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Article type:  
Original Research

Article history:  
Received 11 February 2026  
Revised 02 June 2026  
Accepted 10 June 2026  
Initial Publish 25 June 2026  
Published online 01 January 2027

#### How to cite this article:

Keyhan, J., & Aslkandi, N. (2027). Designing an Optimal Educational Model to Reduce Vandalistic Behaviors of Elementary School Students Using a Fuzzy Logic Approach. *Assessment and Practice in Educational Sciences*, 5(1), 1-18.  
<https://doi.org/10.61838/japes.281>

# Designing an Optimal Educational Model to Reduce Vandalistic Behaviors of Elementary School Students Using a Fuzzy Logic Approach

## ABSTRACT

The present study aimed to design and validate an optimal educational model for reducing vandalistic behaviors among elementary school students through the integration of meta-synthesis, structural equation modeling, and fuzzy logic analysis. This study employed a mixed-methods exploratory sequential design. In the qualitative phase, a meta-synthesis approach based on the Sandelowski and Barroso model was conducted using Persian and English studies published between 2014 and 2024 to identify educational factors associated with the reduction of vandalistic behaviors. Following systematic screening and qualitative content analysis, the extracted dimensions and components were used to develop a preliminary conceptual model. In the quantitative phase, the model was validated through expert review, the Delphi technique, and a survey of elementary school teachers in Urmia. Researcher-developed questionnaires were assessed for validity and reliability. Confirmatory factor analysis and structural equation modeling were performed using LISREL and SPSS software. In the final phase, a fuzzy expert system based on the Mamdani inference method was developed in MATLAB to determine the optimal combination and relative influence of the identified dimensions. The Kaiser–Meyer–Olkin coefficient (0.852) and Bartlett’s test ( $\chi^2 = 336.297$ ,  $p < .001$ ) confirmed the suitability of the data for factor analysis. First-order confirmatory factor analysis demonstrated significant factor loadings ranging from 0.35 to 0.71, with all t-values exceeding 1.96. Convergent validity was supported by AVE values ranging from 0.521 to 0.630, while composite reliability coefficients ranged from 0.706 to 0.836. Second-order confirmatory factor analysis confirmed the significance of all structural paths. The model exhibited satisfactory fit indices ( $\chi^2/df = 2.17$ , RMSEA = 0.060, NFI = 0.92, CFI = 0.94, IFI = 0.94, PNFI = 0.71). Fuzzy logic analysis revealed that Developing Positive Skills and Behaviors had the greatest contribution to reducing vandalistic behaviors (41.22%), followed by Strengthening Awareness and Moral Values (39.46%) and Creating a Constructive Environment and Positive Interactions (19.32%). The optimized model predicted an 85.1% reduction in vandalistic behaviors when all dimensions were simultaneously strengthened. The results indicate that interventions emphasizing behavioral skill development, moral and ethical education, and supportive educational environments can effectively decrease destructive behaviors. Furthermore, the integration of fuzzy logic with educational modeling provides a robust decision-making framework for prioritizing intervention strategies and optimizing school-based behavioral prevention programs.

**Keywords:** Vandalistic behavior, elementary school students, educational model, fuzzy logic, behavioral skills, moral values, school environment

## Introduction

Vandalistic behavior among school-aged children has increasingly emerged as a significant educational, social, and psychological concern. Although vandalism is commonly defined as the intentional destruction, defacement, or misuse of public and private property, contemporary educational research suggests that such behaviors represent more than isolated acts of misconduct. Rather, they are manifestations of broader developmental, emotional, social, and environmental challenges experienced by children during critical stages of socialization and identity formation (1, 2). Within educational settings, vandalistic behaviors may include damaging school facilities, writing on walls and desks, destroying educational equipment, harming classmates' belongings, and engaging in other forms of deliberate property destruction. These behaviors impose substantial financial costs on schools, disrupt learning processes, weaken students' sense of belonging, and contribute to the deterioration of the overall educational climate (3, 4). As schools are expected not only to provide academic instruction but also to foster social responsibility, ethical development, and citizenship competencies, understanding the antecedents and prevention of vandalistic behaviors has become an important priority for educators, policymakers, and researchers.

The significance of addressing vandalism during the elementary school years is particularly evident because childhood represents a formative developmental period during which behavioral patterns, moral reasoning, and social norms are established. Research has consistently demonstrated that maladaptive behaviors emerging in childhood frequently persist into adolescence and adulthood if appropriate interventions are not implemented (5, 6). School environments provide children with opportunities to learn cooperation, empathy, respect for rules, and responsibility toward communal resources. Consequently, destructive behaviors directed at school property often reflect deficiencies in these developmental processes and may indicate broader difficulties related to self-regulation, social adjustment, and emotional competence (7, 8). Furthermore, studies examining urban and educational contexts have shown that vandalism is frequently associated with weakened social cohesion, inadequate supervision, limited school engagement, and insufficient opportunities for constructive participation in educational activities (4, 9).

Theoretical explanations of vandalistic behavior emphasize the interaction of individual, familial, social, and educational factors. Social capital theory suggests that stronger bonds between students and social institutions such as schools and families reduce the likelihood of deviant behaviors by fostering attachment, commitment, and adherence to social norms (2). Similarly, research on delinquency pathways indicates that weak parental attachment, unfavorable peer influences, and reduced social supervision contribute significantly to the development of destructive and antisocial behaviors among youth (5). Family environments play a particularly important role because parents serve as children's primary socialization agents and role models. Children who experience supportive relationships, consistent behavioral expectations, and constructive parental monitoring are more likely to develop responsibility and respect for communal property. In contrast, inconsistent supervision and exposure to problematic behavioral models may increase the probability of vandalistic tendencies (5, 10). These findings suggest that effective interventions should not focus exclusively on students but should also consider family-related factors that shape behavioral development.

