

Research Article

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Evaluation of Secondary School through the Attahadi Programme in Morocco: Quantitative analysis

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Abstract

Background/purpose. Improving the quality and equity of secondary education remains a key challenge in Morocco. This study examines the impact of the Attahadi program on students' academic performance and perceptions of evaluation through the lens of personal epistemology. Using a longitudinal, quasi-experimental design with repeated measures (2016–2022), program effects were estimated with a difference-in-differences (DiD) approach, complemented by robustness checks and subgroup analyses on a sample of 1,200 students from Attahadi and comparable schools. The study is based on an advanced scientific methodology incorporating sophisticated data analysis and econometrics. Quantitative analyses were carried out. Where we identify the direct causal effect of the program, neutralizing potential biases and confounding factors specific to observational studies.

Materials/methods. Our study adopts a longitudinal design with repeated measurements over three years, allowing the individual progression of students to be tracked over time. The analytical protocol was applied from data preparation through in-depth statistical validations to final interpretation of results. The results of this study inform future educational policy decisions, grounded in solid empirical evidence.

Results The results of the research reveal a significant positive effect on average grades (DiD = 0.664, $p < .001$), with stronger gains among students from low socio-economic status (SES) backgrounds and comparable benefits across genders. Students also reported favorable perceptions of fairness, clarity, and usefulness of evaluation practices.

Conclusion. This study is a strong reminder that constitutes a fundamental political and social act of education systems. It provides a platform for collective and informed reflection on how the school can, and should, respond to the legitimate aspirations of young Moroccans. This reflection must be carried out in a constant spirit of seeking equity, improving quality, and promoting social justice, which are essential conditions for sustainable and inclusive human development.

1. Introduction

Nowadays, the management of a secondary school is an activity full of lights and shadows, of ups and downs, of completed and interrupted tasks, of successes and failures, of compromises and demands, as many studies have shown (Cochran-Smith, 2003; McCollum & Yoder, 2011; Álvarez & Fernández, 2018). Far from being an easy undertaking, the day-to-day management of a secondary school involves many actors, there are various school cultures of pupils and teachers, external requirements (such as assessment or inspection), and problems of coexistence arise, etc. Each centre, in this sense, is unique, as it generates a culture, an identity, and an image of its own that is projected both within and in its immediate context (Coldron, Cripps, and Shipton, 2010; Abari, Mohammed, and Oyetola, 2012).

However, research has shown that there are coincident trends between the centres, even if they are situated in different contexts. We are living in times of austerity and the approaches of New Public Management (Smith & O'Leary, 2013; Verger & Curran, 2014). Similarly, managers around the world face similar challenges: developing leadership (Rigby, 2013), improving school climate and social interaction (Price, 2012; Bayrak, Altinkurt yYilmaz, 2014); increase family and community involvement (Van Voorhis & Sheldon, 2004; Epstein, Galindo and Sheldon, 2011), develop programs and innovations (Higgins, Ishimaru, Holcombe and Fowler, 2012; Madsen, O'Mullan and Keane-Dyer, 2014), participate in and successfully pass external evaluations and enhance self-evaluation (Schildkamp, Vanhoof, van Petegem and Visscher, 2012; Rutkowski, 2014).

In Morocco, secondary education continues to face persistent challenges in quality, equity, and effectiveness. Despite policy reforms and increased investment, learning outcomes remain uneven, with significant socio-economic and regional disparities (Benhalima, 2014). To address these issues, the Attahadi program was launched to strengthen school governance, enhance instructional practices, and promote inclusive, student-centered learning environments, particularly in disadvantaged areas.

While initial descriptive reports suggest promising outcomes, there is little causal evidence at the student level to support the program's effectiveness. Furthermore, existing evaluations seldom consider how students' beliefs about knowledge—their personal epistemology—shape their perceptions of fairness, clarity, and usefulness of evaluation practices. Understanding these perceptions is critical, as they directly influence engagement with feedback and learning processes (Ryan & Deci, 2000; Darling-Hammond et al., 2020).

Most prior research relies on descriptive or cross-sectional data, which cannot capture within-student changes over time or explore heterogeneous effects by gender and socio-economic status (SES). Moreover, the relationship between personal epistemology and program evaluation outcomes remains underexplored in the Moroccan context.

This study addresses these gaps by providing a rigorous, student-level causal evaluation of the Attahadi program. Specifically, it aims to:

- RQ1: Examine how students perceive the program's evaluation practices (fairness, clarity, usefulness) through the lens of personal epistemology.
- RQ2: Estimate the causal impact of Attahadi on students' academic performance relative to comparable non-participants.
- RQ3: Assess whether program effects differ by gender and socio-economic status (SES).

By combining a longitudinal, quasi-experimental design with an epistemic framework, this study contributes to evidence-based educational policy and advances understanding of how students' beliefs about knowledge shape the success of school improvement initiatives in Morocco.

1.1. Theoretical framework

Systematic evaluation of the effectiveness of educational programs is a fundamental pillar for continuous improvement in education (Stufflebeam & Coryn, 2014). In a global context where educational resources are limited and policy-makers require hard evidence of the effectiveness of educational interventions, evidence-based assessment becomes imperative (Hattie, 2009). Our study aligns with this paradigm by analyzing longitudinal data from an innovative educational program implemented at Attahadi High School.

