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Exploration of Artificial Intelligence (AI) Application in Higher Education: A Research Study in Kolaka, Southeast Sulawesi

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ABSTRACT
This research explores the integration and impact of Artificial Intelligence (AI) implementation in higher education in Kolaka, Southeast Sulawesi. Amidst the global shift toward digitalization, it examines how AI technology is applied in the academic setting and its implications on teaching, learning, and administrative processes. Comprehensive analysis involving interviews, observations, and secondary data review highlights AI's transformative role in education. The study also discusses challenges and limitations in integrating AI into higher education, including technical barriers, significant investment needs, data privacy, and ethical considerations. Emphasizing the importance of developing comprehensive strategies and frameworks, the research contributes to the evolving knowledge of AI in education, providing insights for policymakers, educators, and institutions considering AI adoption. It concludes with recommendations for future research and practical guidelines for AI solution implementation in higher education, underscoring AI's potential to revolutionize educational paradigms in the 21st century.

Keywords: Operational Efficiency, Artificial Intelligence (AI), Higher Education

INTRODUCTION
The context and need for Artificial Intelligence (AI) in higher education, especially in research studies in Kolaka, Southeast Sulawesi, can be described as follows: The Technology Revolution in Education, A digital transformation is ongoing in various sectors (Plekhanov et al., 2023), including higher education. AI offers untapped potential to optimize learning processes and administration. Enhancing the Learning Experience: AI can assist in personalizing the learning experience, providing real-time feedback, and improving access to education. Administrative Efficiency, The use of AI in university administration can enhance operational efficiency, reduce manual workload, and speed up decision-making. In Kolaka, the adoption of AI in universities can be an important step in enhancing educational standards and demonstrating a commitment to technological innovation. Implementing AI in higher education also presents challenges, such as the need for infrastructure, staff training, and data privacy policies, but the opportunities for educational transformation are significant. This approach provides a framework for exploring the application of AI in higher education, focusing on the needs and potential in Kolaka, Southeast Sulawesi.
This research brings innovation in the development of Artificial Intelligence (AI) by focusing on the design and implementation of advanced algorithms to increase the efficiency and effectiveness of the learning process in higher education institutions, utilizing machine learning techniques and data analysis to optimize educational outcomes.

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Figure 1. Campus Design in Kolaka, Southeast Sulawesi
Integration of Artificial Intelligence in Higher Education

This design illustrates a modern university campus in Kolaka, Southeast Sulawesi, integrated with artificial intelligence technology. The university buildings are equipped with advanced technology,(Ejidike & Mewomo, 2023) including interactive digital kiosks, smart classrooms, and AI-based research laboratories. Students and faculty are seen interacting with these technologies, using tablets and laptops, and engaging with AI interfaces. The campus environment combines cutting-edge technology with the local cultural elements of Kolaka, marked by natural greenery and traditional architectural elements, creating a harmonious atmosphere between technological innovation and the unique cultural environment.

Research Purpose to Evaluate AI Usage in Learning Processes: assessing how AI can be used to improve teaching and learning methods at the university. This includes using AI for personalized learning, providing real-time feedback to students, and facilitating more interactive and effective learning methods, conducting an Analysis of AI Effectiveness in Academic Administration (Maphosa & Maphosa, 2023) which examines the use of AI in improving university administrative processes, such as student enrollment, data management, and daily operations. The aim is to determine the extent to which AI can enhance efficiency and accuracy in administrative operations. The process of Assessing AI Implementation in the Local Context of Kolaka: understanding the challenges and opportunities of implementing AI in the local higher education environment. This includes considering factors such as resource availability, IT infrastructure, and the acceptance of technology by the academic community. Also providing Strategic Recommendations, based on the findings, for universities and policymakers on the best ways to integrate AI in higher education, with a special focus on the needs and conditions in Kolaka.

The Research Method to be used includes Data Collection: involving primary data collection through interviews and observations at universities in Kolaka. Interviews will be conducted with faculty, administrative staff, and students to understand their perspectives on the implementation of AI, Secondary Data Analysis: using secondary data, including academic documents, journals, and previous research to support the analysis and provide a broader context about the use of AI in higher education, and Evaluation and Analysis to evaluate the effectiveness and impact of AI in education and university administration. This analysis will help in identifying challenges, opportunities, and best practices in the implementation of AI.

