IDENTIFYING STUDENTS' CONFLICT RESPONSE STYLES BASED ON ADVANCED QUANTITATIVE ANALYSIS

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ABSTRACT
Background: Understanding how students respond to interpersonal conflict is essential for developing emotional, social, and teamwork competencies. This study explores students' conflict-handling styles using an integrative framework that combines Information Theory, cluster analysis, and Game-Theoretic concepts.
Objective: The study aims to identify latent behavioral profiles in conflict management among university students and interpret them through quantitative and theoretical modeling.
Methods: A total of 156 students (79 males and 77 females) from the National Sports Academy "Vassil Levski" participated in the survey. Conflict-handling styles were measured with the Thomas-Kilmann Conflict Mode Instrument (TKI), with responses modeled as probability distributions across five styles: competing, collaborating, compromising, avoiding, and accommodating. Descriptive statistics, the Mann-Whitney U-test, Chi-squared test, Shannon entropy, and hierarchical clustering with Jensen-Shannon distance were applied to evaluate behavioral consistency and subgroup structure.
Results: Both genders mainly favored collaboration and accommodation, while avoidance was least common. Cluster analysis revealed three distinct subgroups per gender, with males showing greater avoidance and females stronger collaboration. The derived median entropy values deviated less than 2% from the theoretical maximum, indicating flexible, mixed-strategy responses and partial convergence toward equilibrium.
Conclusion: Integrating behavioral, informational, and Game-Theoretic approaches offers a multidimensional understanding of students' conflict management styles. The findings can inform educational programs designed to enhance communication, cooperation, and adaptive conflict resolution in academic and sports settings.

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INTRODUCTION

The rapid advancement of modern civilization has reshaped social structures and interpersonal relations, leading to higher psychological stress, lower physical activity, and more frequent conflicts. When managed effectively, conflict can promote both personal and collective development (Kalaidzhiev, 2008). The main conflict-handling styles include competing, collaborating, compromising, avoiding, and accommodating (Thomas & Kilmann, 1975). In sports, such conflicts are inherent, making their effective management essential for the psychological growth of athletes and coaches. Previous research has explored the socio-psychological aspects of conflicts in sports (Domuschieva-Rogleva, 2000), examined links between conflict styles and interpersonal interactions (Georgiev & Domuschieva-Rogleva, 2002), and proposed conceptual models for understanding and resolving them (Domuschieva-Rogleva, 2023).

Conflicts, as natural dynamics within social systems, frequently arise in the university environment, which strongly influences students' personal and social development. Recent studies identify compromising and collaborating as the most effective strategies for maintaining a positive academic climate (Dianasari et al., 2023). However, their effectiveness depends on situational factors. Several authors emphasize that no single conflict management approach is universally optimal and that strategies must be adapted to specific organizational contexts (Meadows & Ojikutu, 2023; Rudnak et al., 2024).

Behavioral Game Theory extends the situational perspective by conceptualizing conflicts as structured interactions involving players, strategies, payoffs, and equilibria (Camerer, 1997). It provides a mathematical framework for analyzing both cooperative and competitive situations, clarifying why behavioral patterns emerge and where human biases diverge from rational models. In line with the "No Free Lunch" theorem, which states that no optimization algorithm is universally superior (Wolpert & Macready, 1997), no single conflict resolution style can be effective in all contexts. Therefore, conflict management should be context-specific, and a Game-Theoretic framework enables the analysis of how pure strategies combine into adaptive mixed strategies that reflect the complexity of human behavior.

Aim and objectives

The primary aim of this study is to evaluate the applicability of advanced analytical approaches rooted in Information Theory, unsupervised machine learning, and Game-Theoretic concepts for examining students' conflict-handling styles. The research seeks to integrate traditional psychometric assessment with modern quantitative modeling to identify latent behavioral patterns and gender-related tendencies in conflict management.

To accomplish this aim, the following specific objectives were defined:

1. To establish the theoretical and methodological framework for analyzing conflict response styles through statistical, probabilistic, and informational measures.
2. To conduct an exploratory empirical study among university students using the Thomas-Kilmann Conflict Mode Instrument (TKI).
3. To apply statistical and computational techniques, including descriptive analysis, hypothesis testing, entropy estimation, and hierarchical clustering, to identify latent subgroups and their behavioral consistencies.
4. To formulate conclusions and propose educational recommendations aimed at enhancing students' conflict resolution skills in academic and sports contexts.