From a psychological perspective, vandalistic behaviors have been associated with deficits in emotional regulation, impulse control, problem-solving skills, and social competence. Children who struggle to manage frustration, anger, and interpersonal conflicts may express these emotions through destructive actions directed toward their environment. Research in developmental psychopathology highlights the importance of self-regulation and adaptive coping mechanisms in preventing externalizing behavioral problems (1, 6). Communication skills training and emotional management programs have been shown to improve children's ability to navigate challenging social situations and reduce maladaptive responses (11). Likewise, studies examining

social maturity and behavioral development emphasize the role of structured educational experiences in enhancing self-control, empathy, and responsible decision-making among children (12). Consequently, interventions designed to reduce vandalistic behavior should prioritize the development of behavioral competencies that enable students to respond constructively to environmental and interpersonal challenges.

Educational research has increasingly highlighted the importance of school climate and instructional practices in shaping student behavior. Schools characterized by supportive teacher-student relationships, collaborative learning opportunities, and positive classroom management strategies tend to report lower levels of disruptive and destructive behaviors (13, 14). When students perceive themselves as valued members of a school community, they are more likely to develop a sense of ownership and responsibility toward school facilities and resources. Conversely, educational environments that fail to engage students meaningfully may contribute to alienation, frustration, and behavioral problems (9, 15). Contemporary approaches to classroom management increasingly emphasize self-regulation, participation, and positive reinforcement rather than punitive control mechanisms. Such approaches not only improve academic engagement but also promote prosocial behaviors and reduce tendencies toward vandalism and other forms of misconduct (13).

Another important factor in the prevention of vandalistic behaviors is the development of moral and ethical values. Moral education contributes to children's understanding of social responsibility, respect for others' rights, and the consequences of destructive actions. Educational programs focused on citizenship, ethical reasoning, and communal responsibility have demonstrated positive effects on students' attitudes and behaviors (8, 16). By fostering awareness of the social and economic consequences of property destruction, schools can encourage students to adopt more responsible attitudes toward public resources. Furthermore, strengthening students' identification with school values and community norms can enhance their motivation to protect rather than damage educational facilities (2, 3). These findings support the notion that vandalism prevention requires educational strategies that extend beyond behavioral management and incorporate broader moral and civic development objectives.

A growing body of evidence also supports the effectiveness of play-based, cognitive-behavioral, and therapeutic educational interventions in promoting adaptive behaviors among children. Cognitive-behavioral play therapy has been widely recognized as an effective approach for helping children develop emotional awareness, self-control, and problem-solving skills (17, 18). Studies have demonstrated positive outcomes of cognitive-behavioral play therapy in addressing behavioral difficulties, anxiety, impulsivity, and emotional dysregulation among children (19-21). Similarly, group-based therapeutic interventions have been shown to improve social functioning, reduce problematic behaviors, and enhance emotional adjustment (22, 23). Therapeutic play groups and structured recreational activities provide opportunities for children to practice cooperation, empathy, and constructive conflict resolution in supportive environments (24, 25). Research further suggests that creative and experiential interventions such as music therapy, art therapy, and play-based learning can contribute to behavioral improvement by promoting emotional expression and social engagement (12, 26, 27). Although many of these interventions were originally developed for clinical populations, their underlying principles offer valuable insights for educational programs aimed at preventing vandalistic behaviors.

Recent educational studies have emphasized the importance of integrating innovative technologies and evidence-based decision-making approaches into school management and behavioral intervention programs. Traditional linear models often fail to capture the complexity and interdependence of factors influencing student behavior. Educational phenomena such as vandalism involve dynamic interactions among psychological, social, familial, and environmental variables, making them difficult to analyze using conventional methods alone (13, 28). Advances in educational modeling and fuzzy systems have provided researchers with tools capable of addressing uncertainty, ambiguity, and nonlinear relationships. Fuzzy approaches

allow for the integration of expert knowledge and empirical evidence to identify the relative importance of multiple influencing factors and generate more realistic representations of educational processes (13, 28). Such approaches are particularly valuable in the context of behavioral interventions because they acknowledge the complexity of human behavior and support more flexible decision-making frameworks.

Despite increasing scholarly attention to student misconduct and behavioral problems, several important gaps remain in the literature concerning vandalistic behavior among elementary school students. Existing studies have frequently focused on identifying correlates of vandalism rather than developing comprehensive intervention models capable of guiding educational practice (9, 15). Many investigations have examined individual or environmental factors in isolation, thereby neglecting the multidimensional nature of vandalistic behaviors. Furthermore, relatively few studies have concentrated specifically on elementary school populations, despite the importance of early intervention in shaping long-term behavioral trajectories (6, 14). Additional limitations include the limited application of advanced analytical approaches capable of modeling complex relationships among educational, psychological, and social variables. Research on cognition and information processing has repeatedly demonstrated that human behavior emerges from interconnected systems rather than isolated influences (29, 30). Therefore, more comprehensive and integrative frameworks are needed to understand and address vandalistic behaviors effectively.

Given these considerations, there is a clear need for an evidence-based educational model that simultaneously incorporates moral development, behavioral skill enhancement, and environmental support while utilizing advanced analytical methods capable of prioritizing and optimizing intervention strategies. Such a model could provide educators, school administrators, and policymakers with practical guidance for designing preventive programs that address the underlying causes of vandalism and promote positive student development. Accordingly, the aim of the present study was to design and validate an optimal educational model for reducing vandalistic behaviors among elementary school students using a fuzzy logic approach.

## Methods and Materials

The present study was conducted with the aim of designing and validating an optimal educational model for reducing vandalistic behaviors among elementary school students through the application of a fuzzy logic approach. Given the exploratory, multidimensional, and complex nature of the research topic, as well as the necessity of identifying, explaining, validating, and optimizing the factors influencing the reduction of vandalistic behaviors, a mixed-methods research design (qualitative–quantitative) with an exploratory sequential approach was employed. This approach enables the simultaneous utilization of the strengths of both qualitative and quantitative methodologies to develop a comprehensive, context-specific, and evidence-based model. The research process was carried out in three main phases, including meta-synthesis of previous studies, model validation and testing through a survey method, and finally, fuzzy logic-based modeling. In the first phase, a meta-synthesis approach was utilized to identify the dimensions, components, and indicators affecting the reduction of vandalistic behaviors among elementary school students. Meta-synthesis is a systematic qualitative research method that facilitates the integration, combination, and interpretation of findings from previous studies, leading to the generation of coherent knowledge and the development of conceptual frameworks. The research population in this phase consisted of all relevant Persian and English scientific articles, dissertations, and scholarly sources published between 2014 and 2024 and indexed in reputable national and international databases. Following a systematic search using specialized keywords related to vandalistic behavior, elementary education, educational interventions, prevention of behavioral problems, and student behavior management, the retrieved studies were screened based on predefined inclusion and exclusion criteria. Subsequently, the data extracted from the selected studies were analyzed using qualitative content analysis and open, axial, and selective coding

procedures. As a result, the initial dimensions, components, and indicators of the proposed research model were identified and organized.

