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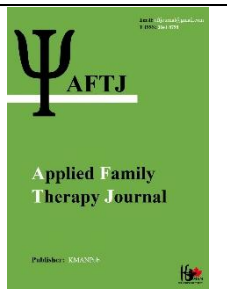

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CatBoost Modeling of Parenting Effectiveness Based on Mindfulness, Emotional Intelligence, Psychological Flexibility, and Reflective Functioning

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A B S T R A C T

Objective: The present study aimed to develop and evaluate a CatBoost machine learning model for predicting parenting effectiveness based on mindfulness, emotional intelligence, psychological flexibility, and reflective functioning among parents in Thailand.

Methods and Materials: This cross-sectional predictive study was conducted among 742 parents recruited from Bangkok, Chiang Mai, Phuket, Khon Kaen, and Nakhon Ratchasima, Thailand. Participants completed the Parenting Sense of Competence Scale, Five Facet Mindfulness Questionnaire, Wong and Law Emotional Intelligence Scale, Acceptance and Action Questionnaire-II, and Reflective Functioning Questionnaire. Following data screening and preprocessing procedures, a CatBoost machine learning algorithm was implemented to predict parenting effectiveness. The dataset was divided into training (80%) and testing (20%) subsets, and hyperparameter optimization was performed using five-fold cross-validation. Model performance was evaluated using the coefficient of determination (R^2), root mean squared error (RMSE), mean absolute error (MAE), and mean absolute percentage error (MAPE). SHAP (Shapley Additive Explanations) analyses were additionally conducted to examine feature importance and interpret predictor contributions.

Findings: The results revealed significant positive associations between parenting effectiveness and mindfulness ($r = .69$, $p < .001$), emotional intelligence ($r = .72$, $p < .001$), psychological flexibility ($r = .65$, $p < .001$), and reflective functioning ($r = .67$, $p < .001$). The CatBoost model demonstrated strong predictive performance, explaining 84.2% of the variance in parenting effectiveness in the training dataset ($R^2 = .842$) and 81.6% in the testing dataset ($R^2 = .816$), with a cross-validation R^2 of .808. Feature importance analysis indicated that emotional intelligence was the strongest predictor (32.8%), followed by mindfulness (28.6%), reflective functioning (21.7%), and psychological flexibility (16.9%). SHAP analyses

confirmed that higher levels of all four predictors contributed positively to parenting effectiveness predictions, with emotional intelligence exerting the greatest overall influence on model outputs.

Conclusion: The findings demonstrate that parenting effectiveness is strongly influenced by emotional, cognitive, and self-regulatory psychological capacities. Emotional intelligence emerged as the most important determinant, followed by mindfulness, reflective functioning, and psychological flexibility. The high predictive accuracy of the CatBoost model highlights the utility of machine learning approaches for understanding complex parenting processes and identifying key psychological resources that may serve as targets for intervention. Strengthening these capacities may enhance parenting effectiveness and contribute to healthier family functioning and child development outcomes.

Keywords: *Parenting effectiveness, CatBoost, machine learning, mindfulness, emotional intelligence, psychological flexibility*

1. Introduction

Parenting effectiveness has become a central construct in developmental, family, and clinical psychology because parents play a pivotal role in shaping children's emotional, social, cognitive, and behavioral development. Effective parenting is generally characterized by warmth, responsiveness, emotional availability, consistency, and the capacity to support children's developmental needs while maintaining appropriate behavioral expectations. Research consistently demonstrates that parenting effectiveness contributes substantially to children's psychological adjustment, academic achievement, emotional regulation, social competence, and long-term well-being. Conversely, ineffective parenting practices are associated with a broad range of adverse outcomes, including emotional difficulties, behavioral problems, poor social adaptation, and compromised mental health among children and adolescents (Chen, 2022; Delgado et al., 2022). As contemporary families encounter increasingly complex social, economic, and psychological challenges, identifying the psychological factors that contribute to effective parenting has become an important priority for both researchers and practitioners.

Recent theoretical and empirical developments suggest that parenting effectiveness is not determined solely by parenting knowledge or behavioral skills but is profoundly influenced by parents' underlying psychological capacities. Among these capacities, mindfulness has emerged as a particularly influential factor. Mindfulness refers to the ability to maintain awareness of present-moment experiences with openness, curiosity, and nonjudgmental acceptance. In parenting contexts, mindfulness enables parents to respond intentionally rather than react impulsively to children's behaviors and emotional expressions. Mindful parents tend to demonstrate greater emotional attunement, enhanced self-regulation, and improved parent-child interactions. The concept of mindful parenting has attracted considerable attention because it integrates attentional regulation, emotional awareness, self-compassion, and relational sensitivity into parenting practices (Sansone, 2024). Studies have shown that mindfulness-based approaches can reduce parental stress, improve emotional resilience, and promote healthier family functioning (Abdelrasheed & Saeed, 2024; Ruskin et al., 2021).