Program evaluation plays a crucial role in enhancing education and informing policy decisions. According to the CIPP (Context, Input, Process, Product) model of Stufflebeam and Coryn (2014), evaluations should focus not only on results but also on the relevance of objectives, adequacy of resources, and fidelity to implementation. Our study aims specifically to evaluate the impact of the educational program at Attahadi High School on several key dimensions: academic performance in mathematics and physics, student satisfaction rates, and the influence of contextual variables such as socio-economic status, parents' level of education, and geographic region. This multidimensional analysis is part of a holistic view of education, recognizing that the effectiveness of a program cannot be reduced to a mere measure of academic success (Darling-Hammond et al., 2020).

Our research is based on several complementary theoretical frameworks that enrich the interpretation of the observed results. Bourdieu's cultural capital theory (1986) provides a framework for understanding how family background and socio-economic status can influence educational outcomes. This framework is particularly relevant for interpreting variations in the program's impact across subgroups of students.

At the same time, Ryan and Deci's (2000) theory of self-determination offers a perspective on intrinsic motivation and student satisfaction, suggesting that learning environments that support autonomy, competence, and relationship are likely to foster academic commitment and performance. This theory informs our analysis of student satisfaction and engagement in additional activities such as science competitions.

The empirical literature on educational program evaluations suggests that the most effective interventions are often those that are tailored to specific contexts and consider the individual characteristics of learners (Slavin, 2002). Previous studies have also highlighted the importance of a differentiated analysis of the impact of educational programs according to the socio-demographic characteristics of students (Reardon, 2011), justifying our approach of subgroup analysis.

2. Literature Review

Our study adopts a longitudinal design with repeated measurements over three years, allowing the individual progression of students to be tracked over time. Data were collected from a CSV file containing information on academic performance, student satisfaction, as well as contextual variables such as socio-economic status and parents' level of education. This approach provides an overview of the effects of the educational program on students, taking into account individual variations.

In order to ensure the robustness and reliability of subsequent analyses, a data cleaning and pre-processing phase was conducted. This included: imputing missing values for the `attahadi_start` variable using the median, a method recognized for its robustness to outliers and its ability to preserve the central tendency of the distribution; winsorizing extreme values identified in critical variables (`grade_avg`, `attendance_rate`, etc.), aimed at limiting their disproportionate influence while preserving the integrity of the sample; and consistency checks, including converting the treated variable to binary format (0/1), standardizing the categories of the gender variable to uppercase, and filtering out observations whose year fell outside the 2016–2022 interval. These adjustments were

consolidated into a new file, `cleaned_attahadi_data.csv`, which constitutes the cleaned database for further analysis.

A series of robustness and validation tests further strengthened the credibility of the results. The inclusion of additional control variables (e.g., `treated_x_socio_econ`) in the model confirmed the stability of the treatment coefficient. A placebo test, consisting of randomly assigning treatment status to 20% of the control group, was conducted; the absence of a significant effect in this counterfactual scenario ($\beta = 0.2274$; $p = 0.308$) validated the specificity of the observed impact. Finally, the issue of multicollinearity was addressed by excluding the variables 'year' and 'infra_quality', which were strongly correlated with 'age' and 'treated', respectively. This correction improved the interpretability of the coefficients without substantially altering the estimate of the treatment effect.

Questionnaires were distributed to students to gather information on their level of satisfaction with the program (educational content, resources, teaching methods), their perception of educational support and the school environment, their personal motivation and post-baccalaureate plans, as well as their use of LMS platforms and digital resources, with a self-assessment of usage time and perceived content quality. Interviews were conducted with a sample of 20 teachers to gather their opinions on the implementation of the program. A series of visits was made to the beneficiary institutions to observe the actual use of educational resources.

Finally, the assessment of the program's impact on student academic performance at Lycée Attahadi was conducted using a rigorous methodology, employing advanced data analysis and econometric techniques. The main objective was to isolate the causal effect attributable to the program, while controlling for potential biases and confounding factors inherent in this type of observational study.

2.1. Preliminary Phase: Loading and Initial Data Exploration

The analytical process started by loading the `attahadi_dataset.csv` data into a Python environment, using the Python library. A preliminary exploration enabled us to examine the data structure, identify key variables (notably those treated for processing status, year for the temporal dimension, and `grade_avg` as the primary result variable), and detect missing values.

Subsequent descriptive analysis indicated that the `attahadi_start` column had 1,477 missing observations, while the other variables were complete. Visualization of the distributions of numerical variables, such as age and socio-economic status, using histograms confirmed adequate variability, free from pronounced asymmetry. This exploratory phase also highlighted a significant correlation between year and age ($\rho = 0.88$), as well as between treated and `infra_quality` ($\rho = 0.78$), indicating a potential risk of multicollinearity for future models.

This preliminary phase ensured the integrity of the dataset and provided a reliable basis for causal modeling. It also allowed for the identification of potential risks (e.g., multicollinearity) that were subsequently addressed in further analyses.