In the second phase, a survey method was employed to localize, validate, and examine the conceptual structure of the preliminary model. The statistical population of this phase was defined at two levels. At the first level, the expert panel consisted of university faculty members specializing in elementary education, curriculum studies, educational psychology, and educational management, as well as experienced educational administrators and experts from the Ministry of Education. These experts were selected through purposive sampling based on specific eligibility criteria. The inclusion criteria included holding a doctoral degree or possessing relevant professional experience, having academic or executive experience in the field of elementary education, and familiarity with the research topic. At the second level, the statistical population comprised elementary school teachers in Urmia who participated in testing the proposed model. The sample size for this group was determined using Cochran's formula, and participants were selected through random sampling procedures. The data collection instruments in this phase consisted of researcher-developed questionnaires designed based on the findings of the meta-synthesis stage. To assess the validity of the instruments, face validity, content validity, and construct validity were examined. Face and content validity were evaluated through expert judgment and by calculating the Content Validity Ratio (CVR) and the Content Validity Index (CVI). Furthermore, the Delphi technique was employed to achieve consensus among experts regarding the dimensions and components of the proposed model. The Delphi process was conducted in several iterative rounds until an acceptable level of agreement and consensus among specialists was reached. The degree of expert agreement was further assessed using Kendall's coefficient of concordance. To evaluate the reliability of the research instrument, Cronbach's alpha coefficient was calculated, and the results indicated an acceptable level of internal consistency and reliability for the questionnaire.

After confirming the dimensions and indicators of the model, the quantitative phase of the study focused on testing the measurement structure and examining the relationships among the research constructs through Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). Confirmatory factor analysis was conducted to assess the adequacy of the indicators in explaining the latent constructs and to evaluate convergent and discriminant validity. In addition, the goodness-of-fit of the conceptual model was examined using standard fit indices, including  $\chi^2/df$ , RMSEA, GFI, AGFI, NFI, CFI, and IFI, to determine the extent to which the theoretical model corresponded to the empirical data. In the third phase, a fuzzy logic approach was employed to design the optimal educational model and determine the influence pattern of the identified components. The selection of this approach was justified by the complex, multifactorial, and uncertain nature of vandalistic behaviors, as well as the need to analyze human judgments under conditions of ambiguity. Fuzzy logic, as an advanced decision-making and modeling approach, enables the transformation of experts' subjective judgments into quantitative values and facilitates the analysis of nonlinear relationships among variables. In this phase, the dimensions and components extracted from the previous stages were defined as input variables of the fuzzy system. Subsequently, appropriate membership functions for each variable were designed based on expert opinions, and a fuzzy rule base was developed. The fuzzy inference process was carried out using "if-then" rules, and after performing the stages of fuzzification, inference, and defuzzification, the relative importance and influence of each component were determined.

Finally, based on the findings obtained from qualitative analyses, structural equation modeling, and fuzzy inference, the final research model was designed and presented. In addition to explaining the structural relationships among educational components affecting the reduction of vandalistic behaviors, the model provides a framework for prioritizing educational strategies and identifying the most effective educational and behavioral interventions. Data analysis in the meta-synthesis phase was conducted through qualitative content analysis, while the quantitative data were analyzed using SPSS and LISREL

software packages. The fuzzy modeling procedures were performed using MATLAB software. The integration of findings from the three phases of the study ultimately facilitated the development of a scientific, context-specific, and evidence-based model for reducing vandalistic behaviors among elementary school students.

## Findings and Results

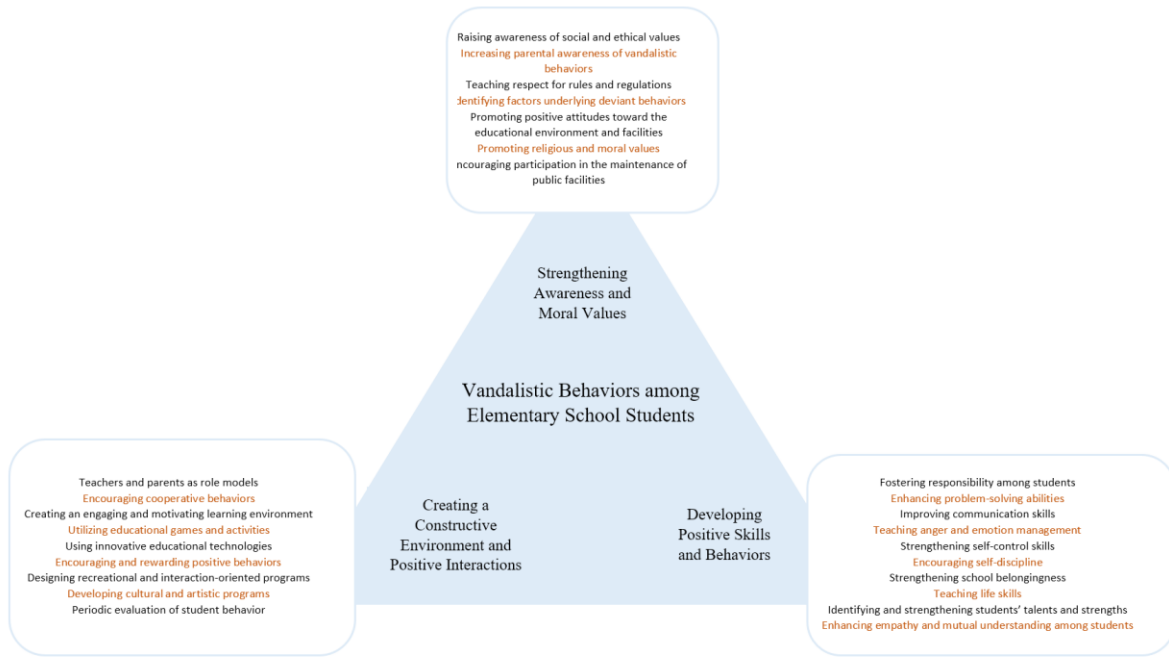
The present study employed a meta-synthesis approach based on the seven-step model of Sandelowski and Barroso to identify and extract the dimensions, components, and indicators influencing the design of an educational model for reducing vandalistic behaviors among elementary school students. In the first step, the research question was formulated with a focus on identifying and classifying educational factors effective in reducing students' vandalistic behaviors. In the second step, a systematic search of scientific literature was conducted across reputable national and international databases. The study corpus included Persian scholarly sources published between 2014 and 2024 (1393–1403 in the Iranian calendar) and English-language publications released between 2014 and 2024. Inclusion criteria comprised thematic relevance, publication in recognized scientific sources, accessibility of full-text documents, and adequate methodological quality. The initial search process yielded 128 scientific sources, including 74 English and 54 Persian publications. During the screening stage, the titles, abstracts, and full texts of the retrieved studies were carefully reviewed, and their methodological quality was evaluated using Glynn's Critical Appraisal Tool (2006). Studies receiving a quality score below 75% were excluded from further analysis. To ensure the reliability of the coding process, a subset of the selected studies was independently reviewed by a second coder. The inter-rater agreement coefficient was calculated at 0.93, indicating a high level of coding reliability and analytical consistency. In the extraction and synthesis phase, the findings obtained from the selected studies were analyzed through qualitative content analysis. The extracted initial codes were continuously compared, merged, and organized into broader concepts, which were subsequently categorized into overarching dimensions.