The relevance of mindfulness to parenting effectiveness is further supported by evidence indicating that mindful awareness strengthens parents' ability to regulate emotions during challenging interactions with children. Parents who are more mindful are better able to recognize emotional triggers, remain emotionally present, and engage in constructive problem-solving rather than reactive discipline. Furthermore, mindfulness has been associated with lower levels of parenting stress, reduced parental burnout, and greater satisfaction in the parenting role (Taştekin et al., 2025). Research among adoptive and biological parents has demonstrated that mindfulness contributes significantly to adaptive parenting outcomes through its influence on emotional regulation and interpersonal responsiveness (Chorão et al., 2022). These findings suggest that mindfulness may represent a foundational psychological resource that enhances parenting effectiveness across diverse family contexts.

Another important determinant of parenting effectiveness is emotional intelligence. Emotional intelligence refers to the capacity to perceive, understand, regulate, and utilize emotions effectively in oneself and others. Theoretical perspectives conceptualize emotional intelligence as a multidimensional competence that facilitates adaptive

AFTJ Applied Family Therapy Journal
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functioning in interpersonal relationships, decision-making, stress management, and emotional communication (Shafik, 2024; Taukeni, 2021). Parenting inherently involves navigating emotionally complex situations that require sensitivity, empathy, patience, and emotional regulation. Consequently, emotional intelligence is particularly relevant for understanding variations in parenting quality and effectiveness.

Parents with higher emotional intelligence are generally better equipped to interpret children's emotional signals, respond appropriately to emotional needs, and manage family conflicts constructively. Emotional intelligence enhances empathic understanding, communication quality, and emotional support within the parent-child relationship. Research has demonstrated that emotional intelligence contributes to children's emotional competence and psychosocial adjustment by creating emotionally supportive family environments (Flores, 2024; Sánchez, 2023). Additionally, interventions targeting emotional intelligence have been shown to reduce emotional vulnerability and strengthen adaptive interpersonal functioning, suggesting that emotional intelligence may serve as a protective factor for parents facing stress and family challenges (Călinici et al., 2024). Recent work examining emotional intelligence in relation to psychological well-being further highlights its role in promoting adaptive functioning and resilience across various life domains (Gannamraju, 2025; Mitsea et al., 2024).

Psychological flexibility represents another construct that has received increasing attention in contemporary psychological research. Rooted in Acceptance and Commitment Therapy, psychological flexibility refers to the capacity to remain aware of present experiences while adapting behavior in accordance with personal values despite the presence of difficult thoughts, emotions, or circumstances. Individuals with high psychological flexibility demonstrate greater adaptability, resilience, and psychological health because they can engage effectively with challenging experiences without becoming dominated by them (Trindade et al., 2022). Within parenting contexts, psychological flexibility enables parents to respond adaptively to the inevitable uncertainties, frustrations, and emotional demands associated with raising children.

Evidence suggests that psychological flexibility is closely linked to parenting competence, parental efficacy, and family well-being. Parents with greater psychological flexibility tend to experience lower parenting stress, better emotional regulation, and more constructive parent-child interactions. Acceptance-based interventions designed to enhance psychological flexibility have demonstrated positive effects on parental functioning, emotional regulation, and family adjustment (Flujas-Contreras et al., 2021; Sairanen et al., 2022). Furthermore, psychological flexibility has been identified as a key predictor of adaptive coping and parental efficacy among parents facing particularly demanding caregiving circumstances (Reich et al., 2025). Research has also highlighted the importance of psychological flexibility in supporting healthy couple relationships and positive parenting transitions during major life stages, such as pregnancy and early parenthood (Sparpana & Brock, 2025). These findings suggest that psychological flexibility may be a critical mechanism through which parents maintain effective functioning despite adversity.

Closely related to psychological flexibility is the construct of reflective functioning, often referred to as mentalization. Reflective functioning encompasses the ability to understand one's own behavior and the behavior of others in terms of underlying mental states such as thoughts, feelings, intentions, desires, and beliefs. Mentalization plays a fundamental role in interpersonal relationships because it facilitates empathy, emotional understanding, and effective communication. Within parenting contexts, reflective functioning enables parents to accurately interpret children's internal experiences and respond in ways that support emotional security and developmental growth (Lee et al., 2024).

The significance of reflective functioning has been increasingly emphasized within attachment theory and developmental psychology. Parents with strong reflective functioning capacities are more likely to provide sensitive caregiving, establish secure attachment relationships, and foster emotional competence in their children. Recent reviews have demonstrated substantial associations between parental mentalization and child mental health outcomes, highlighting the transgenerational transmission of reflective capacities within families (Moreira et al., 2024). Moreover, reflective functioning has been linked to parental efficacy, adaptive coping, and psychological adjustment across various family contexts (Reich et al., 2025). Research examining the relationship between mentalization and broader psychological functioning further suggests that reflective capacities contribute significantly to emotional regulation, resilience, and interpersonal effectiveness (Todosijević & Kojić, 2022; Wang et al., 2025).

