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Attitudes Toward Immigration among Secondary School Students in Various Countries: An International Perspective

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Abstract. This study investigates secondary school students' attitudes toward immigration across multiple countries, utilizing data from the Programme for International Student Assessment (PISA 2018). A cross-national comparative approach combined with advanced dimensionality reduction identifies the strongest factors shaping openness toward immigrants. Results show that international attention encourages welcoming views up to a critical threshold, after which further exposure predicts rising wariness. Partial dependence plots and sensitivity tests confirm the nonlinear nature of this relationship and the stability of the broader pattern. Country differences are further conditioned by socioeconomic context, classroom ethnic diversity, and students' global competence. Respect for cultural difference, balanced curiosity about world affairs, and reflective self-judgement consistently support positive attitudes, whereas frequent exposure to conflict framed news undermines them. The findings signal an urgent need for inclusive curricula, critical media literacy, stronger digital information skills, and authentic, sustained intercultural encounters to nurture empathetic, well-informed citizens in an era of intensifying global mobility and to guide evidence-based equitable education policy.

Keywords: Immigration attitudes, PISA 2018, Dimensionality reduction, Global competence, Education policy

1. Introduction

1.1. Background and significance

In an era of intensified globalization, cross-border mobility has become increasingly prevalent, leading to greater cultural and demographic diversity in many regions of the world. Immigration, in particular, has attracted growing attention in both public discourse and policy-making spheres [1]. While much of the existing research centers on adult populations, adolescents' attitudes toward immigration remain comparatively underexplored. Secondary school students, positioned at the developmental juncture between childhood and adulthood, constitute a critical demographic whose perspectives may influence future societal values, political dynamics, and international cooperation.

Adolescents' attitudes toward immigration carry considerable significance for at least three key reasons [2]. First, as future citizens, they will play a pivotal role in shaping the development of multicultural societies and determining the extent to which social cohesion can be sustained.

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Second, educational institutions are uniquely positioned to cultivate inclusive perspectives, given their ability to engage students in diverse curricula, peer interactions, and cross-cultural experiences. Third, in an increasingly interconnected global economy, the demand for adaptable, culturally competent workforces underscores the importance of understanding how young people perceive and respond to diversity during their formative years.

This study examines how sociocultural, educational, and individual factors influence adolescents' openness to immigration. It aims to illuminate both cross-national differences and shared patterns, thereby providing an evidence-based foundation for policies and educational practices that foster intercultural understanding among secondary school students.

1.2. Research questions

Situated within the broader context of globalization and comparative education, this study addresses the following research questions:

How do secondary school students' attitudes toward immigration vary across different national and regional contexts?

Which key factors—such as socioeconomic status, school diversity, and cultural exposure—most strongly influence these attitudes?

2. Literature review

Research on adolescents' attitudes toward immigration has emphasized the significance of social, cognitive, and contextual factors in shaping young people's openness to cultural diversity. Traditionally, Allport's contact hypothesis posits that meaningful intergroup contact can reduce prejudice by fostering empathy and mutual understanding [3]. This framework is especially relevant in educational settings, where schools serve as primary sites for adolescents to engage with peers from diverse backgrounds—interactions that can significantly influence their perceptions of immigrants.

Socioeconomic status and family background are also influential in shaping attitudes toward immigration. Students from higher socioeconomic backgrounds often have greater access to multicultural experiences—such as international travel, diverse peer networks, and global media—which can mitigate stereotypical perceptions [4]. Conversely, economic insecurity may heighten concerns about resource competition and cultural displacement, thereby fostering more negative attitudes toward immigration [5].

School diversity has also emerged as a significant factor influencing adolescents' openness to immigration. Studies suggest that exposure to multicultural curricula and peers from diverse ethnic or national backgrounds can enhance intercultural competence and reduce prejudice. This finding aligns with Tajfel and Turner's social identity theory, which posits that in-group favoritism diminishes when individuals recognize multiple, overlapping group identities that transcend ethnic boundaries [6].

Cross-cultural awareness and global competence—emphasized in the PISA 2018 framework—are increasingly recognized as important determinants of adolescents' attitudes toward immigration [7]. Young people who demonstrate critical thinking about global issues, empathy toward other cultures, and an appreciation for diverse perspectives are more likely to hold supportive views on immigration [8]. These competencies can be developed through formal instruction, experiential learning, and extracurricular activities that engage students with global themes.