METHODOLOGY

The study was designed to identify distinct patterns of conflict management styles among students. A total of 156 students (79 male and 77 female) from the National Sports Academy "Vassil Levski" studying in the faculties of "Sport" and "Pedagogy" were surveyed. All participants provided informed consent to participate after being briefed that their anonymized data would be used for scientific purposes only. Conflict-handling styles were measured using the Thomas-Kilmann Conflict Mode Instrument (TKI) (Thomas & Kilmann, 1975), which was adapted and translated into Bulgarian by Stoyanova (2008). To allow comparability across individuals and between conflict management styles, raw scores were normalized into the interval [0, 1] using the formula:

$$p_{ij} = \frac{x_{ij}}{\sum_{k=1}^{5} x_{ik}} = \frac{x_{ij}}{30} \qquad (1)$$

where x_{ij} – raw score of the Student for conflict management style j,
$\sum_{k=1}^{5} x_{ik}$ – total score across all five conflict handling styles for Student (for the TKI the total score is 30).

The resulting normalized values (p_{ij}) were treated as probability estimates or estimates of the relative frequency of occurrence for each strategy. Hence, a probability mass function (PMF) that represents each respondent's likelihood of each style being employed can be derived from the TKI results (assuming all conflict management styles are mutually exclusive in a given situation). To compare the preferences of male and female groups, hypothesis tests were conducted at both the absolute-score and normalized-score levels. For this purpose, the Mann-Whitney U-test was applied to the absolute scores, while the Chi-squared test was used for the normalized scores. In each case, the null hypothesis was defined as:

- *Mann-Whitney U-test H_0*: There is no significant difference between male and female students in their median raw conflict management scores for a particular style.
- *Chi-squared test H_0*: There is no significant association between gender (male vs. female) and the frequency of applying a particular style.

In addition, Shannon Entropy (Shannon, 1948) was calculated for each student's derived conflict style profile, assumed as a PMF, to quantify the behavioral consistency of a student's conflict response profile:

$$H_i = -\sum_{j=1}^{5} p_{ij} \cdot \log_2 p_{ij} \qquad (2)$$

Lower entropy values indicate dominance of a single response style (high behavioral consistency), whereas higher values reflect more flexible use of multiple styles (low consistency). This measure captures whether students favor fixed strategies or adopt flexible, mixed-strategy profiles in managing conflicts. To uncover hidden group structures, Hierarchical cluster analysis was applied on all male and female groups normalized scores, using the Jensen-Shannon distance (Endres, Schindelin, 2003):

$$d_{JS}(P,Q) = \sqrt{\frac{D_{KL}(P||Q)+D_{KL}(Q||P)}{2}} \quad (3)$$

$$D_{KL}(P||Q) = \sum_{j=1}^{5} P(j) \cdot \log_2 \frac{P(j)}{Q(j)} \quad (4)$$

where $D_{KL}(P||Q), D_{KL}(Q||P)$ – Kullback-Leibler divergence between two discrete probability distributions P and Q (P with respect to Q and Q with respect to P).

The Kullback-Leibler divergence (Kullback & Leibler, 1951) can quantify how one student's conflict style profile diverges from another's. However, since it is asymmetric, the Jensen-Shannon distance was used instead, offering a symmetric and bounded measure of dissimilarity. Hierarchical clustering with the complete linkage method provided better cluster separation, grouping students with similar response patterns into semi-homogeneous clusters. Beeswarm plots and kernel density estimates visualized results. This combined methodological approach integrated comparative analysis (hypothesis testing) with exploratory pattern recognition (clustering and entropy estimation), ensuring both statistical rigor and interpretive depth. Last but not least, all calculations related to the applied methods were carried out using Python 3.12.3 (Python Software Foundation, n.d.) and standard statistical and data science libraries (Pandas, n.d.; Scikit-learn, n.d.; Scipy, n.d.), while all graphs were created via the Matplotlib (Matplotlib, n.d.) and Seaborn library (Seaborn, n.d.).

RESULTS

Initially, male and female students' conflict management profiles were compared. An overview of the results revealed that the obtained samples of conflict management styles in both student groups (male and female) are relatively similar in their mean conflict response profiles (Table 1).