**Table 1. Summary of Meta-Synthesis Findings on Educational Strategies for Reducing Vandalistic Behaviors among Elementary School Students**

Dimensions	Components	Indicators
Strengthening Awareness and Moral Values	Raising awareness of social and ethical values	Teaching citizens' rights and responsibilities; increasing awareness of the role of social values in societal development
	Increasing parental awareness of vandalistic behaviors	Promoting responsibility toward the environment; encouraging participation in group activities
	Teaching respect for rules and regulations	Identifying problems and proposing solutions; logical decision-making and evaluation of consequences
	Identifying factors underlying deviant behaviors	Strengthening discussion and dialogue skills; teaching active listening
	Promoting positive attitudes toward the educational environment and facilities	Understanding the consequences of rule violations; encouraging orderliness and discipline
	Promoting religious and moral values	Demonstrating positive behaviors by teachers; parental role-modeling of ethical conduct
	Encouraging participation in the maintenance of public facilities	Implementing collaborative classroom projects; participation in voluntary activities
Developing Positive Skills and Behaviors	Fostering responsibility among students	Designing interactive learning activities; utilizing visual and auditory educational tools
	Enhancing problem-solving abilities	Teaching relaxation techniques; recognizing and regulating negative emotions
	Improving communication skills	Time management and planning; preventing impulsive behaviors
	Teaching anger and emotion management	Setting short- and long-term personal goals; monitoring personal performance

	Strengthening self-control skills	Participation in school activities; enhancing students' sense of self-worth
	Encouraging self-discipline	Organizing educational workshops for parents; raising awareness of the consequences of vandalistic behaviors
	Strengthening school belongingness	Designing interactive educational games; employing simulation-based learning
	Teaching life skills	Examining the role of family environments in student behavior; identifying peer and social influences
	Identifying and strengthening students' talents and strengths	Teaching the importance of protecting public facilities; encouraging participation in school beautification activities
	Enhancing empathy and mutual understanding among students	Organizing cultural and artistic festivals; encouraging participation in artistic activities
Creating a Constructive Environment and Positive Interactions	Teachers and parents as role models	Using feedback forms for teachers and students; conducting regular progress review meetings
	Encouraging cooperative behaviors	Teaching stress-management skills; strengthening decision-making abilities in challenging situations
	Creating an engaging and motivating learning environment	Organizing religious ceremonies and activities; promoting respect for diverse viewpoints
	Utilizing educational games and activities	Designing digital educational content; employing interactive software and learning platforms
	Using innovative educational technologies	Providing rewards for positive behaviors; implementing student progress point systems
	Encouraging and rewarding positive behaviors	Offering positive feedback regarding students' strengths; supporting individual interests and talents
	Designing recreational and interaction-oriented programs	Organizing educational and recreational field trips; implementing group activities to enhance social interaction
	Developing cultural and artistic programs	Teaching the importance of preserving and maintaining facilities; implementing environmental cleanliness and maintenance programs
	Periodic evaluation of student behavior	Teaching acceptance of individual differences; promoting cooperation and mutual respect

The meta-synthesis findings presented in Table 1 demonstrated that educational factors influencing the reduction of vandalistic behaviors among elementary school students can be classified into three primary dimensions. The first dimension, "Strengthening Awareness and Moral Values," encompassed components such as raising awareness of social and ethical values, increasing parental awareness, teaching respect for rules and regulations, identifying factors contributing to deviant behaviors, promoting positive attitudes toward educational environments, fostering moral and ethical values, and encouraging participation in maintaining public facilities. The second dimension, "Developing Positive Skills and Behaviors," included responsibility, problem-solving ability, communication skills, anger management, self-control, self-discipline, school belongingness, life skills, identification of individual strengths, and empathy development. The third dimension, "Creating a Constructive Environment and Positive Interactions," consisted of teachers' and parents' role-modeling functions, cooperative behaviors, motivating learning environments, educational games and activities, innovative educational technologies, reinforcement of positive behaviors, recreational and cultural programs, and continuous behavioral assessment of students.