AFTJ Applied Family Therapy Journal
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Importantly, emerging evidence indicates substantial conceptual and empirical overlap among mindfulness, emotional intelligence, psychological flexibility, and reflective functioning. Mindfulness promotes awareness of internal experiences, which may facilitate both emotional intelligence and reflective functioning. Psychological flexibility allows individuals to engage openly with emotional and cognitive experiences, thereby supporting mindfulness and mentalization processes. Reflective functioning enhances emotional understanding and interpersonal responsiveness, which are central components of emotional intelligence. Recent integrative analyses have highlighted meaningful connections between mindfulness and mentalization, suggesting that these constructs may operate synergistically in promoting adaptive functioning (Teräsahjo, 2025). Such interrelationships underscore the possibility that these psychological capacities collectively contribute to parenting effectiveness through interconnected emotional, cognitive, and relational mechanisms.

The growing interest in these constructs reflects broader developments in positive psychology and strength-based approaches to family functioning. Rather than focusing exclusively on parental deficits or risk factors, contemporary research increasingly emphasizes protective psychological resources that enable parents to thrive despite challenges. Mindfulness, emotional intelligence, psychological flexibility, and reflective functioning each represent modifiable capacities that can potentially be enhanced through psychological interventions and educational programs. Research examining resilience, coping, emotional regulation, and psychological well-being consistently identifies these factors as important contributors to adaptive functioning across diverse populations (Dąbkowska et al., 2021; Laifer et al., 2024; Salicru, 2023). Furthermore, self-compassion and related psychological strengths have been recognized as important resources that support effective parenting and family adjustment (Żmuda, 2024).

Family and developmental contexts further highlight the importance of these psychological capacities. Children's emotional understanding, behavioral adjustment, executive functioning, and social competence develop within relational environments shaped significantly by parental psychological characteristics (Happaney & Zelazo, 2022; Асланова et al., 2024). Parents who possess greater emotional awareness, adaptability, and reflective capacities may be better positioned to provide the supportive and responsive caregiving necessary for optimal child development. In turn, effective parenting contributes to healthier family systems and improved developmental outcomes across the lifespan.

Despite the growing literature examining mindfulness, emotional intelligence, psychological flexibility, and reflective functioning independently, relatively few studies have investigated their simultaneous contribution to parenting effectiveness within a unified predictive framework. Most previous research has relied on traditional statistical approaches that focus primarily on linear relationships among variables. However, psychological phenomena such as parenting are inherently complex and likely involve nonlinear interactions among multiple psychological processes. Machine learning approaches offer a promising alternative because they can model complex relationships, identify subtle patterns, and generate highly accurate predictions without imposing restrictive statistical assumptions.

Among contemporary machine learning methods, CatBoost has emerged as a particularly powerful gradient boosting algorithm capable of handling complex datasets while maintaining strong predictive performance and interpretability. Unlike traditional regression approaches, CatBoost can identify nonlinear relationships and interaction effects among predictors that may otherwise remain undetected. Consequently, applying CatBoost modeling to parenting effectiveness may provide novel insights into the relative importance and predictive value of mindfulness, emotional intelligence, psychological flexibility, and reflective functioning.

Therefore, the aim of the present study was to develop and evaluate a CatBoost machine learning model for predicting parenting effectiveness based on mindfulness, emotional intelligence, psychological flexibility, and reflective functioning among parents in Thailand.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a cross-sectional predictive research design to investigate the extent to which mindfulness, emotional intelligence, psychological flexibility, and reflective functioning contribute to the prediction of parenting effectiveness using the CatBoost machine learning algorithm. The study was conducted in Thailand between January and April 2026 and focused on parents who had at least one child between the ages of 6 and 16 years. A total of 742 parents participated in the study. Participants were recruited from public and private schools located in

AFTJ Applied Family Therapy Journal
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Bangkok, Chiang Mai, Phuket, Khon Kaen, and Nakhon Ratchasima through collaboration with school administrators and parent associations. A stratified convenience sampling strategy was used to ensure adequate representation of parents from diverse socioeconomic backgrounds and educational levels.

Eligibility criteria included being a biological or adoptive parent, residing in Thailand for at least one year, having sufficient literacy to complete self-report questionnaires, and providing informed consent. Parents with severe cognitive impairments or currently receiving intensive psychiatric treatment that could interfere with questionnaire completion were excluded from participation. Data collection was conducted through both online and paper-and-pencil formats to maximize accessibility. Prior to participation, all respondents were informed about the objectives of the study, the voluntary nature of participation, the confidentiality of their responses, and their right to withdraw from the study at any time without penalty.

2.2. Measures

Parenting effectiveness was assessed using the Parenting Sense of Competence Scale (PSOC) developed by Johnston and Mash (1989). The PSOC is one of the most widely used instruments for evaluating parental effectiveness and competence. The scale consists of 17 items measuring parental efficacy and parental satisfaction. Responses are recorded on a six-point Likert scale ranging from strongly disagree to strongly agree. Higher scores indicate greater perceived parenting effectiveness and competence. Previous studies have demonstrated satisfactory psychometric properties for the instrument, with internal consistency coefficients generally exceeding 0.80 and evidence supporting its construct and criterion validity across different cultural contexts.