Table 1. *Conflict management styles of the surveyed students (male and female)*

Conflict Management Styles	Male – 79		Female – 77		M-W U-test		χ^2 test (df=1)	
	Mean absolute score	Mean relative score	Mean absolute score	Mean relative score	U	p-value	χ^2	p-value
S1. Competing	5.73	0.1911	6.19	0.2065	**2515.0**	***.054**	**5.467**	****.019**
S2. Collaborating	7.54	0.2515	7.44	0.2481	3025.5	.953	0.093	.760
S3. Compromising	5.75	0.1916	5.38	0.1792	**3624.5**	****.031**	**3.077**	***.079**
S4. Avoiding	4.27	0.1422	4.29	0.1429	2961.0	.753	0.005	.943
S5. Accommodating	6.71	0.2236	6.70	0.2234	3057.0	.955	0.032	.857

Notes: significant for α=.10, ** significant for α=.05*

The results show that the surveyed female students are more inclined to compete with their peers and, to some extent, less willing to compromise, compared to the studied male students. It is also evident from the corresponding mean relative score values that certain behavioral biases are present for both male and female students – the most prominent ones being the increased willingness to collaborate and the reduced preference to avoid conflict. It can be hypothesized that these profiles are due to the background of the surveyed students, as they are primarily involved in sports activities and hence, are more accustomed to competitive environments, structured teamwork and clear role expectations.

A more nuanced understanding of the intrinsic characteristics of both groups was achieved through the application of cluster analysis, which allowed for the identification of underlying patterns and distinct response profiles within the surveyed students. Figure 1 visually illustrates the identified subgroups of male students (referred to as clusters).

The identified three distinct groups of male students are:

- *Cluster 1 (19 students):* Students tending to avoid conflict or withdraw from confrontation. This indicates a slight predisposition towards indecisiveness.
- *Cluster 2 (43 students):* Students favoring competitive, collaborative and accommodating strategies, while being less likely to avoid conflict. These students show flexibility by having both the capacity to stand their ground and to yield.
- *Cluster 3 (17 students):* Students preferring collaboration and compromise, with little inclination toward competition. This group reflects a cooperative style, seeking win-win solutions.

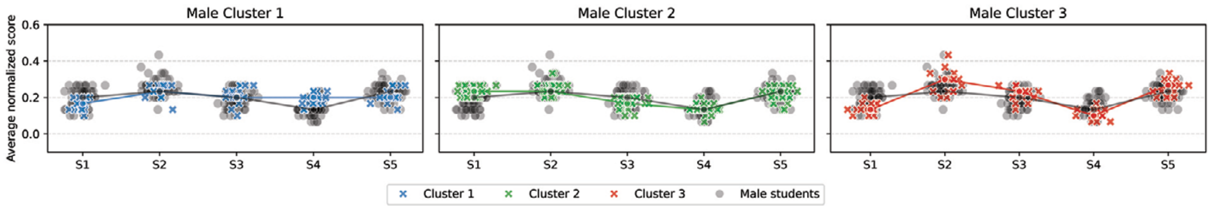

Figure 1. *Profile of the conflict management styles of the surveyed male students and the identified subgroups*

Cluster analysis was applied to the conflict management styles among the female students, revealing to some extent similar profiles (Figure 2)

Clustering revealed the presence of three underlying subgroups (excluding one student, whose answers were disregarded). The interpretations of the conflict management profiles of the students in the three established female clusters are as follows:

- *Cluster 1 (29 students):* Students in favor of collaboration and accommodation, while avoiding withdrawal. These students are oriented towards maintaining positive ties with their peers.
- *Cluster 2 (42 students):* Students emphasizing collaboration, but less on compromise and avoidance. This group represents proactive problem solvers.
- *Cluster 3 (5 students):* Students from this cluster display a balanced use of all five styles without a clear preference. Moreover, given the nature of the strategies, this cluster would be characterized more by indecision rather than versatility.

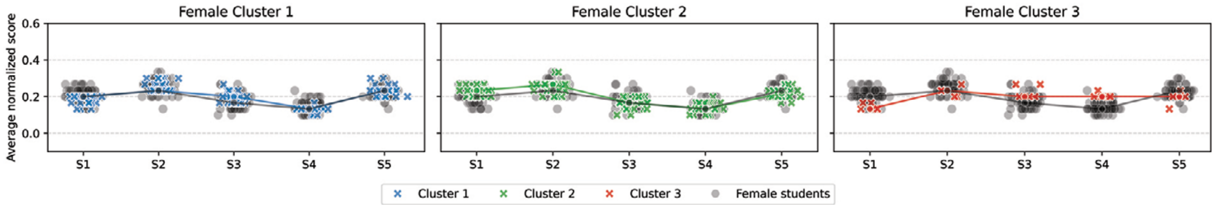

Figure 2. *Profile of the conflict management styles of the surveyed female students and the identified subgroups*