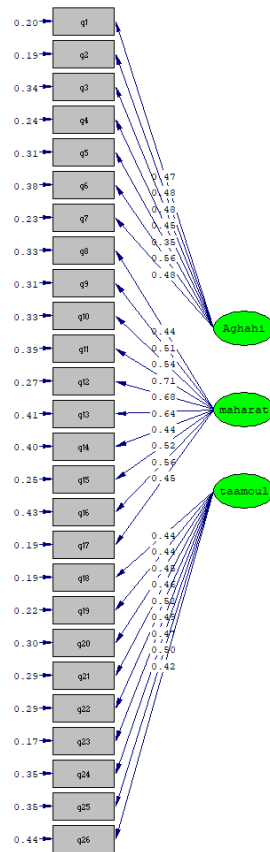
**Figure 1. Model for Reducing Vandalistic Behaviors among Elementary School Students**

Figure 1 presents the conceptual framework derived from the meta-synthesis findings. The analysis led to the identification of three overarching dimensions, twenty-six components, and a broad range of educational indicators related to the reduction of vandalistic behaviors among elementary school students. These dimensions encompass strengthening awareness and moral values, developing positive skills and behaviors, and creating a constructive environment and positive interactions. The resulting framework constituted the initial model of the study and served as the basis for instrument development, expert validation, and the formulation of a fuzzy logic–based educational model for reducing vandalistic behaviors among elementary school students. To examine the structure of the educational model for reducing vandalistic behaviors among elementary school students and to determine the importance of the identified dimensions and components, inferential statistical methods based on Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) were employed. In this regard, the adequacy of the data for conducting factor analysis was first assessed.

**Table 2. Sampling Adequacy Test**

Indicator	KMO Statistic	Chi-square Statistic	Degrees of Freedom	Significance Level
Reduction of vandalistic behaviors among elementary school students	0.852	336.297	36	0.000

To evaluate the suitability of the data for factor analysis, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett’s Test of Sphericity were applied. The results presented in Table 2 indicated that the KMO value was 0.852, which exceeds the acceptable threshold of 0.60, demonstrating that the sample size was adequate for factor analysis. Furthermore, Bartlett’s Test yielded a Chi-square value of 336.297 with a significance level lower than 0.001, indicating that the correlation matrix was appropriate for factor extraction. Therefore, the research data satisfied the necessary conditions for performing factor analysis. Following confirmation of data adequacy, the measurement model was examined through first-order confirmatory factor analysis.



**Figure 2. Educational Model for Reducing Vandalistic Behaviors among Elementary School Students in the First-Order Standardized Estimation State**

The results presented in Figure 2 showed that all factor loadings of the model components exceeded 0.30 and ranged from 0.35 to 0.71. Therefore, all components possessed sufficient explanatory power for their corresponding constructs and were retained in the model. In addition, the t-statistics for all measurement paths were greater than 1.96, indicating significant relationships between the components and their respective dimensions at the 0.05 significance level. These findings demonstrate that the designed indicators appropriately measure the dimensions of the educational model for reducing vandalistic behaviors.

**Table 3. Results of the Statistical Analysis of the Educational Model for Reducing Vandalistic Behaviors among Elementary School Students**

Dimensions	Components	Factor Loading	AVE	CR
Strengthening Awareness and Ethical Values	Raising awareness of social and ethical values	0.47	0.586	0.712
	Increasing parental awareness of vandalistic behaviors	0.48		
	Teaching respect for rules and regulations	0.48		
	Identifying factors underlying deviant behaviors	0.45		
	Promoting positive attitudes toward the educational environment and facilities	0.35		
	Promoting religious and ethical values	0.56		
Developing Positive Skills and Behaviors	Encouraging participation in maintaining public facilities	0.48	0.630	0.836
	Fostering responsibility among students	0.44		
	Developing problem-solving ability	0.51		
	Improving communication skills	0.54		
	Teaching anger and emotion management	0.71		
	Strengthening self-control skills	0.68		
	Encouraging self-discipline	0.64		

	Strengthening school belongingness	0.44		
	Teaching life skills	0.52		
	Identifying and strengthening students' strengths	0.56		
	Enhancing empathy and mutual understanding among students	0.45		
Creating a Constructive Environment and Interaction	Teachers' and parents' role-modeling function	0.44		
	Encouraging participatory behaviors	0.44		
	Creating an engaging and motivating learning environment	0.48		
	Using games and educational activities	0.46		
	Employing innovative educational technologies	0.52	0.521	0.706
	Encouraging and rewarding positive behaviors	0.45		
	Designing recreational and interaction-oriented programs	0.47		
	Developing cultural and artistic programs	0.50		
	Periodic assessment of students' behaviors	0.42		

To assess convergent validity, the Average Variance Extracted (AVE) and factor loadings were examined. The results presented in Table 3 indicated that the AVE values for the three main dimensions of the model (Strengthening Awareness and Ethical Values (0.586), Developing Positive Skills and Behaviors (0.630), and Creating a Constructive Environment and Interaction (0.521)) all exceeded the recommended threshold of 0.50. Moreover, all factor loadings were above the minimum acceptable level. Therefore, it can be concluded that the indicators adequately explain their respective constructs and that the model demonstrates satisfactory convergent validity. To evaluate construct reliability, Composite Reliability (CR) was calculated. The CR values for the three main dimensions were 0.712, 0.836, and 0.706, respectively, all exceeding the recommended threshold of 0.70. These findings indicate satisfactory internal consistency among the indicators of each dimension and confirm the construct reliability of the model.

