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Application of Artificial Neural Network in Web Expert System for Emotional Preschool Children

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Abstract *- This study developed a web-based expert system to assist parents in identifying emotional parenting styles for preschool children using an Artificial Neural Network (ANN). The ANN model consists of an input layer, one hidden layer, and an output layer, using the sigmoid activation function. The parenting styles assessed include authoritarian, democratic, and permissive patterns. The observed symptoms refer to parental behaviors, such as the level of control, frequency of punishment, and involvement in conversations with the child. Data were collected through interviews with psychology experts and literature reviews, resulting in a dataset of 384 samples. The system was developed using the Waterfall software development model. Testing with ten sample cases showed that the system's predictions matched expert evaluations in nine cases (90% accuracy), while one case indicated a discrepancy. These results demonstrate that ANN can effectively classify parenting patterns based on observable symptoms. This expert system offers a practical tool for parents and educators to better understand and apply appropriate parenting strategies, contributing to the emotional development of preschool children.*

Keywords**:** *Artificial Neural Network; Parenting; Parenting Style*.

1. INTRODUCTION

Children acquire a wide range of skills primarily within the family environment, where education and guidance play a central role in their upbringing. Parenting encompasses the processes of teaching, nurturing, guiding, and providing direction to children, and it is recognized that parents employ various approaches and styles in this role [1]. It is crucial to understand that a child's formal education effectively begins at home, with parents acting as the first and most influential teachers. Supporting this view, numerous studies highlight that parents hold the primary responsibility for early childhood education within the home setting, making them key figures in shaping their child's moral development and overall education [2]. A significant challenge observed in this context is the child's struggle to develop social independence within their surroundings. Specifically, many children face difficulties in interacting effectively with peers and cultivating the ability to function independently, which can hinder their social development [3].

According to Isnaini and Prajayanti [4], there are differences in parenting styles of parents in Matesih. For example, some parents in Matesih apply inappropriate parenting styles to their children due to appearance. The parenting style that parents apply to their children is inappropriate, such as when the child looks moody, irrational, or likes to fight with his siblings and friends, is irritable, moody, likes to fight with friends and family, and some even refuse to go to school. The difference between authoritarian and permissive parenting styles is clear here [5]. Permissive parenting usually avoids the use of punishment and does not help children learn acceptable behavior in society, which may hinder the development of children's ability to establish appropriate social boundaries. Parents prefer to give a lot of opportunities and freedom to their children without really caring about them. Based on Hanum et al. research [6], authoritarian parenting involves enforcing rules that parents apply and children are expected to follow. Such rigid enforcement can stifle children's initiative and limit their independent social interactions. Sari et al. [7] say democratic parenting is a parenting approach in which parents raise and educate their children by giving them freedom under strict supervision, supporting the balanced development of independence and social skills.

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The above-mentioned presentation describes the challenges associated with early childhood emotional development; therefore, solutions are needed to address these issues. Parents who are the primary caregivers of their children should practice effective and responsible parenting as this can reduce the risks and dangers associated with harmful effects on children [8]. Parents can use a three-parenting approach: authoritarian (parents who emphasize many rules to their children), democratic (parents who give their children free will), and permissive (parents who think for themselves) [9]. This research uses parenting theories that include understanding, urgency, and forms of parenting, as well as how parenting affects early childhood emotional development. To address these challenges, this research proposes the development of a web-based expert system utilizing artificial neural networks (ANN) to assist in identifying and understanding parenting styles. Artificial neural networks are particularly suitable for this task because human parenting behavior involves complex and nonlinear patterns that are difficult to model with traditional rule-based approaches. ANNs can learn and generalize from diverse and subtle patterns in data, making them effective for analyzing and classifying parenting styles. Nonlinear modeling of intelligent computing approaches known as artificial neural networks has gained significant traction in science and is considered an important achievement in computing and information processing technology in recent years [10].

2. RESEARCH METHODOLOGY

This research employed a combination of expert interviews, literature studies, and system development using the Waterfall model. An Artificial Neural Network (ANN) was utilized as the core method for classifying parenting styles based on observed parental behaviors [10].

2.1. Requirement Analysis

The Requirement Analysis stage aimed to identify the key features and requirements necessary for developing an expert system capable of classifying parenting styles. Data collection was conducted through two main methods: interviews and literature studies. Interviews were conducted with two psychology experts specializing in early childhood emotional development. The interviews focused on identifying behavioral indicators associated with different parenting styles, such as control over children's behavior, use of punishment, freedom of choice, and degree of parent-child communication. Additionally, the experts validated the categorization scales (low, medium, high) for each symptom [1].