Mindfulness was measured using the Five Facet Mindfulness Questionnaire (FFMQ) developed by Baer and colleagues in 2006. The instrument contains 39 items and assesses five dimensions of mindfulness, including observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. Participants respond using a five-point Likert scale ranging from never or very rarely true to very often or always true. Higher scores reflect greater levels of dispositional mindfulness. The FFMQ has demonstrated strong reliability and validity across diverse populations, and previous research has consistently reported Cronbach's alpha coefficients above 0.80 for the total scale.

Emotional intelligence was assessed using the Wong and Law Emotional Intelligence Scale (WLEIS), developed by Wong and Law in 2002. The scale consists of 16 items distributed across four dimensions: self-emotion appraisal, others' emotion appraisal, use of emotion, and regulation of emotion. Responses are rated on a seven-point Likert scale ranging from strongly disagree to strongly agree. Higher scores indicate greater emotional intelligence. Numerous studies have confirmed the scale's factorial validity, convergent validity, and internal consistency reliability, with reported alpha coefficients typically ranging from 0.85 to 0.92.

Psychological flexibility was measured using the Acceptance and Action Questionnaire-II (AAQ-II) developed by Bond and colleagues in 2011. The AAQ-II contains 7 items designed to assess experiential avoidance and psychological flexibility. Participants rate each item on a seven-point Likert scale ranging from never true to always true. Following recommended scoring procedures, higher scores after reverse interpretation indicate greater psychological flexibility. The AAQ-II has been extensively used in psychological and behavioral research and has demonstrated satisfactory reliability, temporal stability, and construct validity in numerous studies across different populations.

Reflective functioning was evaluated using the Reflective Functioning Questionnaire (RFQ) developed by Fonagy and colleagues in 2016. The RFQ consists of 8 items designed to measure an individual's capacity to understand mental states in oneself and others. The instrument evaluates certainty and uncertainty regarding mental states, providing an index of reflective functioning. Participants respond on a seven-point Likert scale, with higher scores indicating more adaptive reflective functioning. Previous investigations have reported acceptable reliability coefficients and substantial evidence supporting the questionnaire's construct validity and clinical utility.

Demographic information was collected through a researcher-developed questionnaire that included age, gender, marital status, educational attainment, employment status, family income, number of children, child's age, and residential location. These variables were used to describe the sample and explore potential confounding influences during data analysis.

AFTJ Applied Family Therapy Journal
E-ISSN: 3041-8798

2.3. *Data Analysis*

Data analysis was conducted using Python programming language and relevant machine learning libraries. Initially, descriptive statistics, including means, standard deviations, skewness, and kurtosis values, were calculated to evaluate the distributional characteristics of the study variables. Missing data were examined and handled using multiple imputation procedures when the proportion of missing values was less than 5%. Outliers were identified through interquartile range analysis and Mahalanobis distance diagnostics and were evaluated prior to model development.

The primary analytical approach involved the implementation of the CatBoost algorithm, a gradient boosting framework specifically designed to efficiently handle complex nonlinear relationships and interactions among predictor variables. Parenting effectiveness served as the target variable, while mindfulness, emotional intelligence, psychological flexibility, and reflective functioning were entered as predictor variables. The dataset was randomly divided into training and testing subsets, with 80% of observations allocated to the training set and 20% reserved for out-of-sample testing. Hyperparameter optimization was performed using five-fold cross-validation combined with grid-search procedures to identify the optimal model configuration. Parameters including learning rate, tree depth, number of iterations, L2 regularization coefficient, and subsampling ratio were systematically tuned to maximize predictive performance.

Model performance was evaluated using multiple metrics, including the coefficient of determination (R^2), root mean squared error (RMSE), mean absolute error (MAE), and mean absolute percentage error (MAPE). Feature importance scores generated by CatBoost were examined to determine the relative contribution of each predictor to parenting effectiveness. In addition, SHAP (Shapley Additive Explanations) analyses were conducted to provide interpretable insights into the direction and magnitude of each predictor's influence on model predictions. The final model was selected based on its generalization performance on the test dataset, and statistical significance was evaluated at the 0.05 level where applicable. The combination of machine learning prediction and explainable artificial intelligence techniques provided a comprehensive framework for understanding the factors associated with parenting effectiveness among Thai parents.

3. Findings and Results

A total of 742 parents participated in the study. The mean age of the participants was 39.84 years (SD = 7.12), ranging from 24 to 58 years. Among the participants, 432 (58.2%) were mothers and 310 (41.8%) were fathers. Most participants were married (91.5%), while 5.4% were divorced and 3.1% were widowed or separated. Regarding educational attainment, 18.3% had completed secondary education, 26.8% held vocational diplomas, 41.9% possessed bachelor's degrees, and 13.0% had postgraduate qualifications. The average number of children per family was 2.14 (SD = 0.89). Participants were recruited from multiple regions of Thailand, with 35.4% residing in Bangkok, 18.6% in Chiang Mai, 14.7% in Phuket, 16.3% in Khon Kaen, and 15.0% in Nakhon Ratchasima. Preliminary data screening indicated no serious violations of statistical assumptions. Missing values accounted for less than 2% of the dataset and were handled using multiple imputation procedures. Skewness and kurtosis values for all study variables remained within acceptable ranges, suggesting adequate normality for descriptive analyses.