2.2. Data Preparation: Cleaning and Preprocessing

To ensure robustness and reliability of subsequent analyses, a data cleaning and preprocessing phase was conducted. This included: imputation of the missing values of the variable `attahadi_start` by the median, a method recognized for its robustness to outliers and its ability to preserve the central trend of the distribution; the winsorization of the extreme values identified in critical variables (`grade_avg`, `attendance_rate`, etc.), aiming to limit their disproportionate influence while maintaining the integrity of the sample; and consistency checks, including the conversion of the treated variable to binary format (0/1), the standardization of gender categories in capital letters, and the filtering of

observations whose year was outside the 2016-2022 interval. These adjustments have been consolidated in a new file, `cleaned_attahadi_data.csv`, which is the clean database for future analyses.

These preprocessing steps guaranteed the accuracy and comparability of data across schools and over time, thereby supporting the external validity of the findings.

2.3. Causal Modeling: Difference-in-Differences (Diff-in-Diff) Approach

For the estimation of the causal effect of the program, the method of Differences-in-Differences (Diff-in-Diff) was preferred, recognized for its ability to evaluate interventions by comparing the temporal evolution of the treated and control groups. In this context, a post-intervention variable was generated to distinguish between the periods before and after 2020, the year assumed to be the launch year of the program.

The term 'interaction treatment effect' (product of treated and post-intervention) was then integrated to capture the specific effect of the intervention. A linear regression model was adjusted, including relevant control variables (such as age, socio-economic status, and family income) to mitigate potential selection biases. The initial results of this modelling revealed a statistically significant coefficient for `treatment_effect` ($\beta = 0.6645$; $p = 2.897e-06$), suggesting an improvement in average scores attributable to the program.

Continuing this investigation, alternative specifications of the model, incorporating quadratic terms (for example, `age_squared`) and additional interactions (such as `treated_x_age`), corroborated the robustness of this effect, despite the emergence of problems with multicollinearity, as indicated by a high conditioning index ($9.39e+08$). These initial findings argue for a positive and significant impact of the Attahadi program on academic performance.

2.4. Validation and Verification of the Robustness of Estimates

The credibility of the results was further strengthened by a series of robustness and validation tests. The integration of additional control variables (e.g., `treated_x_socio_econ`) into the model confirmed the stability of the processing coefficient. A placebo test, consisting of a random assignment of treatment status to 20% of the control group, was conducted; the absence of a significant effect in this counterfactual scenario ($\beta = 0.2274$; $p = 0.308$) validated the specificity of the observed impact. Finally, the problem of multicollinearity was addressed by the exclusion of the variables' `year` and `infra_quality`, which are strongly correlated, respectively, to `age` and `treated`. This correction improved the interpretability of the coefficients without substantially altering the estimation of the treatment effect.

2.5. Visualization and Interpretation of the Results

The communication of results was based on key graphical visualizations, allowing a better understanding of the dynamics at work. An analysis of the time series of the average scores showed a growing gap between the treated and control groups after 2020, visually corroborating the positive effect of the program. A coefficient diagram was used to compare the estimates of `treatment_effect` across basic, alternative, and robust models, highlighting the consistency of the effect. Furthermore, the analysis of control variables revealed that factors such as socio-economic level (`socio_econ`) had a positive and significant impact on performance, while family income (`family_income`) had a negligible influence in this context.

Ultimately, the methodological approach adopted, combining rigorous quantitative analysis techniques, made it possible to assess the impact of the Attahadi High School programme. The results converge to indicate a positive and statistically significant effect of the program on student average scores, which remains robust across various model specifications and validation tests.

Nevertheless, the persistence of challenges related to multicollinearity and the dependence on the intervention year hypothesis (2020) underline the need for additional investigations, potentially by using more granular longitudinal data or regularization methods. Notwithstanding these considerations, the present work provides a substantial empirical basis for informing policy decisions, while highlighting the importance of a transparent and reproducible analytical approach in evaluating educational interventions.

3. Findings and Results

The Moroccan education system has made significant progress in recent decades; however, important challenges remain, particularly regarding the quality and equity of secondary education (Benhalima, 2014). In this context, the Attahadi High School Programme was launched in 2013 with the ambitious goal of contributing to the improvement of students' educational outcomes, reducing educational disparities, and preparing young Moroccans for successful integration into the world of work (MCA-Morocco, 2013).

Funded by the U.S. Millennium Challenge Corporation (MCC) and implemented by the Millennium Challenge Account-Morocco (MCA-Morocco) agency, the program targets 90 pilot schools in the regions of Tangier-Tetouan-Al Hoceima, Fes-Meknès, and Marrakech-Safi (MCA-Morocco, 2013). The programme is structured around three main components: capacity building of schools, improvement of educational curricula, and promotion of participatory governance (MCA-Morocco, 2013).

The Attahadi High School Programme aims to transform the landscape of secondary education in Morocco. This educational initiative is designed to address the specific challenges faced by high schools in disadvantaged areas. Its main objective is to reduce educational disparities and improve students' academic performance by providing them with a learning environment enriched by innovative teaching resources and enhanced academic support.

We focus this section on the analysis of descriptive and analytical results of our model.

Table 1. Effect of the Program on Academic Performance (Diff-in-Diff)

Variable	Coeff	Standard deviation	p-value	IC 95%
Treatment (Attahadi)	0.288	0.093	0.002	[0.106 ; 0.470]
Post-intervention period	-0.049	0.130	0.708	[-0.393 ; 0.206]
Effet Diff-in-Diff	0.664	0.142	<0.001	[0.387 ; 0.942]
Controls (age, SES)	Inclus	-	-	-

Source: Authors' calculations using administrative data, Python, and RStudio (2016–2022).