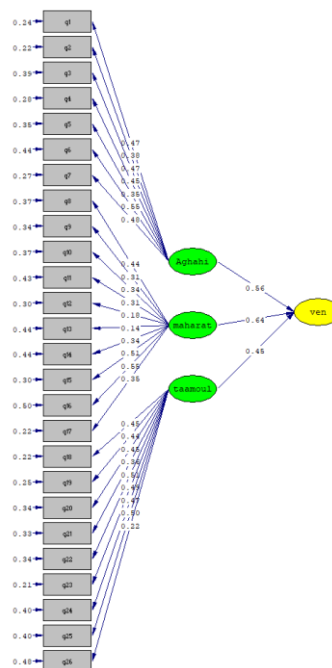
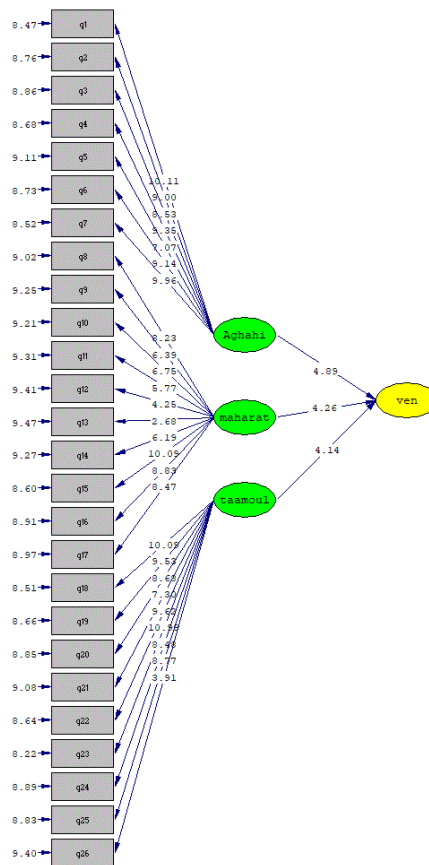


Figure 3. Significance Coefficients Model



**Figure 4. Standardized Coefficients Model**

Following confirmation of the measurement model, the overall structure of the model was tested using second-order confirmatory factor analysis. The results of the significance model indicated that all path coefficients between the three dimensions and the principal construct, namely the Educational Model for Reducing Vandalistic Behaviors among Elementary School Students, had t-values greater than 1.96. Consequently, all structural relationships were found to be statistically significant at the 95% confidence level. Furthermore, the standardized path coefficients demonstrated the significant contribution of each dimension to explaining the main construct of the study. Overall, the findings from the second-order confirmatory factor analysis revealed that the three-dimensional structure of the model was empirically supported and that the identified dimensions significantly explained the educational model for reducing vandalistic behaviors. Subsequently, the model fit indices were evaluated.

**Table 4. Goodness-of-Fit Indices of the Educational Model for Reducing Vandalistic Behaviors among Elementary School Students**

Fit Index	Estimate	Acceptable Fit Criterion
Chi-square to Degrees of Freedom Ratio ( $\chi^2/df$ )	2.17	Less than 3
Root Mean Square Error of Approximation (RMSEA)	0.060	Less than 0.08
Normed Fit Index (NFI)	0.92	Greater than 0.90
Comparative Fit Index (CFI)	0.94	Greater than 0.90
Incremental Fit Index (IFI)	0.94	Greater than 0.90
Relative Fit Index (RFI)	0.89	Greater than 0.90
Parsimonious Normed Fit Index (PNFI)	0.71	Greater than 0.50

The results presented in Table 4 indicated that the Chi-square to degrees of freedom ratio ( $\chi^2/df$ ) was 2.17, which is below the recommended threshold of 3 and therefore reflects a satisfactory model fit. In addition, the RMSEA value was 0.060, which

is below the threshold of 0.08 and indicates an acceptable approximation error. The remaining fit indices were also within desirable ranges, with NFI, CFI, and IFI values of 0.92, 0.94, and 0.94, respectively. Furthermore, the PNFI value was 0.71, exceeding the recommended minimum value of 0.50. Collectively, these results demonstrate that the measurement model exhibits an adequate and acceptable fit with the empirical data of the study. The fuzzy expert system approach based on fuzzy set theory was employed to determine the optimal combination of dimensions within the educational model for reducing vandalistic behaviors among elementary school students. This approach enables the simultaneous analysis of qualitative and quantitative variables and facilitates the identification of the optimal contribution of each model dimension to the reduction of vandalistic behaviors. The modeling process was conducted through a six-stage algorithm comprising fuzzy system design, variable fuzzification, development of inference rules, defuzzification, calculation of the optimal combination of dimensions, and model validation.

The knowledge required for system design, identification of input and output variables, and formulation of inference rules was obtained through a systematic review of the literature and consultation with 15 experts in educational sciences and educational management. The expert panel consisted of 10 faculty members holding doctoral degrees in educational sciences and 5 senior educational administrators with managerial experience in the Ministry of Education. All stages of modeling and fuzzy computations were performed using MATLAB software. In the fuzzy system design stage, the three principal dimensions extracted from previous analyses, namely “Strengthening Awareness and Moral Values,” “Developing Positive Skills and Behaviors,” and “Creating a Supportive Environment and Constructive Interaction,” were defined as the system inputs. The variable “Reduction of Vandalistic Behaviors among Elementary School Students” was considered the system output. Within the fuzzy inference engine, the minimum (Min) operator was used for “AND” relationships and the maximum (Max) operator for “OR” relationships. Furthermore, the Mamdani method was applied for fuzzy inference, the minimum operator for implication, the maximum operator for aggregation, and the centroid method for defuzzification.

During the fuzzification stage, each input variable was partitioned into three linguistic levels using triangular fuzzy numbers. The output variable was partitioned into five linguistic levels: very low, low, medium, high, and very high. Following the specification of membership functions, the fuzzy rule base was developed based on the theoretical literature and expert judgments. Given the presence of three input variables and three fuzzy levels for each variable, a total of 27 inference rules were formulated to cover all possible combinations of the model dimensions.

**Table 5. Optimal Combination for Reducing Vandalistic Behaviors among Elementary School Students**

Dimension	Percentage (%)
Strengthening Awareness and Moral Values	39.46
Developing Positive Skills and Behaviors	41.22
Creating a Supportive Environment and Constructive Interaction	19.32

After executing the fuzzy inference process and performing defuzzification, the optimal combination of model dimensions for achieving the maximum reduction in vandalistic behaviors was calculated. The findings indicated that the optimal contribution of the dimension “Developing Positive Skills and Behaviors” was 41.22%, followed by “Strengthening Awareness and Moral Values” with 39.46%, and “Creating a Supportive Environment and Constructive Interaction” with 19.32%. Based on this combination, the reduction in vandalistic behaviors among elementary school students was estimated at 85.1%.

