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Teacher Perceptions of Deep Learning Models for Special Need Students in Inclusive Vocational Schools: A Fuzzy Logic Analysis

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ABSTRACT

This study investigated teacher perceptions of the Deep Learning model for students with special needs in a vocational school practicing inclusive education. Utilizing the fuzzy logic approach, data from teacher observations and surveys were processed. The research emphasized the critical role of Deep Learning model in addressing the challenges in inclusive education. Teacher insights are essential for enhancing the efficacy of the model in catering to the unique learning needs of special students. Understanding their perspectives contributes to the ongoing discourse on inclusive education, offering valuable insights for educators and policymakers striving to create more inclusive and equitable learning environments. This research contributes to the ongoing dialogue on inclusive education by shedding light on the practical implementation of the Deep Learning model for students with special needs in vocational education settings.

Keywords:
Teacher perceptions; Deep Learning models; special need students; inclusive vocational schools; fuzzy logic

1. Introduction

Exploring the Deep Learning model for students with special needs in inclusive vocational schools is a principle underscoring the equal rights of every individual to receive an education, including students with special needs [1-3]. This paradigm emphasizes that access to education must be guaranteed for all citizens without any discrimination. Thus, every child has the opportunity to grow and develop their full potential [4]. In the inclusive education context, vocational schools for students with special needs play a vital role as institutions that accept and provide education to students with special needs. SMK-PPI is one of the inclusive vocational schools. In SMK-PPI, students with special needs face unique challenges in the learning process, necessitating effective and inclusive teaching strategies to maximize their potential and address their needs optimally.

Teachers at SMK-PPI have a central role in realizing an effective inclusive education. They are responsible for creating an inclusive, supportive, and friendly learning environment for students with

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special needs. Teachers need to adopt innovative and adaptive teaching approaches to meet the needs of students with special needs. In addressing these challenges, one intriguing teaching model to explore is the Deep Learning model [5].

Deep Learning is a branch of artificial intelligence inspired by the human brain workings [6-8]. Its ability to recognize complex patterns in data, such as patterns in images, text, and sound, makes it highly suitable for application in the inclusive education context [9, 10]. Using the Deep Learning model is expected to provide learning experiences tailored to learning styles and individual developmental levels of students with special needs [11, 12].

However, despite the promising potential of the Deep Learning model application, its use for students with special needs still requires an in-depth analysis. The perception and acceptance of teachers regarding this teaching model are crucial factors in determining its successful implementation in the inclusive vocational school environment. Therefore, this research aimed to conduct an initial analysis of teacher perceptions and acceptance of the Deep Learning model in the inclusive education context conducted at SMK-PPI. In this analysis, the fuzzy logic approach was employed to address the complexity and uncertainty of data related to the qualitative and subjective aspects of the teacher perceptions and acceptance [13-21].

This approach is expected to provide profound insights into the integration of the Deep Learning model in the inclusive learning environment [12]. The results of this initial analysis serve as a crucial foundation for developing more effective and adaptive inclusive teaching strategies for students with special needs [22-25].

Furthermore, in this study, we outlined a literature review related to the Deep Learning model, the research method employed, the results of the initial analysis of the teacher perceptions and acceptance, and the fuzzy logic approach applied in the data processing [26]. It is hoped that, through this article, readers can understand the importance of implementing the Deep Learning models in inclusive education and how teacher perceptions can contribute to optimizing the use of the model for the progress and success of students with special needs, especially for those in inclusive vocational schools [27-34].

2. Methodology

This study aimed to examine the teacher perceptions and acceptance of the implementation of the Deep Learning model for students with special needs in an inclusive vocational school, named SMK-PPI. The study employed the fuzzy logic approach in processing data to gain deeper insights [35]. The process of the study consisted of several steps presented in the following sections.

2.1. Fuzzification of Data

In this first step, the data from observation were transformed into linguistic values using the fuzzification process. Fuzzification allows quantitative data [36, 37], such as teacher responses to the Deep Learning model, to be represented in the form of fuzzy sets. Each observed variable has an appropriate fuzzy set reflecting the complexity and uncertainty of the data. For example, the variable "teacher acceptance" can have fuzzy sets like "low," "moderate," and "high" to describe various teacher perceptions of the Deep Learning model.

2.2. Rule Base

After fuzzification, the next step was to construct a rule base. The rule base contains IF-THEN based rules connecting the membership values of various input variables (such as teacher perceptions) to obtain the desired output values [38]. The rule base is constructed based on knowledge and understanding of the data and the research domain. For example, a rule could state "IF Teacher Acceptance is High AND Teaching Skills are Low, THEN Quality of the Learning Model is Good."