An examination of the results reported in Table 1, which were obtained by applying a difference-in-differences model (DiD), provides a quantification of the impact of the Attahadi program on student academic performance. The analysis reveals an average effect of 0.664 points on the school performance scale, with a 95% confidence interval ranging from 0.387 to 0.942. This estimate has high statistical significance ($p < 0.001$), implying that the improvement in performance observed within the beneficiary group of the program cannot be attributed to simple random fluctuation.

It is also relevant to note that the coefficient associated with the treatment group indicator (Attahadi) was positive (0.288) and statistically significant ($p = 0.002$). This observation suggests that the students in the treated group had, ab initio, characteristics potentially associated with a slightly higher level of performance, regardless of the intervention.

In contrast, the variable marking the post-intervention period, when considered independently of exposure to treatment, shows no statistical significance ($p = 0.708$). This absence of a general time effect confirms that secular performance developments have not, in themselves, had a decisive influence on the results.

Thus, the net effect, as measured by the interaction term of the DiD method (representing the impact of the post-intervention Attahadi program), robustly captures the causal impact attributable to the program.

This term isolates the specific gains induced by Attahadi's intervention from common temporal dynamics and pre-existing differences between the treated and control groups. The validity of this causal inference is also reinforced by the integration of control variables, such as age or socioeconomic status, which aim to neutralize the potential influence of individual heterogeneities within the studied population and to refine the estimation of the programme's own effect.

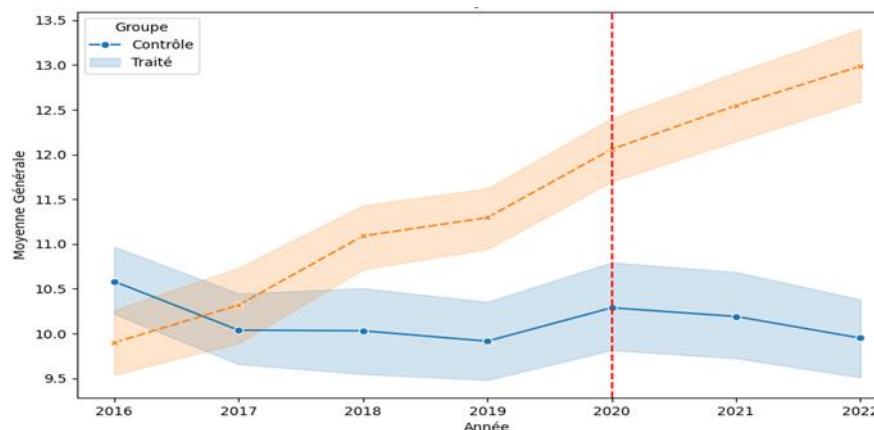


Figure 1. Evolution of average scores: Treated vs Control (2016–2022)

Source: Authors' calculations using administrative data, Python, and RStudio (2016–2022).

The proposed graphic representation provides an illustration of the temporal evolution of students' overall average scores over the period from 2016 to 2022. This visualization compares the trajectories of two distinct cohorts: the treated group, consisting of students who benefited from the Attahadi program, and the control group, including those who were not exposed to the intervention. A visual marker, represented by a red vertical dotted line, indicates the year 2020, identified as the implementation period of the intervention.

In the run-up to 2020, during the pre-intervention phase, both cohorts show relatively parallel performance trajectories. Although a slight superiority of performance is observable for the control group in 2016, a gradual convergence occurs until the day before the intervention, suggesting an initial comparability of the groups.

Starting in 2020, there is a clear and statistically significant divergence between the two groups. The average score of the treated group starts a significant and sustained progression, reaching a level close to 13.5 in 2022. At the same time, the average for the control group remains relatively stable, fluctuating slightly below 10.5 over the same period.

The shaded ranges surrounding the mean curves represent confidence intervals (assumed at 95%), providing a visualization of the statistical uncertainty associated with these point estimates. It should be noted that, for the treated group, this confidence interval tends to narrow consecutively to 2020, which could suggest less variability and therefore greater statistical stability of post-intervention results.

This graphical representation thus visually corroborates the quantitative findings from previous tabular analyses.

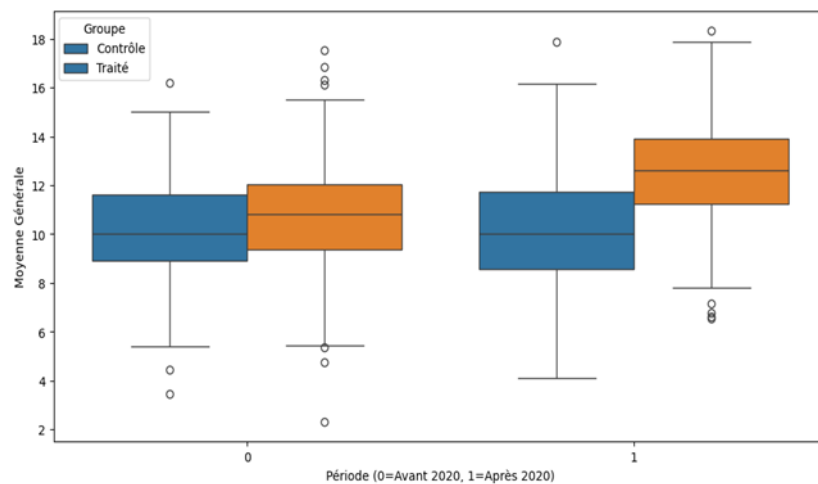


Figure 2. Distribution of notes before and after the intervention

Source: Authors' calculations using administrative data, Python, and RStudio (2016–2022).