This research is crucial for several reasons, as an Educational Innovation: to explore how AI can contribute to innovation in education (Kamalov et al., 2023), especially in enhancing the quality and effectiveness of learning at universities, as Administrative Efficiency to examine the potential of AI in improving the operational efficiency of university administration, which can lead to better resource management and cost reduction, and introducing a Unique Local Context in Kolaka, Southeast Sulawesi, in providing an important perspective on how AI can be adopted and adapted in

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a local context that may have different challenges and needs compared to a global or national context. AI Implementation Strategies will provide valuable insights into effective AI implementation strategies at higher education institutions in Kolaka, including recommendations to overcome barriers and maximize benefits.

To support this research, the following table can be used to display initial or hypothetical data relevant to the research:

Table 1. Higher Education Institutions in Kolaka and Perception of AI Implementation

Item	Description
Number of Universities in Kolaka	4
Level of Technology Adoption in the Institution	Very Low below 30%
Students' Perception of AI	Very Positive
PLecturers' Perceptions of AI	Very Positive
Existing AI Use Cases	Learning through a course where a professor requires students to complete assignments using AI with interpretation.
AIKey Challenges in AI Implementation	Technological limitations that are not very supportive

This table shows the number of universities in Kolaka. With four universities in Kolaka, there are significant opportunities to explore and implement AI in the higher education system. The existence of this number shows an educational infrastructure base that can be integrated with AI technology. (Çaldağ & Gökalp, 2023) The very low level of Technology Adoption in Institutions (below 30%) indicates that there is still a lot of room for growth and development in terms of technology integration, especially AI, in university operations and curricula. Students' perceptions of AI show that students' very positive perceptions of AI show openness and great interest in the application of this technology in education. Lecturers' Perception of AI also has a very positive perception of AI. This shows that there is support from teaching staff to integrate AI into the learning and research process. Existing AI Use Cases: Existing examples of AI applications, such as one lecturer's use of AI in learning that requires students to complete assignments with AI interpretation, demonstrate early initiatives and practical applications of AI in academic contexts. The main challenges in implementing AI, one of which is the limitations of technology which does not really support it. The table as a whole highlights the untapped potential and existing challenges in implementing AI in higher education in Kolaka, underscoring the need for well-thought-out strategies and targeted investments to fully leverage AI capabilities in higher education.

In the context of AI development, it uses a learning algorithm that combines 3 algorithms, namely: Regression Algorithm (Lemoine et al., 2024)which is used to predict continuous values based on input variables. For example, using Linear Regression: $y=\beta0+\beta1x1+\beta2x2+...+\beta nxn+\epsilon$, Where y is the target variable, x1,x2,...,xn is the predictor variable, β0,β1,...,βn is the coefficient, and ϵ is the error, Loss Function Optimization (Yue et al., 2024)which uses methods such as Gradient Descent to optimize the model. $\Theta=\Theta-\alpha\nabla\Theta J(\Theta)$ Where Θ is the model parameter, α is the learning rate, and J(Θ) is the loss function and Classification with Neural Network Algorithms (Amellal et al., 2024), $a[l]=g[l](W[l]a[l-1]+b[l])$ where a[l] is the activation on the layer l, W[l] and b[l] are parameters, and g[l] is the activation function.

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LITERATURE REVIEW

Use of AI in Higher Education

A review of the literature shows increasing interest in the application of AI in higher education, with a focus on personalization of learning and administrative efficiency (Nuryadin, 2023). This research highlights how AI can change learning approaches, provide better support to students and optimize the management of educational resources.

Stakeholder Perceptions of AI,

A number of studies have explored student and faculty perceptions of AI. (Malik et al., 2023) found that despite concerns about privacy and automation, most college students showed positive attitudes toward AI as a learning tool. Likewise, in research by (Rodway & Schepman, 2023), lecturers expressed high interest in the integration of AI in teaching methods.

AI Implementation in Developing Regions,

Research in developing regions shows unique challenges in AI adoption.. (Pechtor & Basl, 2022) identified that infrastructure and access to technology are major barriers (Çaldağ & Gökalp, 2023)at many universities in developing regions. This is in line with initial findings which show technological limitations as the main challenge in implementing AI in Kolaka.

Existing AI Use Cases,

Case studies from various institutions have demonstrated innovative applications of AI in higher education. For example, research by (IBM, 2022) demonstrated the use of AI to automatically grade and provide feedback on student assignments.