Table 1

Descriptive Statistics and Correlations among Study Variables

Variable	Mean	SD	1	2	3	4	5
1. Parenting Effectiveness	72.48	10.91	1.00				
2. Mindfulness	128.73	17.64	.69**	1.00			
3. Emotional Intelligence	84.26	11.92	.72**	.63**	1.00		
4. Psychological Flexibility	34.81	7.15	.65**	.59**	.61**	1.00	
5. Reflective Functioning	43.57	6.83	.67**	.58**	.64**	.55**	1.00

Table 1 presents the descriptive statistics and bivariate correlations among the study variables. The results revealed that parenting effectiveness had significant positive associations with mindfulness ($r = .69$, $p < .001$), emotional intelligence ($r = .72$, $p < .001$), psychological flexibility ($r = .65$, $p < .001$), and reflective functioning ($r = .67$, $p < .001$). Among the predictors, emotional intelligence demonstrated the strongest relationship with parenting effectiveness,

AFTJ Applied Family Therapy Journal
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followed by mindfulness, reflective functioning, and psychological flexibility. The intercorrelations among the predictor variables were moderate to strong, ranging from .55 to .64, indicating that while these constructs were related, they represented distinct psychological capacities. The magnitude of the correlations suggested that parents who reported greater awareness of present-moment experiences, enhanced emotional competencies, increased adaptability to psychological experiences, and stronger mentalization abilities tended to perceive themselves as more effective in their parenting roles. The absence of excessively high correlations further indicated that multicollinearity was unlikely to compromise subsequent machine learning analyses.

Table 2

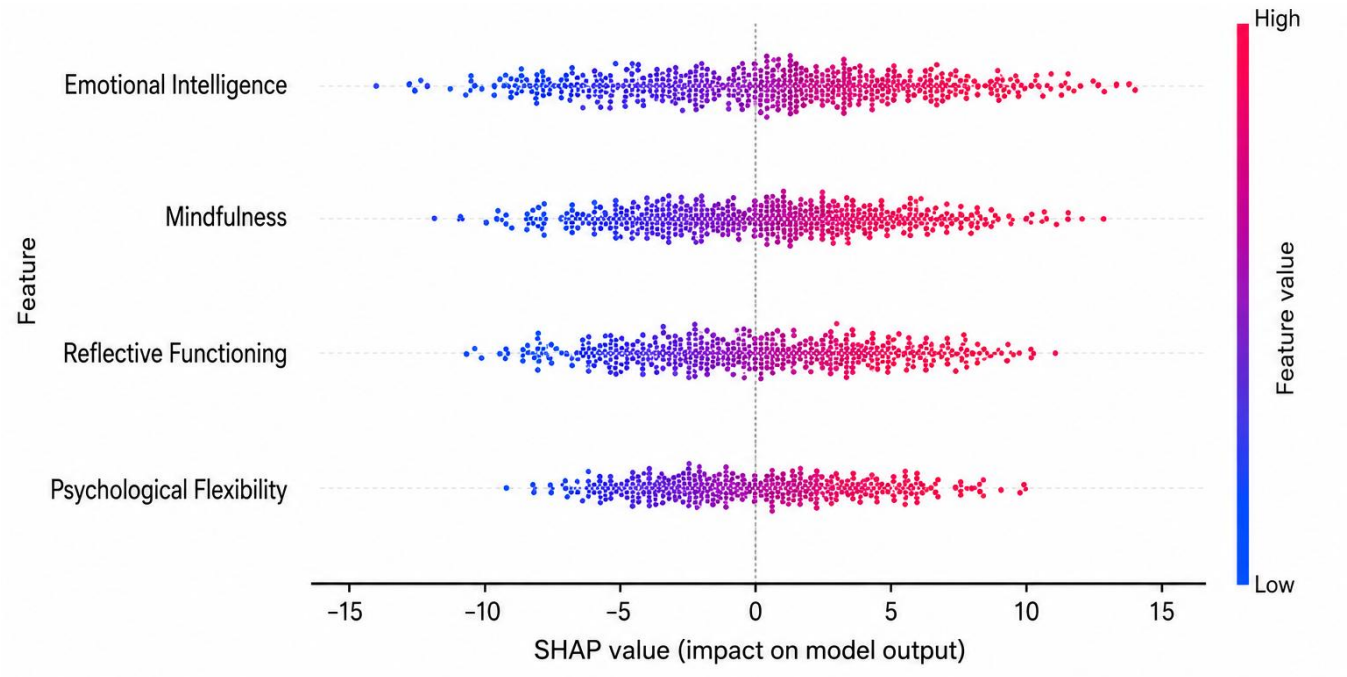
Performance Metrics of the CatBoost Prediction Model

Dataset	R^2	RMSE	MAE	MAPE (%)
Training Set	.842	4.31	3.24	4.48
Test Set	.816	4.76	3.58	4.93
5-Fold Cross-Validation Average	.808	4.88	3.67	5.07

The predictive performance of the CatBoost model is presented in Table 2. The model demonstrated strong predictive capability across both training and testing datasets. On the training dataset, the model explained 84.2% of the variance in parenting effectiveness scores (R^2 = .842), while on the independent test dataset it explained 81.6% of the variance (R^2 = .816). The relatively small difference between training and testing performance suggested minimal overfitting and strong generalizability of the model. Error indices also indicated high predictive accuracy. The RMSE value increased only modestly from 4.31 in the training set to 4.76 in the testing set, while the MAE remained below four points in both datasets. The average cross-validation R^2 value of .808 further confirmed the stability and robustness of the prediction model. Collectively, these findings demonstrated that the combination of mindfulness, emotional intelligence, psychological flexibility, and reflective functioning provided substantial predictive power for explaining individual differences in parenting effectiveness among Thai parents.

