

Multilingual Education in Hebi City: Regression Analysis of Academic Impact and Policy Implications

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Abstract. This paper employs an empirical approach through mathematical modeling and software implementation to analyze the impact of multilingual education on student performance in Hebi City. By constructing a regression model and utilizing statistical software for data analysis, we quantitatively evaluate how multilingual education influences academic achievements. The findings are visualized through clear, effective charts and graphs, enabling a straightforward interpretation of complex data. The results of these models not only reinforce the significance of multilingual education but also serve as a critical tool in guiding policy recommendations. This research aims to provide actionable insights for policymakers to enhance educational strategies and improve the overall efficacy of multilingual education programs in Hebi City.

Keywords: Multilingual Education, Hebi city, Policy Implications, Academic Impact.

1 Introduction

Modern approaches have also focused on the necessity to develop the multilingual educational environment in recent years. Only a few years back, the practice of translanguaging in particular has proved to be beneficial in different contexts as a teaching approach. This shift is a reminder to disrupt monolingualism in education or when using translanguaging in the different environments. Therefore, in the context of multilingualism and education, preservice teachers should be trained in working with multilingualism and containing a certain variety of translanguaging across their learning practices.

Ghajarieh and Aghabozorgi study from 2024 also touches upon the need for the subject-specific preservice teacher preparation and training in the field of translanguaging and teaching and learning material design in multilingual contexts. Frail et al. 's study, which included 117 preservice teachers, identified commonalities of the produced material to elucidate the developmental concerns of infant and primary educators within contextuate education frameworks[1].

In a similar vein, Orcasitas-Vicandi and Perales-Fernandez-de-Gamboa (2024) have examined the enactments of promoting pedagogical translanguaging into preservice teacher education[2]. They also assessed material design for multicultural environments, especially for cases with KRM languages. They emphasis knowledge and skills to help teachers manage multilingual context and, thereby, work towards improvement of the quality of education delivery.

Continuing with the issue of multilingual education, Barruga (2024) have provided a case study of the Mother Tongue-Based Multilingual Education (MTB-MLE) policy in the Philippines for the school-year 2017-2018 to show the reality of multilingual education in practice[3]. Having assessed existing research, some of the problems mentioned included lack of materials and difficult implementation of education policies and also acknowledged possibilities for strengthening the cultural relationships and improving the understanding of other cultures through the first language education.

In general, it seems to emphasize the significance of multilingual education and symbolise the need for proper training and policy service. The given study intends to review the given progress of multilingual education in Hebi, the Henan province, China to determine the extent of multilingual practice among students and teachers including the effect of deploying multilingual practice in both urban and rural schools. By identifying the experiences and accomplishments of multilingualism promotion, this study will give a clearer understanding of the barriers and enablers when the education system mainly supports the delivery of a single language. It is hoped that through the analysis of the experiences of the educators and students expressed in this research, a valuable addition to the body of knowledge on implementing and recognising multilingual education in various contexts is afforded.

2 Research Methodology

2.1 Mathematical Model

To quantitatively assess the impact of multilingual education on academic performance, we developed a regression model. The model is specified as follows: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \epsilon$

Where:

Y represents students' academic performance.

X1 denotes the level of multilingual education received by the students.

X2 reflects the extent of students' participation in extracurricular language activities.

β_0 , β_1 , β_2 are coefficients representing the baseline performance and the impact of the respective variables on academic performance.

ϵ is the error term, accounting for the variation in academic performance not explained by the model.

2.2 Software Implementation

For the empirical analysis, we utilized Python, a powerful tool for statistical data analysis. The process involves data loading, preparation, model fitting, and results output, ensuring robust analysis that provides clear insights into the impact of multilingual education on student success. The use of Python enhances the reliability of the findings, allowing for detailed scrutiny of the data and facilitating the projection of educational outcomes based on current strategies.

3.Computational Implementation and Data Analysis

In the modern educational environment, the importance of multilingual education is increasingly evident. Fuster and Bardel indicate that there is an inseparable relationship between language and culture, and plurilingual awareness significantly enhances intercultural communicative competence. Their study found that plurilingual awareness is not only a strong predictor of the relationship between language and culture but also improves intercultural communicative practices in the classroom, such as translanguaging as a motivational practice, coping with intercultural tensions, and using technology in multilingual classrooms[4]. Decristan et al. explored the impact of translanguaging instruction on the teaching quality in multilingual elementary school classrooms. By analyzing data from 48 classes and 865 students, the study provided empirical evidence that translanguaging instruction can enhance teaching quality and increase students' positive perceptions of teaching, thereby strongly supporting the implementation of translanguaging in multilingual classrooms[5].