A literature study was also conducted, reviewing research articles and journals published between 2018 and 2023 related to parenting theories and the application of artificial neural networks in behavioral classification tasks. Relevant literature findings supported the identification of appropriate attributes for system input and the selection of ANN as the classification method [6]. The insights gained from interviews and literature studies directly informed the selection of seven parenting symptom indicators used as inputs in the ANN model, enabling the system to classify parenting styles as authoritarian, democratic, or permissive [7].

2.2. System Design

During this phase, the architecture of the web-based expert system was designed. This included defining data structures such as user information, parenting symptom indicators, and classification results; establishing the overall software architecture; creating user interface representations; and specifying coding techniques. This research utilized a Use Case Diagram to model user interactions with the system, such as inputting symptom data, initiating assessments, and viewing classification results. Additionally, a Class Diagram was created to represent key system components, including classes like User, SymptomData, and AssessmentResult.

The system development process adopted the Waterfall model, a conventional software development approach often referred to as a linear sequential model [11]. This model proceeds step-by-step through defined phases, ensuring structured progression from requirements gathering to maintenance.

2.3. Implementation (Coding)

In the implementation phase, the design was translated into a working software application. The ANN model was built with one input layer (containing seven nodes for the parenting symptom indicators), one hidden

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layer, and one output layer classifying the parenting style. The sigmoid activation function was applied to the neurons to handle the nonlinear characteristics of the parenting data [10]. The system was developed as a web-based application integrating the ANN model for real-time classification.

2.4. Testing

Evaluation of the system involved comprehensive testing to assess both its overall functionality and the accuracy of the Artificial Neural Network (ANN) in classifying data. During this phase, ten newly collected data samples, which had not been used during training, were input into the system and processed using the pre-trained ANN model. To determine the system's effectiveness, its classification results were directly compared against the assessments provided by human experts in the relevant field. The comparison revealed a high level of agreement, with the system correctly classifying 9 out of the 10 cases, resulting in a 90% accuracy rate. This outcome demonstrates the system's strong potential for reliable classification performance in practical applications.

2.5. Deployment and Maintenance (Future Work)

Although this study focuses primarily on system development and initial testing, further stages of the Waterfall model have been considered. Deployment refers to the implementation of the expert system in real-world educational or parental counseling settings. Maintenance involves continuous refinement of the system based on user feedback, system performance analysis, and updates to the parenting indicators as needed. These stages are planned for future research and practical application development [12].

3. RESULTS AND DISCUSSION

3.1. Requirement Analysis

During the Requirement Analysis stage, essential features and requirements for developing an expert system to classify parenting styles were identified through both interviews and literature review. Two psychology experts specializing in early childhood emotional development were interviewed to uncover key behavioural indicators, such as parental control, punishment methods, freedom of choice for children, and the level of parent-child communication. These experts also validated the symptom rating scale categorized as low, medium, and high [13].

In addition, a review of recent research articles and journals from 2018 to 2023 was conducted, focusing on parenting theories and the application of artificial neural networks (ANN) in behavioural classification. The literature provided important insights that helped determine suitable attributes for the system's input and confirmed ANN as an effective classification method [14]. By combining expert knowledge and current scientific research, the Needs Analysis phase laid a strong foundation for designing a reliable expert system to classify parenting styles accurately. Based on the interview and literature study results, three parenting styles were identified: authoritarian, permissive, and democratic, each associated with a specific range of symptom scores. The parenting scale used is summarized in Table 1.

Table 1. Parenting data scale.

Scale Name	Pattern Range
Low	1-2
Medium	3-4
High	5-6

The collected symptom data encompasses a range of behavioral indicators such as attentiveness to children's opinions, participation in discussions, allowance of freedom in decision-making, application of punishment,

Vol. 6 No. 1, 2025, pp. 39-46 **Jurnal Pepadun**

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regulation of behavior, and how often punishment is administered. Figure 1 depicts the distribution of these parenting symptoms across the various parenting styles.

Data Tabel

Tambah Data | Hapus Data | Kembali

ID	Mendengarkan Pendapat Anak	Melibatkan Dalam Pembicaran	Sedikit Memberi Kebebasan Kepada Anak Untuk Memilih Yang Terbaik	Tidak Memberikan Hukuman Dan Pengadilan	Memberi Kontrol Yang Sangat Ketat Terhadap Tingkah Laku Anak	Membiarkan Anak Bertindak Sesuai Dengan Keinginannya	Sering Memberikan Hukuman Kepada Anak	Pola Asuh
385	1	1	1	1	5	1	5	otoriter
386	5	3	5	1	2	2	1	demokratis
387	5	3	5	1	1	5	1	permisif
388	1	1	1	1	5	1	6	otoriter
389	5	3	5	1	2	2	2	demokratis

Figure 1. Parenting symptoms.