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Methodologically, scholars have employed both quantitative and qualitative approaches to examine the interplay among individual-level factors (e.g., socioeconomic status, cultural exposure), school-level variables (e.g., diversity, inclusiveness policies), and macro-level contexts (e.g., national immigration policies). Comparative cross-national studies frequently utilize large-scale datasets, such as PISA, to analyze variations in students' attitudes. While these methods facilitate broad generalizations, qualitative research—through interviews or ethnographic studies—offers nuanced insights into local contexts [9].

Overall, the existing literature indicates that adolescents' attitudes toward immigration are shaped by a complex interplay of social identity processes, intergroup contact, socioeconomic conditions, and educational experiences. Achieving a comprehensive understanding necessitates the integration of cross-national comparisons, longitudinal data, and mixed-methods approaches to capture the dynamic complexities of global migration and cultural exchange.

3. Data source and methodology

This study employs a multi-stage feature extraction and predictive modeling approach to identify and analyze the principal predictors of secondary school students' attitudes toward immigration.

3.1. Data source

The empirical component of this study draws on data from the Programme for International Student Assessment [7], administered by the Organisation for Economic Co-operation and Development (OECD). While PISA traditionally focuses on assessing students' performance in reading, mathematics, and science, the 2018 cycle incorporated global competence into its assessment framework. Global competence is defined as "the capacity to critically examine global and intercultural issues from multiple perspectives, understand how differences influence perceptions and judgments, and interact openly, appropriately, and effectively with individuals from different backgrounds on the basis of respect for human dignity" [7]. This inclusion provides a robust foundation for large-scale comparative studies on students' attitudes toward immigration.

Within PISA 2018, the primary dependent variable utilized in this study is students' openness to immigrants, often operationalized in the dataset as ATTIMM. This variable measures students' receptivity and supportiveness toward immigration-related issues. Relevant independent variables encompass student-level factors (e.g., socioeconomic status, parental education, cross-cultural exposure), school-level characteristics (e.g., school diversity, cultural inclusiveness policies), and macro-level indicators (e.g., national economic data, historical immigration patterns).

3.2. Research design

This study adopts a comparative education framework to explore how varying national contexts influence secondary school students' attitudes toward immigration. In so doing, it highlights both local variations and overarching global patterns:

Focus: To identify cross-national differences in students' openness to immigration (ATTIMM).

Framework: To analyze the influence of socioeconomic status (SES), school diversity, and global competence indicators on students' attitudes toward immigration.

Multilevel Analysis: To incorporate data at the student, school, and country levels, thereby accounting for variance across multiple contextual layers.

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3.3. Feature selection and dimensionality reduction

Statistical algorithms, combined with domain expertise, were employed to preprocess the data and reduce its dimensionality, thereby enhancing the efficiency and interpretability of subsequent analyses.

3.3.1. Data preprocessing

Drawing on prior knowledge—including literature support and the focus on the impact of 55 variables on ATTIMM and their practical significance—a total of eight categories comprising 55 variables potentially influencing ATTIMM were selected. These variables include GCSELFEFF, and GCAWARE, among others, and consist of eight category-level variables alongside 47 item-level variables nested within them.

Table 1. All selected predictors influencing ATTIMM

GCSELFEFF	GCAWARE	INTCULT	PERSPECT	COGFLEX	RESPECT	AWACOM	GLOBMIND
ST196Q02HA	ST197Q01HA	ST214Q01HA	ST215Q01HA	ST216Q01HA	ST217Q01HA	ST218Q01HA	ST219Q01HA
ST196Q03HA	ST197Q02HA	ST214Q02HA	ST215Q02HA	ST216Q02HA	ST217Q02HA	ST218Q02HA	ST219Q02HA
ST196Q04HA	ST197Q04HA	ST214Q03HA	ST215Q03HA	ST216Q03HA	ST217Q03HA	ST218Q03HA	ST219Q03HA
ST196Q05HA	ST197Q07HA	ST214Q06HA	ST215Q04HA	ST216Q05HA	ST217Q04HA	ST218Q04HA	ST219Q04HA
ST196Q06HA	ST197Q08HA	ST214Q02HA		ST216Q06HA		ST218Q05HA	ST219Q05HA
ST196Q07HA	ST197Q09HA					ST218Q06HA	ST219Q06HA
	ST197Q12HA					ST218Q07HA	ST219Q01HA
	ST197Q01HA						ST219Q02HA

Prior to formal analysis, missing data were addressed systematically. Variables with over 40% missing values were excluded from the dataset. For continuous variables, missing values were imputed using the country-specific mean, while for categorical variables, mode imputation was applied within each country group. Subsequently, any remaining missing values were imputed without grouping to ensure data completeness and maintain interpretability at the individual student level.