2.3 *Inference Engine*

The inference engine is the component responsible for making inferences based on the previously created rule base [39]. At this stage, membership values from various input variables were input into the rule base and fuzzy logic operations (such as AND, OR, and NOT) were applied to obtain fuzzy output values. This process yielded membership values for output variables reflecting the teacher acceptance of the Deep Learning model based on their perceptions.

2.4 Defuzzification

The final step of the process of this study was the defuzzification [40]. In this step, the fuzzy output values obtained from the inference engine were converted into crisp values (single values) so that the values could be understood and used in the decision-making. The defuzzification method used might vary, such as the Centroid Method, Weighted Average Method, or Mean of Maxima Method. The results of the defuzzification process numerically depicted the level of the teacher acceptance of the Deep Learning model implementation for students with special needs in SMK-PPI.

2.5 Validation and Interpretation

After obtaining the defuzzification results, the validation and interpretation stage of the finding was administered. The defuzzification results provided a deeper understanding of the teacher perceptions of the Deep Learning model. The data processed using fuzzy logic are interpreted to identify trends, patterns, or relevant conclusions. The interpreted results will be used to support the research findings. Thus, this method allows the research to address the complexity of data and the uncertainty of information, in this case related to the teacher perceptions and acceptance of the Deep Learning model for students with special needs in SMK-PPI. This method provides deeper insights into the analysis of the conducted observations. The results of this study can be used to develop more effective and adaptive inclusive education strategies for students with special needs.

3. Results

In this study, the fuzzy logic approach was used to overcome the complexity and to analyse data related to teacher perceptions and acceptance of the Deep Learning model in the inclusive education context, specifically at a vocational school practicing inclusive education named the SMK-PPI. Fuzzy logic was applied to several key variables relevant to the inclusive learning environment at SMK-PPI [4, 35]. The analysis process is presented in the following sub-sections.

3.1 "Number of Students" Variable

In this sub-section, the "Number of Students" variable (num_students) was analysed using fuzzy sets "few," "moderate," and "many." This variable provided an overview of the distribution of students with special needs in different categories of disabilities. Through fuzzy membership plot graphs, we could observe how students with special needs were distributed across different quantity categories.

This code defined a variable called num_students and a set of fuzzy membership functions for the "Number of Students" variable. It then called a function plot_fuzzy_membership to visualize the fuzzy membership functions for the "Number of Students" variable. The result of fuzzy plot sets for the number of students is presented in Figure 1.

```
# Variables and fuzzy sets for num_students
num_students = np.arange(0, 16, 0.1)
num_students_membership = {
    'few': [0, 0, 6],
    'moderate': [4, 7.5, 11],
 'many': [9, 15, 15]
}

plot_fuzzy_membership(num_students, num_students_membership, 'Number of Students')
```

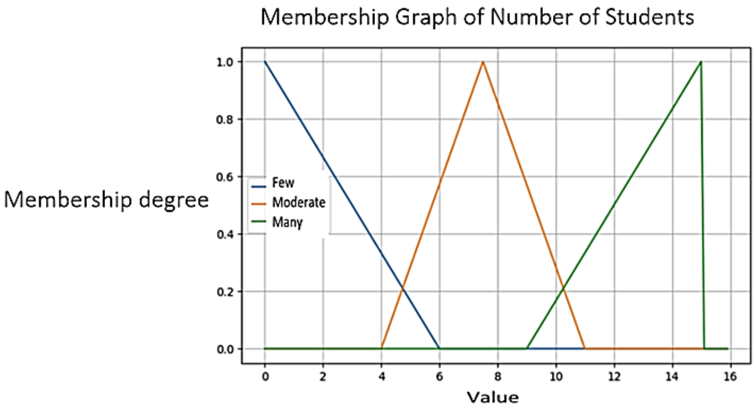

Fig. 1. "Number of Students" variable

3.2 "Infrastructure" Variable

This sub-section considered the "Infrastructure" variable with fuzzy sets "low," "moderate," and "high." This variable depicted the level of supporting infrastructure and facility availability at SMK-PPI. Fuzzy membership plot graphs illustrate the availability of infrastructure at various levels, providing insights into the inclusive educational infrastructure situation. The result of fuzzy plot sets for the infrastructure variable is shown in Figure 2.

```
# Variable and fuzzy sets for infrastructure
infrastructure = np.arange(0, 61, 0.1)
infrastructure_membership = {
   'Low': [0, 0, 25],
   'Moderate': [10, 30, 50],
```

```
    'High': [35, 60, 60]
}

plot_fuzzy_membership(infrastructure, infrastructure_membership, 'Infrastructure')
```

