision of Accreditation Criteria for IAPS 4.0 Study Program Using the Analytic Hierarchy Process Method at IAIN Kediri. *Jurnal Informatika Universitas Pamulang, 7(1), 44-53.*

Tim. (2009). *Pedoman Penelitian Karya Ilmiah* (Guidelines for Researching Scientific Papers). Sekolah Tinggi Agama Islam Negeri (STAIN).

TIPA. (2020). *Sejarah Tadris IPA* (History of Tadris IPA).

Utari, W., Arneliwati, & Novayelinda, R. (2014). Pengetahuan Keluarga Tentang Infeksi Saluran Pernapasan Akut (Ispa) (Family Knowledge About Acute Respiratory Infections (ARI)). *Jurnal Online Mahasiswa Program Studi Ilmu Keperawatan Universitas Riau*, *1*(1), 1–7.

Yulianto, H. (2016). Menghindari Kekerasan Dalam Pengelolaan Karakter Siswa (*Avoiding Violence in Managing Student Character*). *Jurnal Pembangunan Pendidikan : Fondasi Dan Aplikasi*, *4*(1), 91–102. https://doi.org/10.21831/jppfa.v4i1.1 2117