Given that the study centers on secondary school students' ATTIMM at the country level, individual student and school identifiers were removed. Subsequently, the ATTIMM variable and the 55 selected predictors were aggregated by calculating country-level averages, resulting in a dataset comprising 80 countries. To ensure comparability and enhance the robustness of subsequent analyses, all variables were standardized.

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3.3.2. Dimensionality reduction of data features

Further analysis revealed an excessive number of independent variables, prompting an investigation into their interrelationships. Correlation analysis identified substantial multicollinearity among the predictors. In the accompanying figure, lighter shades of red represent stronger correlations between variables. Notably, category-level variables such as GCSELFEFF, GCAWARE, and INTCULT exhibit high correlations with their respective item-level variables.

This study employs the random forest algorithm for feature dimensionality reduction and prediction of the most influential factors shaping immigration attitudes. By constructing an ensemble of decision trees and aggregating their outputs, this method effectively addresses redundancy and noise in high-dimensional datasets. Moreover, it reduces feature dimensionality while maintaining robust model performance. The algorithm's ability to evaluate the relative importance of each feature in predicting ATTIMM offers a solid foundation for informed feature selection.

Using Recursive Feature Elimination (RFE), the optimal balance between reducing the number of features and maintaining model predictive performance was identified. The analysis revealed that utilizing four variables—RESPECT, ST217Q03HA, ST219Q01HA, and ST219Q02HA—as predictors achieved comparable prediction accuracy to using all 55 variables. Consequently, these four variables can be considered to encapsulate the primary information relevant to predicting the dependent variable ATTIMM. Subsequent correlation analysis among these variables indicated the presence of moderate intercorrelations, as illustrated in the figure below.

To address multicollinearity, principal component analysis (PCA) was employed to transform the four original features into a new orthogonal feature space, thereby eliminating collinearity among them. In this transformed space, each principal component represents a linear combination of the original variables and remains uncorrelated with the others. This approach not only reduces data dimensionality but also ensures independence among the new features, mitigating the adverse effects of multicollinearity on model performance and stability.

Loadings for the four variables, as illustrated in the figure, were calculated to indicate the weight of each variable across the principal components. By selecting components that explain the highest variance, PCA effectively reduces dimensionality while preserving the essential information in the data. Generally, a cumulative variance contribution exceeding 85% is considered sufficient to retain most of the original variables' information. In this study, the first three principal components were selected, achieving a cumulative variance contribution greater than 85%, thereby successfully mitigating multicollinearity and reducing dimensionality among the variables.

The first principal component primarily reflects Respect and Care Ability, the second captures Concern for International Issues, and the third represents Self-Judgment Ability.

Each principal component is typically a linear combination of all original features, meaning that each component contains information from multiple variables. This complexity can make it challenging to interpret the meaning of individual components intuitively. Applying a rotated factor loading matrix enhances interpretability by increasing the loadings of certain features on specific principal components while reducing their loadings on others. This simplified structure facilitates the identification of features that most strongly influence each component, thereby providing a clearer explanation of the data's underlying structure.

The first principal component is:

$$PC1 = 0.6159 * RESPECT – 0.1836 * ST217Q03HA + 0.7213 * ST219Q01HA + 0.2692 * ST219Q02HA$$

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The second principal component is:

$$PC2 = 0.1066 * RESPECT–0.4933 * ST217Q03HA + 0.343 * ST219Q01HA + 0.7268 * ST219Q02HA$$

The third principal component is:

$$PC3 = 0.5698 * RESPECT–0.6561 * ST217Q03HA + 0.1505 * ST219Q01HA + 0.2268 * ST219Q02HA$$

The actual meanings of the four original variables RESPECT, ST217Q03HA, ST219Q01HA, and ST219Q02HA are Perspective taking, giving space to people from other cultures to express themselves, Climate change and global warming, and Global health. In the first principal component, RESPECT and ST219Q01HA contribute most significantly, reflecting attributes of kindness and caring. The second principal component is primarily influenced by ST219Q02HA, with secondary contributions from ST217Q03HA and ST219Q01HA, which together represent international attention. In the third principal component, RESPECT and ST217Q03HA are the dominant contributors, capturing the construct of self-judgment.

3.4. Predictive model and evaluation

Using the three non-collinear principal components obtained after dimensionality reduction as independent variables, and students' ATTIMM scores across 80 countries as the dependent variable, predictive models were constructed. Three machine learning algorithms—Random Forest Regression (RF), Support Vector Machine (SVM), and Gradient Boosting (LightGBM)—were employed for experimentation. Model performance was evaluated using Mean Squared Error (MSE) and R-squared (R^2) metrics. Five-fold cross-validation was conducted to ensure the robustness and reliability of the results. The experimental outcomes are summarized in the following table.