The dataset, consisting of 384 samples, formed the basis for training the Artificial Neural Network (ANN) model, with each sample categorized according to the defined parenting style scales.

3.2. System Design

In this stage, the architecture for the web-based expert system was carefully designed. This involved defining essential data structures such as user profiles, parenting symptom indicators, and classification outcomes. The overall software framework was then established to guide the system's development. To illustrate how users would interact with the system, user interface layouts were created. A Use Case Diagram was used to explain user actions such as entering symptom data, starting the assessment, and viewing results. A Class Diagram was also made to show the main parts of the system, including classes like User, SymptomData, and AssessmentResult. The development followed the Waterfall model, which ensures that the project advances through distinct phases—from gathering requirements to system maintenance — in an orderly and methodical manner [11]. The interactions between users and the system are visualized in the Use Case Diagram in Figure 2, while the sequence of system operations is illustrated in the system flowchart shown in Figure 3.

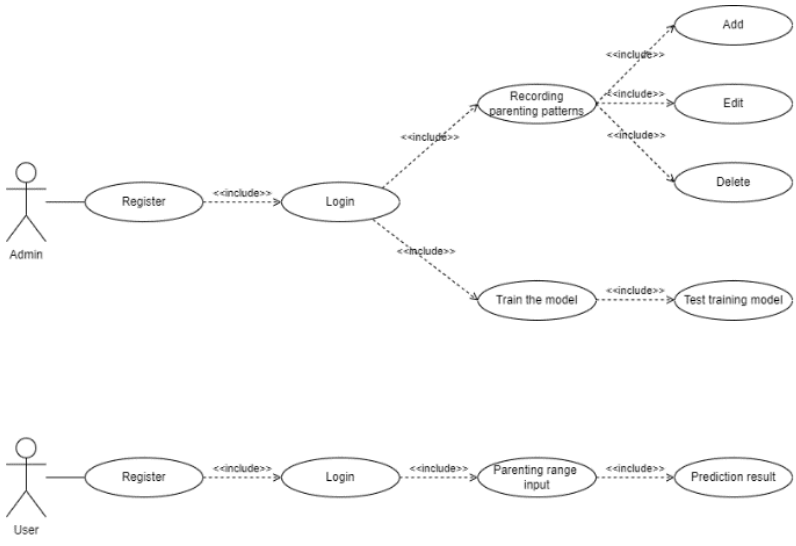

Figure 2. Parenting use case.

Vol. 6 No. 1, 2025, pp. 39-46 **Jurnal Pepadun**

DOI: 10.23960/pepadun.v6i1.264

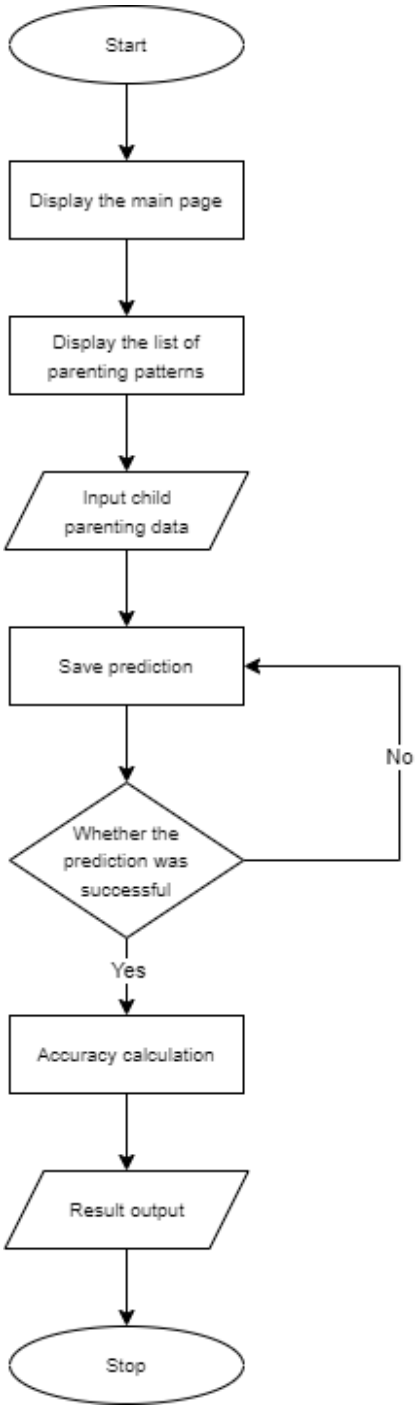

Figure 3. Flowchart of the system flow.