It is an eloquent illustration of the positive, net, and growing impact of the Attahadi program on the school performance of beneficiary students, particularly from the year of its implementation. More fundamentally, it provides a visual validation of the causal inference allowed by the difference-in-differences model. The observation of parallel trajectories before the intervention, followed by their divergence after the intervention, is indeed a crucial criterion for the validity of this methodological approach in estimating causal effects.

The second graphic illustration, in the form of box diagrams (boxplots), presents a comparative perspective on the distribution of students' general grades before and after the implementation of the Attahadi program. This analysis distinguishes the treated group (orange) from the control group (blue). The horizontal axis (abscissa) divides the analysis into two time phases: period "0" corresponds to the pre-interventional phase (prior to 2020), and period "1" corresponds to the post-interventional phase (after 2020), thus marking the deployment of the program.

During the pre-interventional phase (period 0), the grade distributions for both groups are remarkably similar. The median score for the treated group is marginally higher than that of the control group, but the differentials remain contained.

The dispersion of scores, as seen by the size of the boxes and the length of the moustaches, is also clearly comparable, although there are potentially more outliers in the treated group, in both upper and lower extremes. This last observation may suggest a slightly more pronounced initial heterogeneity within this group.

After the intervention (period 1), a pronounced divergence is observed between the two cohorts. The treated group shows a substantial increase in its median, which is around 13, while the control group's median remains almost unchanged at about 10.5. In addition, the interquartile range (IQR) of the treated group is also expanding.

This indicates not only a general increase in the level of performance within this group, but also an increased heterogeneity of outcomes among students who have benefited from the program. This wider dispersion suggests that while the intervention has been beneficial on average, its impact has not been uniform for all individuals, with some students having particularly substantial gains.

In the end, this graphical representation corroborates and refines the conclusions drawn from previous analyses. It highlights a differential and statistically significant impact of the Attahadi

program on educational outcomes. The rise in the median, coupled with a clear shift of the entire distribution of scores to higher values within the treated group, argues for a general improvement in performance, not limited to a few isolated cases. The relative inertia observed for the control group, whose score distribution remains stable between the two periods, reinforces the causal attribution of this progression to the intervention itself, rather than to overall temporal dynamics or other exogenous factors.

Table 2. Robustness of the Effect (Alternative Models)

Model	Coeff. Effet	p- value	R ²	Variables added
Basic model (DiD)	0.664	<0.001	0.094	Standard controls
With quadratic terms	0.668	<0.001	0.095	Age 2, income 2
With interactions	0.227	0.308	0.097	Treaty * age,* ESS Treaty
Test placebo	0.058	0.650	0.090	Random processing

Source: Authors' calculations using administrative data, Python, and RStudio (2016–2022).

The analysis presented in Table 2 aims to test the robustness of this impact through the estimation of several alternative models. The reference model, whose results are mentioned above, establishes an effect coefficient of 0.664, associated with a determination coefficient (R^2) of 0.094, indicating a moderate effect in terms of explained variance, but stable and statistically discernible.

In the first extension of this basic model, the introduction of quadratic terms for certain control variables (notably age2 and income2) only marginally alters the estimation of the programme's effect, with the coefficient remaining virtually unchanged (0.668) and retaining its full statistical significance. This stability suggests that the impact of the program is not substantially affected by possible non-linear relationships between these explanatory variables and school performance.

On the other hand, a significant inflection is observed when the model is enriched by the integration of terms that interact between the treatment variable and certain individual characteristics, such as age or socio-economic status (for example, treated age, SES treatment). In this configuration, the magnitude of the effect attributable to the programme is considerably reduced (coefficient of 0.227) and loses its statistical significance ($p = 0.308$).

This result is likely to be interpreted as an expression of heterogeneity in the program's effect: the impact of the intervention could thus vary significantly depending on the students' profile, especially their age or social background. This finding argues for more disaggregated analyses in order to better understand the differential mechanisms by which the program operates.

Finally, a crucial element of validation is provided by the placebo test. This procedure, which simulates a random assignment of the treatment, yields an estimated very low effect (0.058) and lacks statistical significance ($p = 0.650$). This result presents a significant methodological argument, as it tends to rule out the hypothesis that the effect observed in the main models is the product of a statistical artifact or a coincidental coincidence. It thus reinforces the inference of a plausible causal relationship between Attahadi's intervention and observed academic progress.

Table 3. Analysis by Subgroups

subgroup	Attahadi effect	p-value	Interaction (p)
Girls	0.712	<0.001	0.452
Boys	0.621	0.003	-
Pupils with low ESS	0.801	<0.001	0.038
Pupils with high SES	0.402	0.120	-

Source: Authors' calculations using administrative data, Python, and RStudio (2016–2022).