Table 2. Evaluation of three predictive models

Evaluation	SVR	RF	LightGBM
R^2	0.5991	0.5929	0.6109
MSE	0.0176	0.0179	0.0171

The coefficient of determination (R^2) ranges from 0 to 1, where higher values indicate better predictive performance. Conversely, a lower Mean Squared Error (MSE) signifies reduced prediction error. As shown in the experimental results table, all three algorithms demonstrate strong predictive capabilities, each achieving an R^2 of approximately 0.6. Notably, the LightGBM model outperforms the others, attaining the highest R^2 of 0.6109 and the lowest MSE of 0.0171.

The constructed LightGBM model provides valuable insights for understanding and predicting secondary school students' attitudes toward immigration (ATTIMM) across different countries. Even in the absence of national-level ATTIMM data, collecting just four key variables—RESPECT, ST217Q03HA, ST219Q01HA, and ST219Q02HA—allows for highly accurate predictions of students' openness to immigration within a given country.

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4. Results and analysis

4.1. Partial Dependence Plots (PDPs)

To improve the interpretability of the machine learning models, Partial Dependence Plots (PDPs) were generated. PDPs illustrate how predicted student openness to immigration varies with changes in a single feature (or principal component) while holding other features constant. This visualization technique is especially valuable for education policymakers, as it elucidates the marginal effects of key predictors on student attitudes toward immigration.

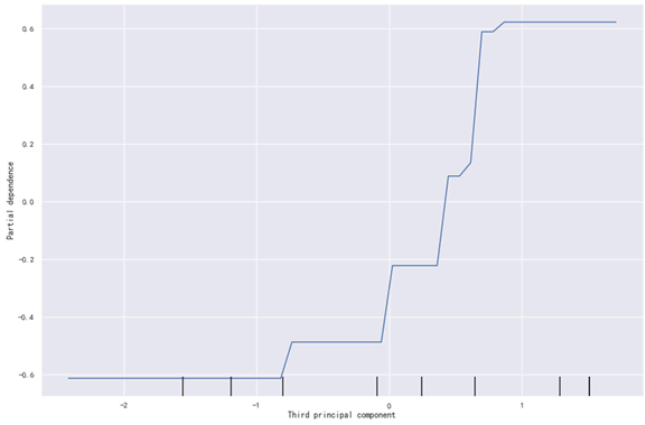

Figure 1. PDP of principal component self-judgment

The above figure shows the partial dependency relationship between the third principal component (PC3) self-judgment and ATTIMM. As self-judgment increases, ATTIMM continues to increase, and self-judgment has a positive promoting effect on ATTIMM. PC1 is also very similar to this situation.

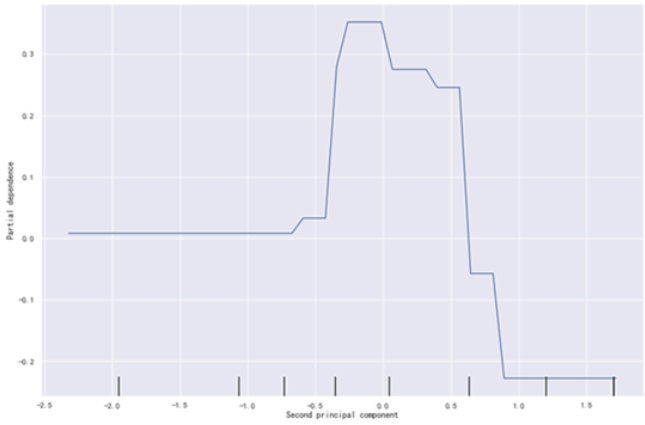

Figure 2. PDP of principal component international attention

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The partial dependence plot illustrates the nonlinear relationship between the second principal component, international attention, and ATTIMM: once attention exceeds –0.7, ATTIMM rises initially, but past an inflection point the effect reverses. At the highest attention levels, predicted ATTIMM falls below the values observed at the lowest levels.

Paradoxically, the inflection contradicts the common belief that greater global awareness naturally translates into a more open stance toward immigration. The PDP suggests that a moderate, almost casual engagement with world affairs corresponds to the most favourable immigration attitudes, whereas those who follow international developments intensely are the ones most prone to oppose immigration. In other words, beyond a certain threshold, heightened exposure to global news —often saturated with conflict, competition, and risk frames—appears to trigger defensive, even exclusionary, responses. Consequently, the group with the very highest international attention scores emerges as the least supportive of immigrant inflows.