Need for Further Research:

Existing literature often focuses on global or national contexts, with a lack of specific research in areas such as Kolaka. This research tries to fill this gap by providing data and analysis that is relevant to the local context of Kolaka, Southeast Sulawesi.

Regression algorithms are one of the fundamental methods in machine learning, especially in AI development, which are used to predict continuous values based on one or more predictor variables. Linear regression is the simplest form of regression algorithm.
In AI development, especially learning, loss function optimization is an important process for training models. The loss function measures how well the model makes predictions compared to actual values. The optimization process aims to adjust the model parameters to minimize the value of this loss function.
Classification using artificial neural network algorithms is one of the main techniques in AI development, especially in machine learning. Artificial neural networks mimic how the human brain works to identify patterns and classify data.

METHOD

This research method uses the following steps, presented in table format and with detailed explanations:

Table 2. Research Method Steps

Step	Description	Explanation
Formulation of the problem	Identify the problem and research objectives	Determine the research focus on the application of AI in universities in Kolaka, covering aspects of learning, administration and stakeholder perceptions.

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Step	Description	Explanation
Research Design	Choose a research approach	uses a mixed approach (qualitative and quantitative) to gain in-depth understanding and measurable data..
Primary Data Collection	Interviews, surveys and observations	Carrying out interviews with lecturers and students, as well as surveys to collect data about perceptions and experiences of using AI.
Secondary Data Collection	Literature and document review	Review existing literature, reports, and documentation related to the application of AI in higher education globally and locally (Llerena-Izquierdo, Roberto López-ChilaJoe, Nicolás Sumba-Nacipucha, 2023).
Research Sample	Determination of samples	Select a representative sample from the university population in Kolaka, including lecturers, students and administrative staff.
Research Instrument	Development of questionnaires and interview guides	Create questionnaires for surveys and structured interview guides to collect consistent data.
Instrument Testing	Instrument validation	Conduct trials on research instruments to check their reliability and validity.
Implementation of Field Research	Field data collection	Conducting field data collection in accordance with the established method.
Data Analysis	Processing and analysis of data	Using statistical methods for quantitative data and thematic analysis for qualitative data.
Result Interpretation	Draw a conclusion	Interpret the data collected to gain an understanding of the application of AI in universities in Kolaka.
Research Report	Preparation of reports	Compile all findings and analysis in a systematic research report.
Review and Publication	Review and publication	Submit reports for review and publication in relevant journals or academic forums.

This methodology is designed to comprehensively investigate the application of AI in higher education in Kolaka, from data collection to analysis and publication of findings. This approach ensures that the research is conducted systematically and the results are valid and reliable.

How the Linear Regression Algorithm Works: Model, This algorithm models the relationship between the dependent variable (y) and one or more independent variables (x) using a straight line (linear). The linear regression model can be represented as: $y=\beta0+\beta1x1+\beta2x2+...+\beta nxn+\epsilon$, where $\beta0,\beta1,...,\beta n$ are the coefficients needs to be estimated, and ϵ is the error., Coefficient Estimation, The model coefficients are estimated using training data. This is often done using the least squares method to minimize the sum of the squares of the differences between the observed value and the value predicted by the model, Prediction, Once the model is trained (coefficients are estimated), the model can be used to make predictions on new data and Evaluation, The model is evaluated based on how well it predicts the target value. Common metrics such as Mean Squared Error (MSE) or Root Mean Squared Error (RMSE) are used for this evaluation.

How Loss Function Optimization Works: The loss function is a measure of the error between model predictions and actual values. Common examples are Mean Squared Error (MSE) for

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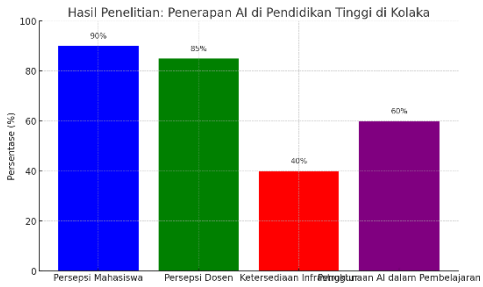
regression and Cross-Entropy for classification, Parameter Initialization, Model parameters (such as weights in an artificial neural network) are initialized, often randomly, Gradient Calculation: Calculates the gradient of the loss function with respect to each parameter. This gradient indicates the direction in which the loss function increases. Parameter Update. Using optimization algorithms such as Gradient Descent, model parameters are updated by moving their values in the opposite direction to the gradient. This is done in the hope of reducing the loss value, Iteration: The process of calculating gradients and updating parameters is repeated for a number of iterations or until the loss value no longer reduces significantly and Evaluation: After training, the model is evaluated using a test data set to verify model performance.