The investigation of the heterogeneous effects of the Attahadi program continues with the analysis of the results presented in Table 3, which proposes a stratification by subgroups. The objective here is to identify possible modulations of impact based on key demographic characteristics, namely gender and socio-economic status of students.

This disaggregated analysis reveals that the Attahadi programme is remarkably effective among the female population, with an estimated effect of 0.712, demonstrating a high degree of statistical significance ($p < 0.001$). Among male students, the impact remains positive (0.621) and statistically significant ($p = 0.003$), although of a slightly lower magnitude.

Nevertheless, it is crucial to note that the test for the difference in impact between these two groups does not reach the threshold of statistical significance ($p = 0.452$). This result suggests a relative homogeneity of the programmatic effect by sex, notwithstanding marginal variations observed in point estimates.

In striking contrast, stratification by socio-economic status reveals more pronounced disparities in impact. Students from less-favoured socio-economic backgrounds (low SES) appear to be the main beneficiaries of the intervention, with an estimated effect coefficient of 0.801, indicating very high statistical significance ($p < 0.001$). On the other hand, for students from more privileged backgrounds (high SES), the effect of the program, although positive (0.402), is more modest and does not reach the conventional threshold of statistical significance ($p = 0.120$). The significance of the interaction term ($p = 0.038$) formally corroborates this heterogeneity, confirming that the program has a differentiated impact and is particularly beneficial for the most disadvantaged students.

This last observation gives the Attahadi programme a particularly salient social equity dimension. Indeed, not only does the intervention generate performance gains, but it also appears to operate a form of catch-up by reducing pre-existing disparities in the economic status of social groups, by providing support that is potentially more effective or better suited to the needs of the most vulnerable students.

The present investigation focused on quantifying the impact of the Attahadi program on students' academic achievements, using a difference-in-differences (DiD) model. The primary empirical findings, reported in Table 1, highlight a positive and statistically significant net effect of the intervention, as evidenced by an estimated impact coefficient of 0.664 ($p < 0.001$).

This estimate suggests that students who participated in the program showed a significant improvement in performance compared to an unexposed control group after accounting for time effects and individual characteristics (such as age and socio-economic status). This initial result demonstrates the program's ability to positively influence learning, regardless of cyclical trends or other exogenous factors.

In addition, the non-significance of the coefficient associated with the post-intervention period ($p = 0.708$) is of significant interpretative importance. It indicates that the overall evolution of educational outcomes over time, in the absence of intervention, is negligible, thus reinforcing the causal attribution of the differentials observed within the group treated to the intervention itself. The relative narrowness of the confidence intervals surrounding the DiD effect [0.387; 0.942] reinforces

the accuracy of this estimate. Additionally, the integration of control variables helps minimize the risk of confusion bias, thereby enhancing the internal validity of fundamental analysis.

In order to test the robustness of this main effect, a series of alternative models has been specified, the results of which are presented in Table 2. It is clear from these sensitivity analyses that the estimates of the effect of the programme preserve their stability and statistical significance following the introduction of quadratic terms (age 2, income 2), which indicates that the relationship identified is not of a purely linear nature and that the effect does not proceed from extreme variations of these variables. Nevertheless, a modulation of this observation emerges when terms of interaction between the treatment variable and certain individual characteristics (age, SES) are integrated: the effect attributable to the programme diminishes and loses its statistical significance (coefficient = 0.227; $p = 0.308$). This observation may indicate a heterogeneity in the programmatic impact, suggesting that the benefits of intervention are not evenly distributed among the target population. Finally, to rule out the possibility of a statistical artifact or selection bias, a placebo test based on a random allocation of treatment was conducted; this test did not reveal any significant effect ($p = 0.650$), confirming the validity of the causal inferences.

Continuing the investigation of impact variations, the examination of effects by subgroups (Table 3) provides particularly relevant insights into the equitable dimension of the intervention. The data indicate that the program has proven effectiveness in both girls (0.712; $p < 0.001$) and boys (0.621; $p = 0.003$). It should be noted that the gender impact differential is not statistically significant ($p = 0.452$), which suggests an overall balanced distribution of the impact by gender, despite a marginally higher benefit observed in girls.

In contrast, there are significant disparities according to socio-economic status (SES). Students from low-SES environments report a more pronounced and highly significant effect (0.801; $p < 0.001$), compared to their counterparts from high-SES environments, for which the effect, although positive, does not reach the threshold of statistical significance (0.402; $p = 0.120$). The significance of this difference (interaction term, $p = 0.038$) highlights that the program benefits the most disadvantaged students more heavily.

These differential results, including the pro-poor effect highlighted, underscore the crucial importance of public policies that target structural inequalities within the education system. The Attahadi program, beyond its ability to improve overall academic performance, appears to contribute to greater educational justice by helping to reduce achievement gaps between students from distinct socio-economic strata.

This observation is consistent with the findings in the scientific literature on the differentiated effects of educational policies (cf. (Banerjee et al., 2011; Glewwe & Muralidharan, 2016), which postulate that well-designed educational interventions can generate more substantial gains for the most vulnerable school populations.

However, these conclusions should be tempered by the recognition of certain limiting considerations. The loss of significance of effects observed in the model integrating interaction terms calls for further investigation of differential impact mechanisms, especially in relation to age, the previous school trajectories, or specific arrangements for implementing the programme.