Figure 1

SHAP Summary Plot



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The SHAP analysis provided a detailed interpretation of the CatBoost model's decision-making process and revealed meaningful differences in predictor importance. Emotional intelligence emerged as the most influential predictor of parenting effectiveness, followed by mindfulness, reflective functioning, and psychological flexibility. The SHAP summary plot indicated that higher emotional intelligence scores consistently increased the likelihood of higher parenting effectiveness predictions. Similarly, elevated mindfulness scores exerted a strong positive influence on model outputs, particularly among participants who demonstrated greater emotional awareness and attentional regulation. Reflective functioning also showed a substantial positive contribution, suggesting that the ability to understand one's own and one's child's mental states played a critical role in effective parenting. Psychological flexibility demonstrated a somewhat smaller but still meaningful impact, with parents exhibiting greater adaptability and acceptance showing more favorable parenting outcomes. The SHAP distributions further revealed nonlinear effects, indicating that improvements in these psychological capacities produced increasingly stronger gains in parenting effectiveness beyond moderate score levels. These findings underscore the utility of explainable artificial intelligence techniques in identifying not only the importance of predictors but also the nature of their relationships with parenting outcomes.

Table 3

Feature Importance Rankings Generated by the CatBoost Algorithm

Predictor Variable	Importance Score (%)
Emotional Intelligence	32.8
Mindfulness	28.6
Reflective Functioning	21.7
Psychological Flexibility	16.9

The feature importance analysis generated by the CatBoost algorithm is presented in Table 3. Emotional intelligence accounted for the largest proportion of predictive information, contributing 32.8% of the total model importance. This finding indicates that the ability to perceive, understand, regulate, and utilize emotions constituted the most critical determinant of parenting effectiveness within the present sample. Mindfulness represented the second most influential predictor, accounting for 28.6% of the model's explanatory capacity. Reflective functioning contributed 21.7%, highlighting the significance of mentalization and perspective-taking abilities in parenting contexts. Psychological flexibility accounted for 16.9% of predictive importance, suggesting that adaptive responses to challenging thoughts and emotions also play a meaningful role in parenting effectiveness. Together, emotional intelligence and mindfulness contributed more than 60% of the total predictive power of the model, emphasizing the central role of emotional awareness, self-regulation, and present-moment attention in effective parenting practices. The distribution of feature importance scores further demonstrated that parenting effectiveness is a multidimensional construct influenced by several interconnected psychological resources rather than a single dominant factor. These results provide strong empirical support for the value of integrating emotional, cognitive, and reflective capacities in theoretical models of parenting effectiveness and demonstrate the usefulness of CatBoost algorithms for uncovering complex predictive relationships in family psychology research.

4. Discussion

The present study aimed to develop and evaluate a CatBoost machine learning model for predicting parenting effectiveness based on mindfulness, emotional intelligence, psychological flexibility, and reflective functioning among parents in Thailand. The findings demonstrated that all four psychological variables were positively associated with parenting effectiveness, with emotional intelligence emerging as the most influential predictor, followed by mindfulness, reflective functioning, and psychological flexibility. The CatBoost model achieved high predictive accuracy, explaining more than 80% of the variance in parenting effectiveness across training, testing, and cross-validation datasets. These findings provide compelling evidence that parenting effectiveness is strongly influenced by a constellation of emotional, cognitive, and self-regulatory capacities and that machine learning approaches

AFTJ Applied Family Therapy Journal
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can successfully model the complex interactions among these psychological factors.

One of the most notable findings of the study was the strong predictive role of emotional intelligence. Emotional intelligence received the highest feature importance score and demonstrated the strongest bivariate association with parenting effectiveness. This finding is theoretically consistent with the view that parenting is fundamentally an emotional process requiring the recognition, understanding, management, and expression of emotions in both oneself and one's children. Parents who possess higher emotional intelligence are more capable of interpreting children's emotional cues accurately, responding sensitively to emotional needs, and regulating their own reactions during stressful parenting situations. These abilities facilitate supportive parent-child interactions, constructive conflict resolution, and emotionally secure family environments. The present findings align closely with previous research emphasizing the central role of emotional intelligence in interpersonal effectiveness and adaptive functioning (Shafik, 2024; Taukeni, 2021). They are also consistent with evidence indicating that emotional intelligence contributes significantly to children's emotional development and psychosocial adjustment through the quality of parenting practices (Flores, 2024; Sánchez, 2023). Furthermore, studies demonstrating the effectiveness of emotional intelligence training in reducing emotional vulnerability and enhancing adaptive functioning provide additional support for the importance of emotional competencies in parenting contexts (Călinici et al., 2024). The prominence of emotional intelligence in the present model suggests that parents' ability to manage emotions effectively may serve as a foundational mechanism through which many other psychological strengths influence parenting outcomes.