4.2. Cross-national comparisons

To investigate secondary school students' ATTIMM across various countries, this study reduced 55 variables into three non-collinear principal components: kindness and caring, international attention, and self-judgment. The LightGBM model constructed using these components demonstrated strong predictive performance for ATTIMM, indicating that these three dimensions are critical determinants of secondary students' attitudes toward immigration at the national level. The specific prediction results are presented below.

Table 3. Summary of prediction results for all 80 countries

CNT	Pred	CNT	Pred	CNT	Pred	CNT	Pred
ALB	0.2675	ESP	0.2675	LBN	-0.1205	QAT	0.0557
ARE	0.1260	EST	-0.1525	LTU	-0.1163	QAZ	-0.2452
ARG	-0.0193	FIN	0.0762	LUX	0.0557	QCI	0.0798
AUS	0.2675	FRA	0.1787	LVA	-0.3437	QMR	-0.2616
AUT	-0.0981	GBR	0.1680	MAC	-0.1652	QRT	-0.3437
BEL	0.1005	GEO	0.0557	MAR	-0.1359	ROU	-0.1735
BGR	-0.3437	GRC	-0.0847	MDA	-0.0151	RUS	-0.3437
BIH	-0.2035	HKG	-0.0026	MEX	0.1748	SAU	-0.2359
BLR	-0.2814	HRV	-0.0147	MKD	0.0153	SGP	0.2102
BRA	0.0183	HUN	-0.2814	MLT	0.1191	SRB	-0.2871
BRN	-0.2768	IDN	-0.1796	MNE	-0.0216	SVK	-0.3437
CAN	0.2675	IRL	0.1442	MYS	-0.2768	SVN	-0.3340
CHE	0.0708	ISL	0.0419	NLD	0.1005	SWE	0.0557
CHL	0.1013	ISR	0.1013	NOR	0.0762	TAP	0.0442
COL	-0.0847	ITA	-0.2814	NZL	0.2459	THA	-0.1285
CRI	0.1855	JOR	-0.0637	PAN	0.1124	TUR	-0.0173
CZE	0.0798	JPN	0.0798	PER	0.1267	UKR	-0.1735
DEU	0.0708	KAZ	-0.2570	PHL	-0.1728	URY	0.0761
DNK	0.0798	KOR	0.2493	POL	-0.2814	USA	0.0557
DOM	0.0008	KSV	0.0203	PRT	0.2675	VNM	-0.2814

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Although the overall trends are consistent across multiple countries, notable variations emerge. Countries that prioritize social welfare, inclusive curricula, and equity measures—such as some Scandinavian nations—generally exhibit higher average ATTIMM scores. In contrast, regions experiencing economic difficulties or sudden, large-scale immigration influxes tend to show lower predicted levels of openness. These cross-national differences highlight the necessity of contextualizing youth attitudes within their broader political and socioeconomic environments.

5. Conclusion and discussion

This study demonstrates that secondary school students' openness to immigration (ATTIMM) varies significantly across national and regional contexts. Countries or regions characterized by robust social welfare systems, culturally inclusive curricula, and stable economic conditions tend to exhibit higher average ATTIMM scores. Conversely, those facing economic instability, limited educational resources, or rapid demographic shifts often report lower levels of openness. The findings highlight the interplay of student-level, school-level, and macro-level factors in shaping these attitudes. In particular, adolescents' respect for others, openness to cross-cultural expression, and concern for global challenges—such as climate change and global health—emerged as pivotal predictors. Additionally, socioeconomic status, school diversity, and cultural exposure collectively influence students' receptiveness to immigration issues. These results underscore the crucial role of supportive educational policies and environments in fostering inclusive and empathetic attitudes toward immigrants among future generations.

While this study provides valuable insights into adolescents' openness to immigration, several limitations warrant consideration from a comparative education perspective. First, the dataset's uneven regional representation and relatively small national samples in some areas limit the generalizability of the findings. Future research should include a broader range of regions, particularly those experiencing large-scale migration, to better capture diverse global contexts. Second, the cross-sectional design restricts the ability to examine how evolving labor markets or political climates influence students' attitudes over time. Longitudinal or mixed-methods approaches would offer a deeper understanding of the causal impacts of policy reforms, economic fluctuations, and cultural discourses. Third, while quantitative models offer a valuable macro-level perspective, they may overlook important local and contextual nuances. Qualitative methods, such as interviews or case studies, could provide richer insights into how specific schools and communities interpret and respond to global trends. Finally, incorporating a wider array of comparative indicators—such as language policies and teacher training in multicultural education—could further elucidate the complex ways globalization shapes curriculum development, pedagogical practices, and adolescent identity formation.

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