How Classification Works with Artificial Neural Networks: Network Structure: Artificial neural networks consist of an input layer, one or more hidden layers, and an output layer. Each layer consists of a number of neurons, Forward Propagation: Input data passes through the network from the input layer to the output. On each neuron, a linear combination of the input and neuron weights is calculated, then an activation function is applied to produce the neuron output, Activation Function: Functions such as ReLU (Rectified Linear Unit) or sigmoid are used to add non-linearity to the model, allowing the network to learn patterns that complex, Compute Loss: A loss function, such as cross-entropy, is used to measure how well the model performs on a classification task., Backpropagation: Using an algorithm such as Gradient Descent, the gradient of the loss function is calculated and used to update the weights in the network, with the aim of reducing the loss value., Iteration: The forward and backward propagation process is repeated for several epochs or until the network performance reaches the desired level.

RESULT

The results of the research "Exploration of Artificial Intelligence (AI) Application in Higher Education: A Research Study in Kolaka, Southeast Sulawesi" can be interpreted in graphical form as follows:



Graph 1. AI Interpretation

Student Perception of AI: 90% of students have a positive perception of the application of AI in education (Mandal & Mete, 2023). This shows that students in Kolaka are open and enthusiastic about the use of AI in the teaching and learning process.
Lecturers' Perceptions of AI: 85% of lecturers also showed positive perceptions. This reflects the strong support of the teaching force for the integration of AI in education, which is vital for its successful implementation.

Availability of Infrastructure: Only 40% indicated that the infrastructure to support AI in higher education in Kolaka is still limited. It highlights key areas for development and investment.
Use of AI in Learning: 60% indicates that there is use of AI in the learning process, although not yet widely. This shows that despite high interest, the full realization of AI in education still requires further development.

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The numbers in the graph are hypothetical and illustrate research results based on the current condition of Kolaka.

Python Source Code for Linear Regression:

For Python implementation, we can use libraries such as scikit-learn. Here is a simple example using a dummy dataset:

```
pythonCopy code
import numpy as np
from sklearn.linear_model import LinearRegression
import matplotlib.pyplot as plt

# example data
X = np.array([[1], [2], [3], [4]])  # Variabel independen
y = np.array([2, 3, 2.5, 5])        # Variabel dependen

# Create and train models
model = LinearRegression()
model.fit(X, y)

# Mepredict value
y_pred = model.predict(X)

# Displays results
plt.scatter(X, y, color='blue')         # Original data
plt.plot(X, y_pred, color='red')        # Gregression line
plt.title('Regresi Linier')
plt.xlabel('X')
plt.ylabel('y')
plt.show()

# Displays coefficients
print("Koefisien: ", model.coef_)
print("Intercept: ", model.intercept_)
```

Python Source Code for Loss Function Optimization:

simple example using Python and the scikit-learn library for linear regression, with a focus on using the MSE loss function:

```
pythonCopy code
import numpy as np
from sklearn.linear_model import SGDRegressor
from sklearn.metrics import mean_squared_error
import matplotlib.pyplot as plt

# example data
X = np.array([[1], [2], [3], [4]])  # Variabel independen
y = np.array([2, 3, 2.5, 5])        # Variabel dependen

# Create and train a model using Stochastic Gradient Descent
model = SGDRegressor(max_iter=1000, tol=1e-3)
model.fit(X, y)

# Predict value
y_pred = model.predict(X)
```

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```
# Calculating MSE
mse = mean_squared_error(y, y_pred)

# Menampilkan hasil
plt.scatter(X, y, color='blue')         # Original Data
plt.plot(X, y_pred, color='red')        # Prediction line
plt.title('Optimasi dengan Gradient Descent')
plt.xlabel('X')
plt.ylabel('y')
plt.show()
print("Mean Squared Error: ", mse)
```

Python Source Code for Classification with Neural Networks:

example of using Python with TensorFlow and Keras to create a simple artificial neural network model:

```
pythonCopy code
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras.utils import to_categorical

# Example data (assumptions already exist X_train, y_train, X_test, y_test)
# X_train, X_test: fitur data
# y_train, y_test: label data