To ensure model validity, validation procedures were conducted at two levels. At the first level, the inputs, outputs, and inference rules were evaluated by the expert panel, and following revisions and resolution of discrepancies, consensus was

achieved regarding the model structure. At the second level, model validation was performed through output behavior analysis. In this procedure, some input variables were held constant while others were systematically varied, and the resulting output behavior was examined. The results demonstrated that increases in the values of the three model dimensions significantly enhanced the reduction of vandalistic behaviors. Moreover, the observed behavioral patterns were fully consistent with the theoretical foundations of the study and the opinions of the experts. Response surface analysis further revealed that the dimension “Strengthening Awareness and Moral Values,” when combined with “Developing Positive Skills and Behaviors,” exerted a substantial effect on reducing vandalistic behaviors, particularly when both dimensions exceeded moderate levels. Similarly, the interaction between “Developing Positive Skills and Behaviors” and “Creating a Supportive Environment and Constructive Interaction,” as well as the interaction between “Strengthening Awareness and Moral Values” and “Creating a Supportive Environment and Constructive Interaction,” produced significant positive effects on the output variable. These findings indicate that the reduction of vandalistic behaviors among elementary school students results from the synergistic effects of the three principal dimensions of the model, and that achieving maximum effectiveness requires simultaneous attention to all identified dimensions.

## Discussion and Conclusion

The present study aimed to design and validate an optimal educational model for reducing vandalistic behaviors among elementary school students using a fuzzy logic approach. The findings identified three major dimensions contributing to the reduction of vandalistic behaviors: strengthening awareness and moral values, developing positive skills and behaviors, and creating a constructive environment and positive interactions. The results of the confirmatory factor analyses demonstrated that all identified dimensions and components significantly contributed to the proposed model, while the goodness-of-fit indices confirmed the adequacy of the model structure. Furthermore, fuzzy modeling revealed that developing positive skills and behaviors represented the most influential dimension, followed by strengthening awareness and moral values and creating a constructive environment and positive interactions. Collectively, these findings suggest that vandalistic behavior among elementary school students is a multidimensional phenomenon that requires comprehensive interventions addressing cognitive, emotional, behavioral, social, and environmental factors simultaneously.

One of the most important findings of this study was the significant contribution of the dimension labeled developing positive skills and behaviors. Fuzzy analysis indicated that this dimension exerted the strongest influence on reducing vandalistic behaviors. This finding suggests that students who possess stronger self-regulation abilities, better communication skills, higher levels of responsibility, stronger problem-solving capacities, and greater emotional control are less likely to engage in destructive behaviors directed toward school property and educational facilities. This result is consistent with previous research emphasizing the role of self-control and behavioral competence in preventing maladaptive behaviors among children and adolescents. Studies have demonstrated that deficits in emotional regulation and behavioral self-management often contribute to impulsive and destructive actions, whereas interventions designed to strengthen self-regulation skills can substantially reduce behavioral problems (1, 6). Similarly, communication skills training and social competence development have been associated with improvements in interpersonal functioning and reductions in problematic behaviors among young people (11). The current findings extend these conclusions by demonstrating that behavioral competencies are not merely protective factors but may constitute the most influential educational target for vandalism prevention within elementary school settings.

The importance of behavioral skills development can also be interpreted through contemporary educational and psychological theories emphasizing active self-regulation and adaptive coping mechanisms. Students frequently encounter

frustrations, interpersonal conflicts, academic pressures, and emotional challenges within school environments. Those who lack adequate coping skills may express their frustration through aggressive or destructive behaviors. In contrast, students equipped with problem-solving strategies, emotional management skills, and self-discipline are more capable of responding constructively to difficult situations. Previous studies examining life-skills training, cognitive-behavioral interventions, and behavioral education have consistently demonstrated positive effects on children's behavioral adjustment and social functioning (14, 17, 18). Research on play-based interventions has likewise shown that structured opportunities to practice emotional regulation and interpersonal skills can improve behavioral outcomes among children exhibiting disruptive tendencies (22, 23). Therefore, the prominence of behavioral skills within the present model aligns with a substantial body of evidence supporting the role of social-emotional learning and self-regulation as central mechanisms for behavioral improvement.

Another significant finding concerns the role of strengthening awareness and moral values as the second most influential dimension in reducing vandalistic behaviors. This dimension encompassed components such as awareness of social values, respect for rules and regulations, understanding the consequences of deviant behaviors, parental awareness, and participation in preserving public resources. The significance of this dimension suggests that vandalism is not solely a behavioral problem but also reflects deficiencies in moral reasoning, social responsibility, and civic awareness. Students who appreciate the value of public property, understand the broader consequences of destructive behavior, and internalize ethical principles are more likely to behave responsibly within educational environments. These findings are consistent with previous research indicating that moral education and social responsibility programs contribute to reductions in aggressive, disruptive, and antisocial behaviors among children (8, 16). Likewise, studies focusing on vandalism have identified weak social commitment, low civic responsibility, and poor awareness of communal rights as important predictors of destructive behavior (3, 4).

The importance of moral awareness can also be explained through social learning and social capital perspectives. According to these frameworks, individuals learn behavioral norms through interactions with significant social agents, including parents, teachers, and peers. When educational environments actively promote ethical values and responsible citizenship, students are more likely to adopt prosocial attitudes and behaviors. Research examining social capital has demonstrated that stronger connections to social institutions and shared values reduce engagement in deviant behaviors by increasing social accountability and collective responsibility (2). Similarly, family-based influences play a crucial role in shaping children's attitudes toward rules, authority, and public resources. Studies have shown that parental monitoring, positive role modeling, and ethical guidance contribute significantly to children's behavioral development (5, 10). The current findings therefore reinforce the importance of integrating moral and civic education into school-based prevention programs aimed at reducing vandalistic tendencies.

The third dimension identified in the present study, creating a constructive environment and positive interactions, also demonstrated a significant contribution to reducing vandalistic behaviors. Although its relative weight was lower than the other two dimensions, the findings indicate that supportive educational environments remain essential components of effective prevention strategies. This dimension included teacher and parent role modeling, cooperative learning opportunities, positive reinforcement systems, engaging educational activities, cultural programs, and the use of innovative educational technologies. These results are consistent with educational research demonstrating that students are less likely to engage in destructive behaviors when they feel emotionally connected to their school environment and perceive positive relationships with teachers and peers (7, 15). A positive school climate fosters belongingness, engagement, and responsibility, thereby reducing feelings of alienation that often contribute to misconduct and vandalism.