3.1 Data Collection

To ensure the objective assessment of the various effects of multilingual education in Hebi City, the research used the following structured data collection tools. Both online and offline questionnaires were completed to include the preferences of the respondents within the target population including students, teachers, and parents. These surveys employed both closed and open-ended questions to gather quantitative response data on the status of multilingual education, and language-related outside-school learning activities and performance. Similarly, there was conduct of quantitative research that followed by qualitative studies to realize the perceptions of the stakeholders. Appropriate self-selection was also applied as a method of choosing the samples and the target population consisted of five middle schools of Hebi City to provide high levels of generality and variability of the sample. Adapting to synchronous and asynchronous online tools, as well as using paper questionnaires allowed to reach more participants and ensure data reliability. This approach is consistent with the findings of contemporary researches that underlined the necessity of applying mixed methods of data collection in given Multilingual Education environment.

3.2 Quantitative Analysis

For quantitative data, we used Python to go through the necessary data cleansing steps and data analyses methods. This involved data cleaning, preparation for the model, estimating the regression model using the stated model and the production of results. These steps ensured that the researcher obtained holistic results indicating the impacts of multilingual education besides extra-curricular activities on academic performance.

3.3 Data Visualization

Data visualizations play a vital role when presenting analyses of big data and creating meaningful insights and interfaces for the audience. Concerning the visualization strategy used in this research, it was important to choose the method suitable for the study to explain its results linked to the impact of the implemented policies and the relationship between multilingual education, extracurricular activities, and academic performance in Hebi City. To clearly present the impact of multilingual education on student outcomes, we employed

various visualization techniques: To clearly present the impact of multilingual education on student outcomes, we employed various visualization techniques:

3.3.1 Scatter Plots

These plots help show the relationship between levels of ME and results with a stronger function in education including academic performance. This is because by displaying the data points along the marked regression line, as presented in Fig. 1, the strength and direction of the relationship can be effectively conducted.

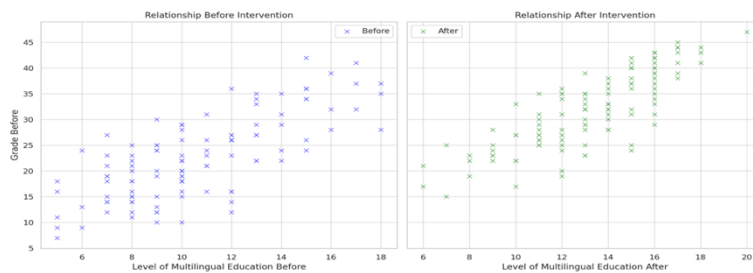


Fig. 1. Academic Grades vs. Multilingual Education Levels Before and After Intervention

Fig. 1. In the picture from the Previous condition, the direct correlation depicts the level of MLE on the first year of teaching and academic performance before any alterations had been made to the program. Fig. 1. The relationships of these two variables before and after intervention are displayed in Figure 3: Changes in (After Intervention) show that there was a general improvement of the grades after intervention though depending on the level of multilingual education.

3.3.2 Bar Graphs

In the case of comparing results prior to the adoption of educational reforms with results obtained after the reforms had been effected, bar graphs were used. The Fig. 2. most effectively compare the changes in attainments per subject and activity enrolments and failures, presented before and after the intervention.

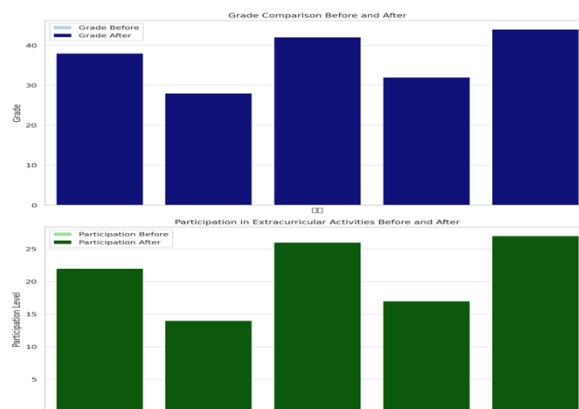


Fig. 2. Academic Grades and Participation in Extracurricular Activities Before and After Intervention

Fig. 2. (Grade Comparison) which visualize selected students ‘previous (light blue) and subsequent (dark blue) academic performance to help in analyzing the effects of multilingual education policies on the target students. Fig. 2. To assess how the level of participation in extracurricular language activities has changed, (Authors: Light Green experiences as compared to Dark Green experiences), the accompanying Participation in Extracurricular Activities highlights the level of student participation before the intervention and the level of participation after the intervention for the same students.

3.3.3 linear regression plot

The Fig. 3. utilizes blue dots to represent data points, each illustrating the relationship between students' levels of multilingual education and their academic performance.