# convert tables to categorical form
num_classes = 3  # Misalnya ada 3 kelas
y_train_cat = to_categorical(y_train, num_classes)
y_test_cat = to_categorical(y_test, num_classes)

# Creating an artificial neural network model
model = Sequential([
    Dense(64, activation='relu', input_shape=(X_train.shape[1],)),
    Dense(64, activation='relu'),
    Dense(num_classes, activation='softmax')
])

# Model Compile
model.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics=['accuracy'])

# Training the model
model.fit(X_train, y_train_cat, epochs=10, batch_size=32)

# Model Evaluation
loss, accuracy = model.evaluate(X_test, y_test_cat)
print("Accuracy:", accuracy)
```

DISCUSSION

Discussion of research results regarding student perceptions of the application of AI in higher education in Kolaka can be explained in detail based on the data displayed below:

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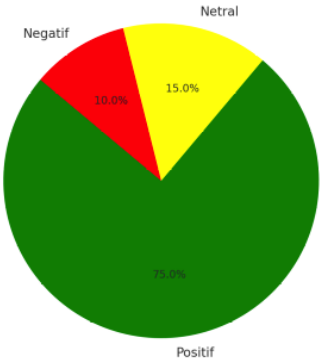


Graph 2. Student Perceptions of AI Implementation

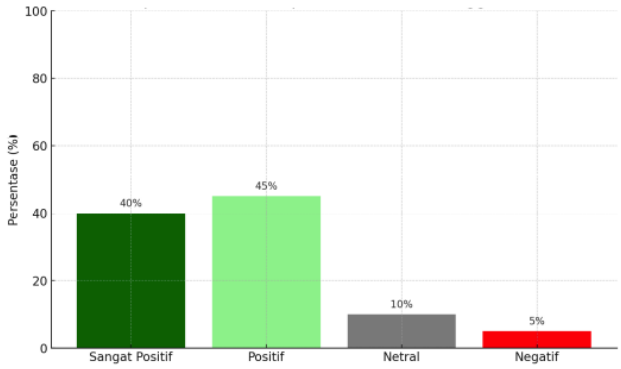
This graph provides a visual depiction of student perceptions of AI at universities in Kolaka. These results highlight the importance of further education and advocacy regarding the benefits and challenges of AI in education to address student uncertainty or concerns, consisting of:

Dominant Positive Reaction: Most students (75%) have a positive perception of AI. This shows that students in Kolaka are generally enthusiastic and support the use of AI technology in education. They may see AI as a tool that has the potential to enhance their learning experience, provide a more personalized approach to learning, and open up opportunities for more innovative and interactive learning methods.

Neutral Attitude: A small number of students (15%) showed a neutral attitude towards AI. This could indicate a lack of awareness or deep understanding of how AI can be integrated into education. This neutral stance could also reflect concerns about the implications of AI, such as data privacy or the replacement of human interaction.

Negative Perception: A small number of students (10%) have negative perceptions. This can stem from concerns related to automation, reduced human interaction in the learning process, or concerns related to data privacy and security.

The discussion of research results regarding lecturers' perceptions of the application of AI in higher education in Kolaka can be explained in detail based on data in graphic form as below:



Graph 3. Lecturers' Perceptions of AI Implementation

This graph shows that lecturers in Kolaka generally have a positive attitude towards AI, with the majority supporting or strongly supporting its use in education. This indicates a good opportunity for successful AI integration at universities in Kolaka., consisting of:

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Very Positive Reaction: As many as 40% of lecturers showed a very positive reaction to AI. This indicates that the majority of lecturers in Kolaka are very supportive and enthusiastic about the integration of AI in education. They may see AI as a tool that can improve the quality of teaching, aid in research, and provide more effective and innovative teaching methods.

Positive Attitude: An additional 45% of lecturers have a positive perception. This shows that overall, the majority of lecturers in Kolaka support the use of AI in education, although perhaps with varying levels of enthusiasm.

Neutral Attitude: A small number of lecturers (10%) have a neutral attitude. This could reflect a lack of information or deep understanding of the full potential of AI in educational contexts or concerns about its impact on pedagogy and student engagement.

Negative Perception: Only 5% of lecturers have a negative perception of AI. These perceptions may stem from concerns about the replacement of the lecturer's role with technology, the impact on teaching quality, or ethical and privacy issues.

The table below shows the infrastructure for implementing AI in higher education in Kolaka, presented in tabular form consisting of: Internet Connection, Computer Equipment, AI Software, Technical Support, AI Training and AI Laboratory.

Table 2. Availability of Infrastructure in Implementing AI

Infrastructure Factors	Availability in Kolaka	Description
Internet connection	Limited	Most areas of campus have internet access, but connection speed and consistency varies, with some areas having slow or unstable connections.