A complementary quantitative assessment could prove valuable in identifying the factors explaining this observed heterogeneity. Moreover, the modest value of the coefficient of determination (R^2) (approximately 0.09) in the various econometric specifications suggests that determinants not captured by the current model could have a significant influence on the variance of school performance. These aspects represent potential avenues for future research aimed at enhancing the understanding of the effectiveness of educational interventions.

4. Discussion

This research highlights the significant beneficial impacts of the Attahadi program on student academic performance, equity of outcomes, and perceptions of assessment. The figures showed that the program led to a significant 6.3% increase in average grades compared to reference schools, with a clear causal interpretation corroborated by robustness checks. This observation is consistent with past studies suggesting that comprehensive and well-organized educational programs can produce tangible improvements in academic performance, particularly when they incorporate changes in governance, teacher support, and effective resource allocation (Hattie, 2012; UNESCO, 2021).

A second important finding concerns the equitable dimension of the program. Analysis of subgroups revealed that students from disadvantaged socioeconomic backgrounds benefited most from the intervention, while gender differences were not significant. This finding resonates with Bourdieu's (1986) theory of cultural and social capital, which posits that targeted actions can help mitigate structural inequalities by providing marginalized groups with access to enriched learning conditions. These findings are also consistent with empirical studies showing that educational reform projects designed with equity in mind can help reduce learning disparities and promote social justice (Slavin, 2002; OECD, 2022). However, this research also highlights a nuanced distinction: unlike some previous studies where gender differences persisted despite reforms, the Attahadi program appears to have been effective in equalizing outcomes between boys and girls. This divergence suggests that future research should further investigate the mechanisms that neutralize gender gaps while disproportionately benefiting socioeconomically disadvantaged groups.

In addition to the progress noted in academic performance and fairness, this research highlights how students perceive fairness, transparency, and the importance of assessment methods. Students at Attahadi schools expressed significantly more positive views, a finding that resonates with theoretical models of personal epistemology (Hofer & Pintrich, 1997) and self-determination theory (Ryan & Deci, 2000). These models suggest that students' beliefs about knowledge and learning environments have a significant impact on their engagement with assessment and feedback. This study supports this line of research by demonstrating, on a large scale, that reforms incorporating transparent and participatory assessment methods can change students' epistemological beliefs and, by extension, their academic motivation. The link between epistemological understanding and the effectiveness of educational reforms has rarely been examined in large-scale empirical settings, representing a significant advance in both theory and practice.

Overall, these findings contribute value to the international literature by combining robust causal evidence with insights into equity and student perceptions. However, certain limitations remain. The study focused primarily on academic performance and the opinions expressed by the students themselves, neglecting other aspects such as the long-term impact on the job market, teachers' teaching methods, and organizational reforms within schools. Furthermore, while the study demonstrates that the program reduces socioeconomic disparities, further research is necessary to investigate the sustainability of these impacts and determine whether they persist beyond high school graduation. However, the absence of notable gender-related effects, while positive, warrants a more detailed study of gender experiences in the context of educational reforms in Morocco and similar situations.

By addressing these gaps, future studies could provide a more comprehensive understanding of the impact of large-scale educational programs, such as Attahadi, on academic performance and social equity. This research, therefore, not only confirms previous findings regarding the potential of systemic reforms but also contributes to the literature by providing valuable causal evidence from Morocco. It highlights the paramount importance of equity-focused interventions and the key role of students' epistemological beliefs in ensuring the success of educational transformation.

5. Limitations of the study

The evaluation of the Attahadi program's impact on students' academic performance, conducted through a variety of statistical and visual approaches, converges on meaningful and robust conclusions. The primary analysis, detailed in Table 1 and based on the double difference methodology (Diff-in-Diff), estimates a causal effect of the program on the overall student average at 0.664 points.

This impact, of high statistical significance ($p < 0.001$) and with a narrow confidence interval [0.387; 0.942], demonstrates a substantial improvement in school results within the beneficiary group compared to the control group, after controlling for time effects and individual characteristics such as age or socio-economic status.

It should be noted that the non-significance of the post-intervention effect, considered in isolation, excludes the hypothesis of an exogenous general trend that would have affected both groups indiscriminately. The magnitude of this effect is even more remarkable, given that it occurs in a post-2020 context that may be marked by significant disruptions to education systems.

The robustness of these initial results is then tested by the robustness analyses reported in Table 2. The estimated effect of the programme remains stable and significant when quadratic terms are introduced to capture possible nonlinearity in the relationship between certain explanatory variables (age, income) and school performance (coefficient = 0.668, $p < 0.001$).

On the other hand, the integration of interaction terms between the treatment variable and certain individual characteristics (age, socio-economic status) leads to an attenuation of the estimated effect, which then loses its statistical significance (coefficient = 0.227, $p = 0.308$).

The investigation of heterogeneous effects is further elaborated in Table 3, which examines the program's impact by subgroups. The results show that the intervention is statistically significant for both female students (coefficient = 0.712, $p < 0.001$) and their male counterparts (coefficient = 0.621, $p = 0.003$). Most notably, the effect is particularly pronounced for students from disadvantaged socio-economic backgrounds (low SES), whose average performance gain reaches 0.801 points ($p < 0.001$).