Mindfulness emerged as the second most influential predictor of parenting effectiveness. The strong contribution of mindfulness supports growing evidence suggesting that mindful awareness enhances parents' capacity to remain emotionally present, attentive, and responsive during interactions with their children. Mindfulness facilitates the regulation of automatic reactions and promotes deliberate, reflective responses to challenging parenting situations. Parents who are mindful are less likely to engage in impulsive disciplinary behaviors and more likely to approach their children with curiosity, patience, and acceptance. These characteristics contribute to greater parenting competence and effectiveness. The findings correspond closely with contemporary conceptualizations of mindful parenting, which emphasize awareness, emotional attunement, and nonjudgmental acceptance as key elements of effective caregiving (Sansone, 2024). They also support empirical evidence demonstrating that mindfulness interventions improve parental resilience, reduce stress, and enhance overall family functioning (Abdelrasheed & Saeed, 2024; Ruskin et al., 2021). The results further align with research showing that mindful parenting partially mediates the relationship between parental stress and burnout, highlighting the protective role of mindfulness under challenging conditions (Taştekin et al., 2025). Taken together, these findings suggest that mindfulness strengthens parenting effectiveness by enhancing emotional awareness, attentional control, and adaptive responsiveness.

Reflective functioning also emerged as a significant predictor of parenting effectiveness. Reflective functioning, or mentalization, refers to the capacity to understand behavior in terms of underlying mental states such as thoughts, emotions, intentions, and beliefs. Parents with strong reflective functioning are better able to recognize the internal experiences that drive their children's behaviors and can therefore respond in more sensitive and developmentally appropriate ways. This capacity promotes secure attachment relationships, emotional validation, and constructive communication. The findings are consistent with attachment-based theories emphasizing parental mentalization as a critical determinant of caregiving quality and child development. Recent evidence has highlighted the importance of parental insightfulness and mentalization for children's emotional well-being and attachment security (Lee et al., 2024). Similarly, research examining transgenerational associations between mentalization and child mental health suggests that reflective functioning plays a crucial role in shaping family dynamics and developmental outcomes (Moreira et al., 2024). The present findings further support studies demonstrating positive relationships among mentalization, parental efficacy, and adaptive coping (Reich et al., 2025). Additionally, the observed contribution of reflective functioning aligns with research indicating that mentalization is associated with broader psychological resources, including emotional regulation and interpersonal effectiveness (Todosijević & Kojić, 2022; Wang et al., 2025). The results suggest that understanding children's internal experiences is a vital component of effective parenting and may represent a key mechanism linking parental psychological functioning to child outcomes.

Psychological flexibility also contributed significantly to the prediction of parenting effectiveness, although its

AFTJ Applied Family Therapy Journal
E-ISSN: 3041-8798

relative importance was somewhat lower than that of emotional intelligence, mindfulness, and reflective functioning. Psychological flexibility enables individuals to adapt to changing circumstances, tolerate difficult emotions, and engage in value-consistent behaviors despite psychological discomfort. Parenting inevitably involves uncertainty, frustration, and emotional challenges, making psychological flexibility particularly relevant for maintaining effective functioning. Parents who are psychologically flexible are more likely to cope constructively with parenting stress, adapt to developmental changes, and remain aligned with their parenting values even during difficult interactions. The present findings are highly consistent with previous studies demonstrating the beneficial effects of psychological flexibility on parental functioning and family well-being (Chorão et al., 2022; Flujas-Contreras et al., 2021). They also align with evidence indicating that psychological flexibility contributes to parental efficacy, coping, and adaptation among parents facing particularly demanding caregiving situations (Reich et al., 2025). Furthermore, the observed effects support research showing that acceptance- and flexibility-based interventions improve family outcomes and quality of life among children and parents (Lobato et al., 2025; Sairanen et al., 2022). The results suggest that psychological flexibility serves as an important adaptive resource that enables parents to navigate the complexities of parenting while maintaining emotional balance and effectiveness.

An important contribution of the present study lies in its examination of these four psychological variables simultaneously rather than independently. Although each construct made a unique contribution to parenting effectiveness, the findings suggest that parenting effectiveness is best understood as a multidimensional phenomenon shaped by interacting emotional, cognitive, and self-regulatory processes. The moderate intercorrelations among mindfulness, emotional intelligence, psychological flexibility, and reflective functioning support theoretical perspectives proposing meaningful conceptual overlap among these constructs while also confirming their distinctiveness. Recent scholarship has increasingly emphasized the interconnected nature of mindfulness and mentalization processes, suggesting that awareness of internal experiences facilitates understanding of mental states in oneself and others (Teräsahjo, 2025). Similarly, emotional intelligence may be enhanced by mindfulness and reflective functioning because both capacities contribute to greater awareness and understanding of emotions. Psychological flexibility may further strengthen these processes by allowing individuals to engage openly with emotional experiences rather than avoiding them. The present findings provide empirical support for this integrative perspective and suggest that effective parenting may emerge from the combined influence of multiple psychological strengths.