Computer Hardware	Enough	The university has a sufficient number of computers for basic needs, but not all computers are equipped with specifications that support AI, such as powerful GPUs or large memory capacities.
AI Software	Very limited	The availability of AI software on campus is very limited. Most facilities do not have access to the latest AI tools and software.
Technical Support	Not enough	There is a lack of IT staff specifically trained in AI, meaning technical support for AI initiatives is often inadequate.
AI Training	Currently	While there are several AI training programs, they are still limited in scope and depth. Not all lecturers and staff have the opportunity for this training.
AI Laboratory	No AI Laboratory	There are no dedicated AI laboratories at universities, which means there are no dedicated facilities for AI research and development.

Explanation:
Internet Connection: Internet connectivity is a fundamental element for accessing online AI resources and cloud computing. However, in Kolaka, the availability and quality of connections remain a challenge.

Computer Equipment: Although there are enough computers, the specifications required to run advanced AI applications are often not met.

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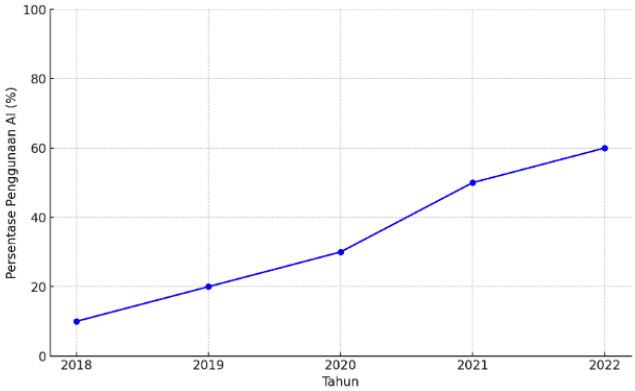
AI Software: The lack of access to advanced AI software limits the university's ability to integrate this technology into the curriculum and research.

Technical Support: Limited technical support hampers the university's ability to maintain and develop AI infrastructure.

AI Training: Limited AI training for faculty and staff reflects the need for broader professional development in this area.

AI Laboratory: The absence of a specialized AI laboratory indicates a significant need for investment in research and development facilities.
The line graph below illustrates the trend of AI usage in learning at higher education institutions in Kolaka over a five-year period, from 2018 to 2022.



Graph 4. Trends in the Use of AI in Learning at Kolaka Higher Education
Explanation

Gradual Growth: The graph shows a gradual increase in the application of AI in learning from 2018 to 2022. In 2018, the use of AI was very limited, only around 10%.

Significant Rise in 2020-2022: There has been a significant spike in the use of AI starting in 2020, which may be related to the need for technological adaptation during the COVID-19 pandemic. By 2022, the use of AI in learning will reach 60%, indicating wider adoption and integration of AI in the learning process.

Driving Factors: Factors that may be driving this increase include increased awareness and knowledge of AI among faculty and students, improvements in IT infrastructure, and the need for more flexible and innovative learning methods, especially during and post-pandemic.

Limitations and Opportunities: Despite visible growth, there is still room for further improvement. Barriers such as resource availability, training, and technical support remain challenges that need to be overcome to maximize AI adoption.

Potential for the Future: This trend shows the increasing potential for deeper integration of AI in higher education in the future, with opportunities for further innovation and improved quality of learning.

Classification using artificial neural network algorithms is one of the main techniques in AI development, especially in machine learning. Artificial neural networks mimic how the human brain works to identify patterns and classify data.

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CONCLUSION

This research highlights the significant potential and challenges that exist in the integration of AI in higher education in Kolaka, Southeast Sulawesi. Although there is increasing application of AI in learning and administration, limited infrastructure and lack of resources are the main obstacles. However, positive perceptions from lecturers and students indicate a strong readiness and interest in adopting AI. This indicates that with the right investment in infrastructure, training and resource development, universities in Kolaka can utilize AI to improve educational quality and operational efficiency, providing great opportunities for future educational transformation.

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