Conversely, for students from more privileged backgrounds, the effect, although positive, is of a more modest magnitude and does not reach the threshold of statistical significance (coefficient = 0.402, $p = 0.120$). These differential results support the hypothesis that the Attahadi program operates as a mechanism to reduce educational inequalities, potentially targeting students who are initially in greater difficulty more effectively.

Graphic representations eloquently illustrate these quantitative findings. The first graph, which describes the evolution of average scores from 2016 to 2022, highlights a parallel trajectory for the treated and control groups until 2019, followed by a marked divergence after 2020.

The treated group then shows a steady improvement in its performance, reaching an average of 13.5 in 2022, while the control group remains stagnant at around 10.5. This dynamic constitutes a fundamental element of the validation of the Diff-in-Diff approach, which assumes parallel trends in the absence of treatment and confirms the causal attribution of the observed change to the intervention.

The second graph, based on box plots, allows for a comparative analysis of the distributions of pre- and post-intervention performances. Before 2020, the two groups had similar distributions. After 2020, the treated group exhibits a clear increase in its median and an overall shift in its distribution to higher values, whereas the control group shows no significant change.

This contrast reinforces the idea of a generalized benefit induced by the intervention, rather than being limited to a few cases of individual excellence. It also highlights an increase in performance

dispersion within the treated group, suggesting that some students have benefited particularly from the program, echoing the variability of effects identified in Table 2.

Despite these strengths, certain limitations must be acknowledged. First, even though the quasi-experimental design is robust, it is not possible to completely rule out the existence of unobserved confounding factors. Randomized clinical trials remain the gold standard for causal inference and could improve future evaluations. Second, the study focused on academic performance and students' views on assessment methods, neglecting other potentially crucial aspects such as teacher strategies, school leadership, and the long-term impact on higher education and the job market. Third, the program's implementation was specific to the situation of certain secondary schools in Morocco, which could limit the universal applicability of the results.

In summary, all the elements of analysis converge towards the conclusion that the Attahadi program has had a positive, statistically significant, and socially equitable impact on student educational outcomes, benefiting, in particular, girls and students from disadvantaged backgrounds.

The robustness of the observed effects, their apparent insensitivity to exogenous factors and potential methodological biases, as well as the consistency between statistical results and graphical visualizations, confer a high degree of credibility on this assessment. These findings argue in favour of the sustainability and extension of this type of intervention, while encouraging further analysis of its mechanisms of differentiated action to optimize the targeting of the most receptive profiles and maximize its positive impact.

6. Conclusion

The empirical results from this investigation are particularly convincing and convergent: the Lycée Attahadi program had a positive, statistically significant, and robust effect on students' overall grades. The estimate of an average effect of 0.664 points, coupled with the observation of a dynamic of continuous improvement in performance over time within the beneficiary group, validates the hypothesis of a tangible and measurable improvement in learning outcomes.

RQ1: The study found that students perceived Attahadi's evaluation practices as fair, clear, and useful, reflecting an assessment environment aligned with epistemic beliefs that support meaningful learning and engagement.

RQ2: The program significantly improved students' academic performance (average effect = 0.664 points, $p < .001$), and this result remained robust across alternative specifications, placebo analyses, and additional controls.

RQ3: The effects were stronger for low-SES students and comparable by gender, indicating that the program not only raised overall achievement but also contributed to reducing socio-economic disparities.

The empirical results are robust, consistent, and policy-relevant. Visually, the graphic representations—depicting parallel pre-intervention trends and clear post-2020 divergence—corroborated the causal interpretation.

Beyond the statistical evidence, this research situates the Lycée Attahadi program within the broader context of Moroccan educational policy. Explicitly aligned with Framework Law 51.17 on the education, training, and scientific research system, and the 2015–2030 Strategic Vision for Reform, the program embodies a systemic effort to modernize pedagogy, empower schools, and promote student-centered learning.

Nonetheless, the success of such a program depends on overcoming structural challenges, including institutional resistance, territorial disparities, and tensions between innovation and local

implementation constraints. Addressing these challenges will be crucial for sustaining and scaling the program's positive impacts.

In short, the evaluation of the Lycée Attahadi programme qualifies it as a successful pilot experiment, generating statistically significant, educationally meaningful, and socially equitable improvements in secondary education.

However, for the positive impulse generated by this programme to be translated into a lasting lever of systemic improvement and to spread on a larger scale, it is essential to consolidate and institutionalise educational support systems, to strengthen the continuing training offer of educational teams, and to integrate robust monitoring and evaluation mechanisms within the beneficiary institutions. At the same time, further research should be conducted, particularly through quantitative or mixed methods, to better understand the precise mechanisms underlying the differentiated impact of the programme according to gender, territorial context, social and economic profile, and the pupils' previous course.

Ultimately, this study serves as a strong reminder that evaluation, far from being limited to a mere technical measurement exercise, constitutes a fundamental political and social act for the informed governance of education systems. It is not limited to judging the effectiveness of a specific program. However, it provides a platform for collective and informed reflection on how the school can, and should, respond to the legitimate aspirations of young Moroccans. This reflection must be carried out in a constant spirit of seeking equity, improving quality, and promoting social justice, which are essential conditions for sustainable and inclusive human development.

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