Another significant finding concerns the performance of the CatBoost model itself. The model demonstrated excellent predictive accuracy, explaining more than four-fifths of the variance in parenting effectiveness. This level of predictive performance suggests that machine learning approaches can provide valuable insights into the complex determinants of parenting outcomes. Traditional statistical methods often assume linear relationships among variables and may struggle to capture the dynamic interactions that characterize psychological phenomena. In contrast, CatBoost is capable of modeling nonlinear patterns and interactions without imposing restrictive assumptions. The strong performance of the model therefore highlights the value of incorporating advanced analytical techniques into family psychology research. The use of SHAP analyses further enhanced interpretability by identifying the relative contribution of each predictor and illustrating how specific variables influenced model predictions. These findings demonstrate the potential of explainable artificial intelligence approaches for advancing understanding of parenting processes and informing intervention development.

The findings also have implications for broader theoretical frameworks emphasizing resilience, well-being, and adaptive functioning. Parenting effectiveness appears to be closely connected to psychological resources that promote emotional regulation, cognitive flexibility, interpersonal understanding, and self-awareness. Previous studies examining resilience and adaptive functioning have consistently identified similar psychological capacities as protective factors across diverse populations and life contexts (Dąbkowska et al., 2021; Laifer et al., 2024). Research on self-compassion and parental well-being similarly highlights the importance of internal psychological resources in supporting effective parenting behaviors (Żmuda, 2024). Furthermore, evidence concerning spiritual and emotional dimensions of well-being suggests that broader psychological strengths contribute to adaptive interpersonal functioning and life satisfaction (Dewi & Primayana, 2023; Gannamraju, 2025). The present study extends these findings by demonstrating that these

AFTJ Applied Family Therapy Journal
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psychological resources are also strongly associated with parenting effectiveness.

The developmental implications of the findings are particularly noteworthy. Effective parenting serves as a critical context for children's emotional, social, and cognitive development. Children learn emotional understanding, self-regulation, and interpersonal skills through repeated interactions with caregivers. Research has shown that family environments influence children's emotion understanding, executive functioning, and broader developmental outcomes (Happaney & Zelazo, 2022; Асланова et al., 2024). Consequently, psychological capacities that enhance parenting effectiveness may indirectly contribute to healthier developmental trajectories among children. By fostering mindfulness, emotional intelligence, psychological flexibility, and reflective functioning among parents, practitioners and policymakers may be able to promote both parental well-being and child development simultaneously.

5. Conclusion

The findings should be interpreted within the context of contemporary family challenges. Modern parents often face considerable stress arising from economic pressures, changing family structures, technological influences, and increasing caregiving demands. Such challenges can undermine parenting effectiveness and family well-being. The present results suggest that psychological resources such as mindfulness, emotional intelligence, psychological flexibility, and reflective functioning may help parents navigate these challenges more successfully. By strengthening emotional awareness, adaptability, and interpersonal understanding, these capacities enable parents to maintain effective caregiving even under stressful circumstances. Consequently, interventions targeting these psychological resources may represent valuable strategies for promoting healthy family functioning in diverse cultural and social contexts.

6. Suggestions and Limitations

The study has several limitations that should be acknowledged. First, the cross-sectional design limits the ability to draw causal conclusions regarding the relationships among the study variables. Second, all measures relied on self-report questionnaires, which may be influenced by social desirability bias and subjective perceptions. Third, although the sample was relatively large and geographically diverse within Thailand, the findings may not generalize to other cultural contexts. Fourth, parenting effectiveness was assessed through parental self-perceptions rather than direct observations of parenting behavior. Finally, additional psychological, social, and contextual variables not included in the model may also contribute to parenting effectiveness.

Future research should employ longitudinal and experimental designs to examine causal pathways among mindfulness, emotional intelligence, psychological flexibility, reflective functioning, and parenting effectiveness. Researchers may also investigate potential mediating and moderating mechanisms that explain how these psychological resources influence parenting outcomes. Future studies should incorporate multi-informant assessments, behavioral observations, and child outcome measures to obtain a more comprehensive understanding of parenting effectiveness. Comparative cross-cultural studies and investigations involving different family structures would further enhance the generalizability of findings. Additional machine learning algorithms may also be compared with CatBoost to identify the most effective predictive approaches in family psychology research.

The practical implications of the present findings are substantial. Parenting programs should incorporate components designed to enhance emotional intelligence, mindfulness, psychological flexibility, and reflective functioning. Mental health professionals, educators, and family counselors can develop interventions that strengthen parents' emotional awareness, adaptive coping skills, and capacity to understand children's mental states. Schools, community organizations, and healthcare systems may benefit from implementing evidence-based training programs that support these psychological resources among parents. Such initiatives have the potential to improve parenting effectiveness, strengthen family relationships, promote child well-being, and contribute to healthier communities overall.

Authors' Contributions

All authors have contributed significantly to the research process and the development of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

AFTJ Applied Family Therapy Journal
E-ISSN: 3041-8798

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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