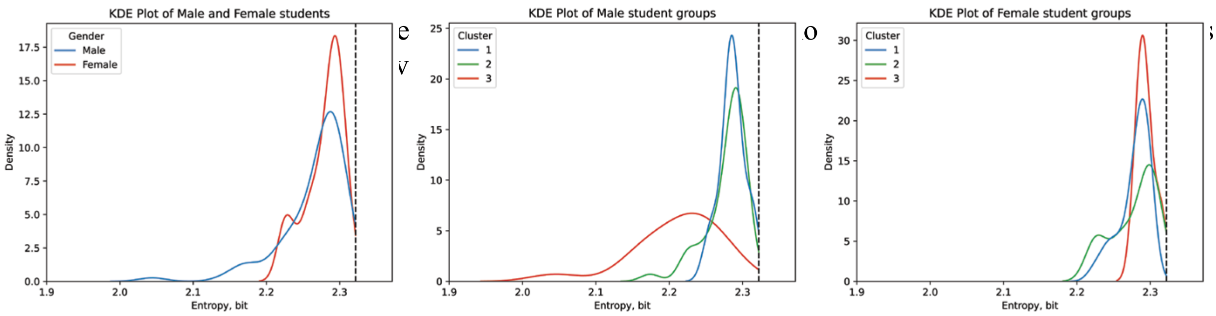

Figure 3. *Shannon entropy distribution among male and female students, along with their corresponding clusters*

Under the given assumptions (5 predefined conflict management styles), the theoretical maximum entropy value is 2.3219 bits, while both groups (male and female) empirically exhibit marginally different mixed-strategy entropy values (p = .051 from Mann-Whitney's U-test, $\widetilde{H_{male}}$ =2.2812 bits, $\widetilde{H_{female}}$=2.2881 bits, U=2494). Both group medians remained within 2% of the maximum entropy, indicating a state close to equilibrium, where no single conflict management style dominates or consistently outperforms others, implying consistence with the "No Free Lunch" Theorem. This suggests that most student subgroups employ flexible, balanced strategies rather than fixed patterns, likely reflecting their shared educational background. Moreover, the mild bias can be attributed to the students' general perception of active conflict resolution as more effective.

DISCUSSION AND FUTURE WORK

Although this study highlights gender-related differences and cluster-specific profiles in students' conflict management styles, its results both align with and diverge from earlier findings. While Rudnák et al. (2024) reported that females are generally less competitive than males, the present study found that female students displayed greater competitiveness and lower compromise, proving to be more consistent with the findings of Gbadamosi et al. (2014). Both genders preferred collaboration and accommodation, supporting evidence that university settings promote cooperative conflict resolution (Dianasari et al., 2023). However, the relatively small and homogeneous sample limits generalizability. Thus, future studies should employ longitudinal designs and cross-institutional comparisons to examine developmental and cultural differences.

Cluster analysis revealed distinct behavioral subgroups, indicating that overall conflict-handling profiles emerge from multiple combined styles.

Regardless, the proposed methodology allows the identification of subgroups and targeting specific skill areas for improvement, such as assertiveness training for avoidance-oriented individuals or compromise development for competitive ones. Such tailored interventions can strengthen communication, teamwork, and resilience, particularly in high-pressure academic and sports contexts.

Conclusions

Based on the studied student cohort, it can be concluded that both male and female students show strong preferences for collaboration and accommodation, alongside a consistent avoidance of withdrawal. Based on the applied hierarchical cluster analysis, a total of six meaningful gender-specific subgroups were identified. A better understanding of persistent conflict-handling profiles is achieved through quantitative methods such as Hierarchical clustering based on the Jensen-Shannon distance as means of quantifying behavioral consistency and biases. Shannon entropy estimates confirmed that students generally adopt flexible strategies, though with a common bias against conflict avoidance. In addition, despite the study's limitations, parallels were drawn between TKI-defined styles and Game-Theoretic concepts. The minimal deviation between empirical and maximum theoretical Shannon entropy suggests convergence of behavioral patterns toward the equilibrium state described by the "No Free Lunch" Theorem. Moreover, the magnitude of this deviation closely matches the observable one from prior studies across genders and organizational levels, given it is estimated from the mean conflict management scores (Thomas et al., 2007).

To conclude, the proposed methodology provides a comprehensive, extended framework for a diagnostic analysis based on advanced quantitative measures that would foster adaptive and context-sensitive conflict management competencies among students. Last but not least, these insights suggest that university programs on conflict management should be tailored to accommodate gender-specific tendencies and the unique learning requirements of the identified subgroups.

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