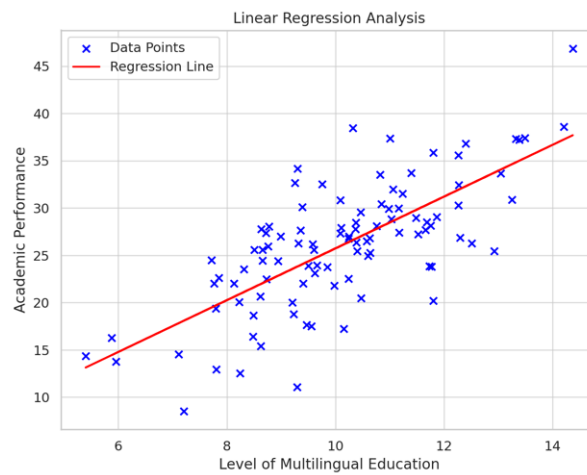


Fig. 3. Academic Performance vs. Multilingual Education Level

Fig. 3. (Blue Dots) represent the relationship between students' levels of multilingual education and their academic performance. Fig. 3. (Red Line) indicates the predicted linear relationship between the levels of multilingual education and academic performance.

4. Results

4.1 Model Findings

The analysis of the regression results proves the existence of a strong and direct relationship between the extent of multilingual education that has been implemented and the academic performance of the students. Regarding this, the graph below showing the linear regression of the results put forward a positive regression line though was not too steeper but the general trend demonstrates a positive correlation between multilingual education and improvement in academic grades. The findings that were revealed by the regression coefficients also confirmed the hypothesis, pointing at the statistical significance of the multilingual education ‘s positive effects on students.

4.2 Visualization Insights

4.2.1 Before and After the Intervention Graph in the Style of a Scatter Graph

The graphs labeled “Before” and “After” intervention for two variables – ‘multilingual education’ and ‘academic performance’ show a significant change in correlation. Firstly the data points in the “Before” plot are more scattered and there is a larger variation in grades attained from students with similar levels of education. The “After” plot indicates improved concentration of higher grade points at higher levels of education, and thus the study suggests that the intervention probably improved the multilingual education intervention or better aligned the students’ performance unto their levels of education.

4.2.2 Bar Graphs for Grad Comparison and participation

The bar graphs provide a straightforward comparison of the fraction of the total marks obtained in the academics and the part of the total time dedicated to the extra-curricular activities before and after the intervention. Albeit general, it is noticed that students’ academic performances or, at the very least, their willingness to contribute in class pale in comparison to their previous levels in most cases after an intervention. This may imply not only the improvement in the academic results but also the distinctions in the participation of students in various activities outside class, therefore correlating to the overall educational gains observed.

4.2.3 Integrated General Contribution to Educational Policy Formation

From the quantitative analysis including the regression analysis and the results from the scatter plots, there is enough reason to believe that the policy changes that have been undertaken to promote the use of multilingual education in the United States of America have been enhancing the cause. It is knowledge that is very essential to policymakers and educational administrators since it offers direction where and how change in strategies can be offered to enhance learning outcomes of students.

5. Conclusion

This paper also employ qualitative approach and quantitative analysis and computer programs to investigate the effectiveness of multilingual education in Hebi City on the students’ performance. It is necessary to give significant attention to translanguaging instruction to adapt to the challenges of each society[6]. Quantitative analysis of the impact that multilingual education has on academic performance was done by using a structured regression model, and statistical software to support the analysis of the results presented graphically by the use of charts. The results outlined highlight the importance of multilingualism and these findings are valuable knowledge regarding policy suggestions.

Another type of data and data collection included quantitative data collected through paper-pencil online and offline surveys done to students, teachers, and parents to determine the extent of multilingual education, extracurricular language activities, and academic performance. Pre-testing and random sampling of the target population across five different middle schools in Hebi City ensured generalisability. Teachers need more professional knowledge[7]. As seen in the following section, the mixed-methods approach that employed

both quantitative and qualitative data fits well into the current research because it finds ways of integrating the methods in order to capture the dynamic and multilayered nature of the multilingual education contexts as highlighted by current research .

The research findings indicate that implementation of multilingual education enhance students' academic scores as supported by quantitative information and data visualization. Promoting developments in multilingual education correlated with positive changes in results in academic work, and the greater involvement in other extracurricular language activities also led to higher academic achievements and all round abilities of students[8]. This accredits the hypothesis showing the relationship between multilingual education and positive results as well as supply a background that enables the policymakers to maximize the education strategies.

Furthermore, the data presented also affirms more to the hypothesis that multilingual education enhances academic results to actually give educational policymakers a foundation on which to modify and encourage measures of educational effectiveness, particularly in the case of multilingual education to positively transform education quality and learner performance[9]. In terms of the implication of the result of this study, it is suggested that the Hebi City's educational policymakers keep on enhancing and strengthening the multilingual education programs to produce student with stronger competitiveness in the international scene and with better ability to intergerate into the global culture.

In conclusion, one could state that ML education is especially relevant in the present world where globalization is viewed as one of the most significant tendencies. This paper has also illustrated the special case of Hebi City to show how Multilingual Education has a great impact on boosting the performance of students which is a recommendation and model that other regions and countries may embrace. All the above indicates that in order to realise the above mentioned outcomes it was important to negate monolingualism among teachers and to make educational translanguaging context sensitive [10].

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