These diagrams provide a clear picture of how the system functions and how users engage with it. By applying this structured design and development methodology, the project aims to deliver a reliable and efficient expert system that facilitates accurate classification of parenting styles based on user input.

3.3. System Implementation and ANN Utilization

The Artificial Neural Network (ANN) was utilized as the classification engine within the expert system. It was trained on a dataset of 384 validated samples, each containing seven behavioral indicators. The supervised learning approach with backpropagation was applied to optimize network weights during training [10].

Vol. 6 No. 1, 2025, pp. 39-46 **Jurnal Pepadun**

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During the prediction phase, user inputs consisting of symptom values were fed into the ANN model, which then produced a classification output corresponding to authoritarian, democratic, or permissive parenting styles. This process allowed the system to autonomously analyze parenting patterns based on input symptoms and provide accurate categorization without direct human judgment.

3.4. System Testing

System testing was performed by entering ten new test cases and comparing system predictions with expert evaluations. Table 2 presents a detailed comparison.

Table 2. Comparison of system and expert classifications.

No	PAA 1	PAA 2	PAA 3	PAA 4	PAA 5	PAA 6	PAA 7	Category	System	Expert
1	5	5	3	2	2	1	2	Democratic	Appropriate	Appropriate
2	5	6	5	2	1	2	1	Democratic	Appropriate	Appropriate
3	1	2	1	3	5	2	6	Authoritarian	Appropriate	Appropriate
4	3	3	4	5	2	6	1	Permissive	Appropriate	Appropriate
5	5	5	4	5	1	5	1	Permissive	Appropriate	Appropriate
6	1	2	1	5	6	5	6	Authoritarian	Appropriate	Appropriate
7	5	6	5	1	5	1	5	Democratic	Appropriate	Appropriate
8	1	2	3	5	5	5	5	Authoritarian	Appropriate	Appropriate
9	3	3	3	5	2	5	1	Permissive	Appropriate	Appropriate
10	1	2	2	3	3	3	4	Authoritarian	Appropriate	Inappropriate

As shown in Table 2, the system achieved a prediction accuracy of 90%, with nine out of ten samples matching the expert evaluations. Only one sample (Sample 10) showed a discrepancy, indicating a potential area for further model refinement. These results validate the capability of the ANN-based expert system in classifying parenting styles based on observed symptom data.

3.5. Discussion

The results show that the Artificial Neural Network (ANN) model was able to learn and imitate expert thinking about parenting behaviour patterns, achieving 90% accuracy. This means the model can recognize complex patterns similar to how experts do. However, the small mistake in one sample suggests the model could be improved. This might be done by adding more training data with diverse examples and adjusting settings like learning rate or the number of neurons in the network to better capture subtle differences.

Using ANN is a good choice here because parenting behaviours are complex and don’t follow simple rules. Traditional methods may struggle to represent these nonlinear and complicated patterns, but ANNs can learn from small variations in data, making them well suited for analysing parenting styles based on behaviours. For future improvements, the system could benefit from having more sample data, trying different types of neural networks that might capture time-based or layered behaviour patterns better, and using ensemble

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learning (combining several models) to increase accuracy. These steps would help make the system more accurate and reliable in classifying parenting styles.

4. CONCLUSIONS

This study demonstrates the effectiveness of a parenting pattern prediction system developed using the artificial neural network (ANN) method, which can accurately identify and classify various parenting styles. The system was trained and tested on a dataset comprising 384 samples, each categorized into one of three parenting styles: authoritarian, democratic, and permissive. When evaluated against expert assessments using five test samples, the system's predictions showed a strong concordance with expert judgments, indicating its reliability and precision in recognizing parenting patterns.

The results highlight the significant potential of artificial intelligence technology as a valuable tool to assist parents, educators, and caregivers in better understanding the nuances of parenting styles. By providing clear, data-driven insights, the system enables users to make informed decisions that can lead to the adoption of more effective and supportive parenting approaches. Moreover, beyond its predictive capabilities, the system serves as a practical evaluation instrument to identify potential issues or maladaptive patterns within parenting behaviours that might negatively impact children's social and emotional development. This early detection capability is crucial, as it facilitates timely and targeted interventions, promoting healthier developmental outcomes for children.

In summary, this study underscores the promise of integrating AI-driven methods like ANN into family and educational contexts to enhance parenting quality. It provides a foundation for further development of technological solutions that can support early childhood development through scientifically grounded assessment and guidance, ultimately contributing to the well-being of families and communities.

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