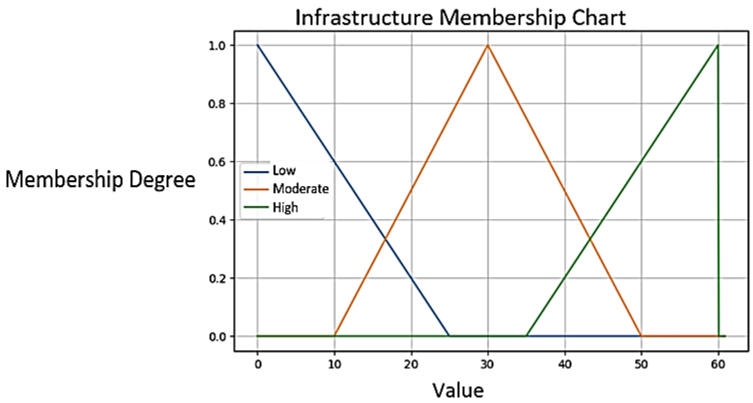

Fig. 2. "Infrastructure" variable

3.3 "Facility" Variable

This sub-section analysed the "Facilities" variable using fuzzy sets "low," "moderate," and "high." This variable indicated the level of availability of supporting facilities, such as the technology and equipment in the inclusive learning environment. Through fuzzy membership plot graphs, we could understand how the availability of facilities affected the potential learning of students with special needs. The result of fuzzy plot sets for the facility variable is illustrated in Figure 3.

```
# Variable and fuzzy sets for facilities
facilities = np.arange(0, 51, 0.1)
facilities_membership = {
    'Low': [0, 0, 20],
    'Moderate': [10, 25, 40],
    'High': [30, 50, 50]
}

plot_fuzzy_membership(facilities, facilities_membership, 'Faciities')
```

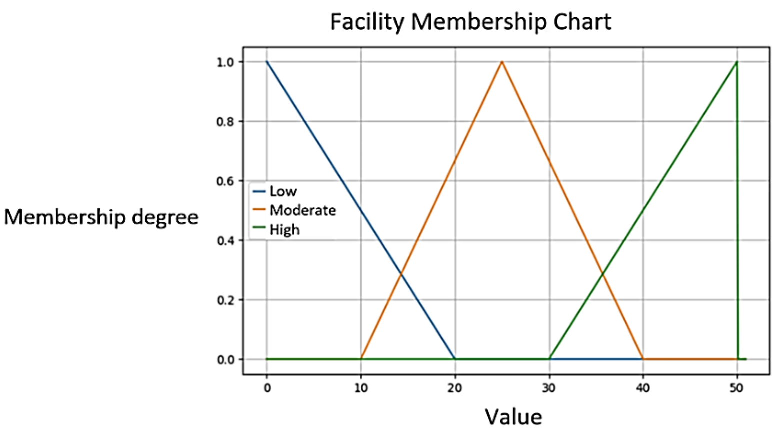

Fig. 3. "Facility" variable

3.4 Evaluation of "Deep Learning Needs"

In this sub-section, we evaluated the "Deep Learning Needs" variable (deeplearning_need) using fuzzy sets involving categories "very low," "low," "moderate," "high," and "very high." This variable provided an overview of how students with special needs required the Deep Learning model in the inclusive education context. Fuzzy membership plot graphs depicted the variation in the levels of need among students. The result of fuzzy plot evaluation of "Deep Learning Needs" is presented in Figure 4.

```
# Variable and fuzzy sets for deeplearning_need
deeplearning_need = np.arange(0, 101, 0.1)
deeplearning_need_membership = {
    'Very Low': [0, 0, 25],
    'Low': [15, 30, 45],
    'Moderate': [35, 50, 65],
    'High': [55, 70, 85],
    'Very High': [75, 100, 100]
}

plot_fuzzy_membership(deeplearning_need, deeplearning_need_membership, 'Deep learning
Needs')
```

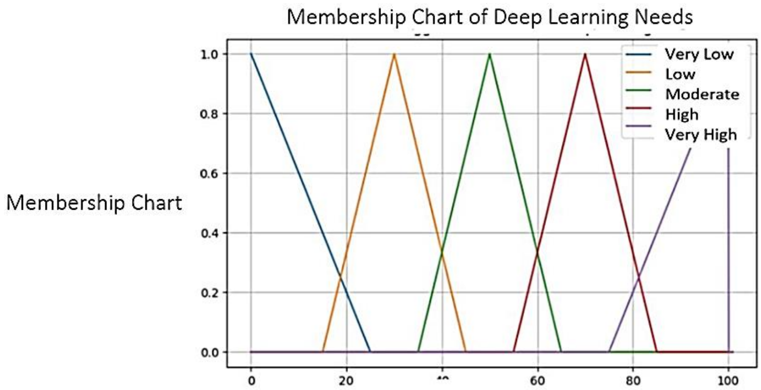

Fig. 4. Evaluation of "Deep Learning Needs"