The significance of environmental factors is further supported by studies highlighting the importance of participatory and student-centered educational practices. Schools that encourage active student involvement, collaborative learning, and meaningful engagement tend to promote stronger emotional attachment and greater respect for school property. Previous

investigations have shown that creative learning environments and interactive educational experiences enhance students' motivation and decrease behavioral problems (13, 29). Moreover, educational technologies and innovative instructional approaches can increase student engagement and create more stimulating learning environments that reduce boredom and frustration, two factors frequently associated with disruptive behaviors. These findings suggest that vandalism prevention should not be viewed exclusively as a matter of correcting individual behavior but should also involve improving the broader educational context in which students learn and develop.

The structural equation modeling results provide additional support for the multidimensional nature of vandalistic behavior. The significant factor loadings and acceptable fit indices indicate that the proposed model accurately represents the relationships among the identified dimensions and the overall reduction of vandalistic behaviors. These findings correspond with previous studies suggesting that vandalism arises from the interaction of multiple psychological, social, and educational factors rather than any single cause (9, 28). Earlier research utilizing systems-based approaches similarly emphasized the interconnected nature of factors influencing students' tendencies toward vandalism and other forms of deviant behavior (28). By validating a comprehensive model encompassing moral, behavioral, and environmental dimensions, the present study contributes to a more holistic understanding of vandalistic behavior and provides empirical support for integrated intervention frameworks.

An important contribution of this study lies in its application of fuzzy logic methodology to educational modeling. Traditional statistical approaches often assume linear relationships among variables and may not adequately capture the complexity of behavioral phenomena. In contrast, fuzzy systems accommodate uncertainty, ambiguity, and nonlinear interactions, thereby providing a more realistic representation of educational processes. Previous research has demonstrated the usefulness of fuzzy approaches in analyzing complex educational and behavioral systems (13, 28). The current study extends this literature by applying fuzzy logic to the specific problem of vandalistic behavior and by identifying the optimal combination of intervention dimensions. The results suggest that maximum effectiveness is achieved not through isolated interventions but through coordinated efforts targeting behavioral skills, moral development, and environmental improvement simultaneously.

The findings also highlight the importance of role models in shaping student behavior. Teachers and parents emerged as critical contributors within the environmental dimension of the model. This finding aligns with social learning principles emphasizing observational learning and behavioral modeling. Children frequently imitate behaviors exhibited by significant adults, particularly when those behaviors are consistently reinforced and socially valued. Research examining therapeutic, educational, and family-based interventions has repeatedly demonstrated that positive adult role models contribute to improved behavioral outcomes among children (21, 24, 25). Consequently, efforts to reduce vandalistic behavior should involve not only direct student interventions but also initiatives aimed at strengthening the capacity of teachers and parents to model responsibility, respect, and constructive social behavior.

Finally, the results support the view that effective vandalism prevention requires an integrated educational approach rather than isolated disciplinary measures. Traditional punitive responses may address the immediate manifestations of vandalism but often fail to address its underlying causes. The present findings indicate that sustainable reductions in vandalistic behavior depend upon fostering moral awareness, developing behavioral competencies, and creating supportive educational environments. This conclusion is consistent with previous research demonstrating the effectiveness of preventive and developmental interventions over purely corrective strategies (19, 26, 27). Accordingly, educational systems seeking to reduce vandalistic behavior should prioritize comprehensive developmental programs that strengthen students' personal, social, and ethical capacities while simultaneously improving the educational environments in which they learn.

Several limitations should be considered when interpreting the findings of this study. First, the model was developed and validated within a specific educational and cultural context, which may limit the generalizability of the findings to other regions and educational systems. Second, although the study integrated qualitative, quantitative, and fuzzy modeling approaches, the validation process relied primarily on expert judgments and teacher perceptions rather than direct behavioral observations of students. Third, the cross-sectional nature of the quantitative phase limits conclusions regarding causal relationships among the identified dimensions. Fourth, some potentially relevant variables, such as socioeconomic conditions, community characteristics, and individual personality traits, were not explicitly incorporated into the final model. Finally, despite the strengths of fuzzy logic modeling, the outcomes remain partially dependent on expert-defined rules and membership functions, which may vary across different contexts.

Future studies should examine the applicability and effectiveness of the proposed model in diverse educational settings and cultural contexts. Longitudinal research designs are needed to evaluate the stability of the identified relationships over time and to determine whether improvements in moral awareness, behavioral skills, and environmental quality lead to sustained reductions in vandalistic behaviors. Researchers may also investigate additional factors that could influence vandalism, including personality characteristics, family functioning, peer-group dynamics, and socioeconomic conditions. Experimental studies evaluating specific intervention programs derived from the proposed model would further strengthen the evidence base. Additionally, future investigations could compare fuzzy logic approaches with other advanced analytical methods such as machine learning, artificial intelligence, and network analysis to determine the most effective frameworks for educational decision-making and behavioral prediction.

Educational policymakers and school administrators should prioritize comprehensive prevention programs that simultaneously address behavioral skills, moral development, and school climate. Schools should implement structured life-skills curricula emphasizing self-regulation, emotional management, communication, empathy, and problem-solving abilities. Teachers should receive professional development focused on positive classroom management, student engagement, and constructive behavior support strategies. Educational systems should also strengthen citizenship education and ethical learning opportunities that encourage responsibility toward public resources and respect for communal property. Furthermore, schools should create engaging learning environments through collaborative activities, student participation, cultural programs, and innovative educational technologies. Active collaboration among teachers, parents, counselors, and school leaders is essential for establishing consistent expectations and reinforcing positive behaviors. Regular monitoring and evaluation of student behavior can help identify emerging concerns early and support timely implementation of preventive interventions.

### **Acknowledgments**

We would like to express our appreciation and gratitude to all those who helped us carrying out this study.

### **Authors' Contributions**

All authors equally contributed to this study.

### **Declaration of Interest**

The authors of this article declared no conflict of interest.

### **Ethical Considerations**

All ethical principles were adhered in conducting and writing this article.

## Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

## Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

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