3.5 Visualization of Results and Statistics

In this sub-section, the results of the analysis were presented in graphs visualizing the level of deep learning needs among students with special needs. Additionally, we performed statistical calculations for the average and median levels of deep learning needs of the students. These averages and medians provided an overview of the central and mean values of the needs of students with special needs regarding the implementation of the Deep Learning model. The result of fuzzy plot visualization of the results and statistics is presented in Figure 5.

```
# Displays a graph of analysis result with connected lines
plt.figure(figsize=(10, 6))
plt.plot(df.index, df['Level_Needs_Deeplearning'], marker='o', color='b', label='Deep learning
Needs')
```

```
# Calculates and displays average
average_value = df['Level_Needs_Deeplearning'].median()
plt.axhline(average_value, color='r', linestyle='--', label='Average')
plt.text(df.index.max(), average_value, f' Average = {average_value:.2f}', va='center')

# Calculates and displays the median value
median_value = df['Level_Needs_Deeplearning'].median()
plt.axhline(median_value, color='g', linestyle='--', label='Median')
plt.text(df.index.max(), median_value, f' Median = {median_value}', va='center')

plt.xlabel('Indeks')
plt.ylabel('Deep Learning Needs')
plt.title('Deep Learning Needs Analysis')
plt.legend()
plt.grid(True)
plt.show()
```

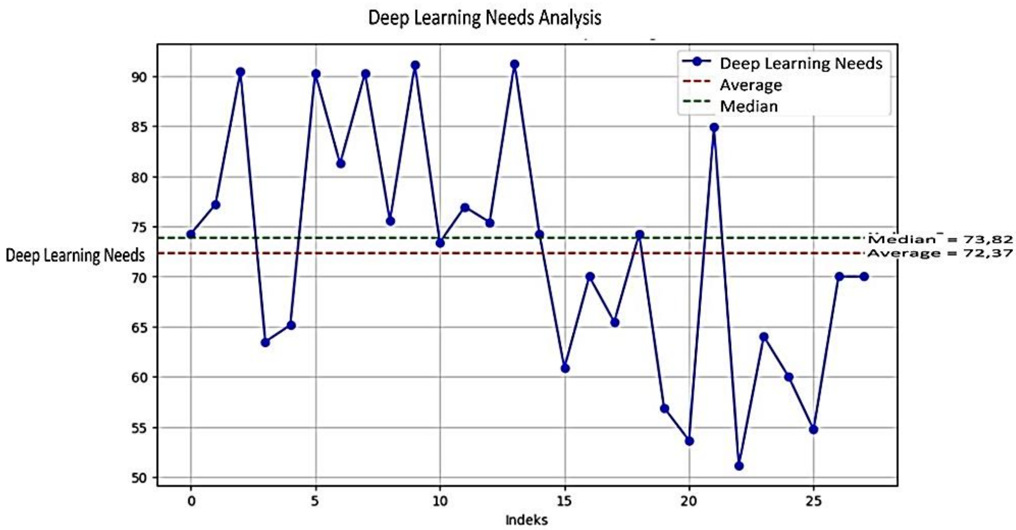

Fig. 5. Visualization of results and statistics

This visualization outlines how the information can be used as a basis for designing more effective and adaptive learning strategies in the inclusive education context, especially at SMK-PPI.

4. Conclusions

Inclusive education and the application of the Deep Learning model are important for the equal access to education, including for students with special needs. Vocational schools organizing inclusive education play an important role in upholding this principle. Students with special needs face unique learning challenges, requiring innovative teaching methods. Teachers at SMK-PPI play an important role in creating an adaptive and inclusive learning environment. Deep Learning, a branch of AI, promises to meet the diverse learning needs of students with special needs by personalizing their educational experience. The teacher perceptions and acceptance of the Deep Learning model became the key to its successful integration in SMK-PPI, thereby improving the learning journey of students with special needs. The use of fuzzy logic for analysing teacher perceptions provides nuanced insights, helping the integration of the Deep Learning model into the inclusive education. The results of the initial analysis form an important foundation for developing more effective and adaptable inclusive teaching strategies aimed at maximizing the student potential and fostering equitable learning environments.

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