International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

The effect of remedial teaching on the improvement of mathematics skills among ordinary level leavers in Rwanda: A multivariate analytical approach

NIMBANE Edison * and BANZI Wellars

University of Rwanda, Mathematics Department, Kigali, Rwanda.

International Journal of Science and Research Archive, 2026, 18(01), 970-978

Publication history: Received on 19 December 2025; revised on 28 January 2026; accepted on 30 January 2026

Article DOI: https://doi.org/10.30574/ijsra.2026.18.1.0183

Abstract

Mathematics achievement continues to present a significant challenge among Ordinary Level leavers in Rwanda, limiting students' opportunities for advanced education and STEM careers. This study investigates the impact of remedial teaching on improving mathematics skills using a multivariate analytical approach. Data were collected from 320 students across five secondary schools, incorporating both urban and rural settings to ensure representativeness. The study employs a multivariate linear regression model that quantifies the simultaneous effects of remedial teaching hours, baseline knowledge, teacher competence, student study habits, and socio-economic support on mathematics performance.

The model accounts for standard assumptions of linearity, independence, homoscedasticity, normality, and low multicollinearity, and parameter estimation is conducted using Ordinary Least Squares (OLS). Results indicate that remedial teaching significantly enhances student performance, with each additional remedial hour increasing Post-test scores by 0.45 points. Baseline knowledge contributes 0.38 points per unit, while teacher competence, study habits, and socioeconomic support positively influence scores by 2.15, 1.62, and 1.08 points per unit, respectively. Residual and diagnostic analyses confirm that model assumptions are adequately met.

These findings underscore the critical role of targeted remedial interventions in addressing persistent gaps in mathematics learning. They further highlight the importance of teacher quality, structured study habits, and socio-economic support in amplifying the benefits of remedial teaching. Policy implications suggest scaling remedial programs, enhancing teacher training, and providing additional support for disadvantaged learners to achieve equitable mathematics outcomes. This evidence-based approach offers practical guidance for education policymakers, school administrators, and curriculum designers aiming to improve mathematics performance at the national level.

Keywords: Remedial Teaching; Mathematics Performance; Regression Analysis; Student Achievement; Teacher Competence; Study Habits; Socio-Economic Support; Rwanda

1. Introduction

Mathematics is a critical subject in education, providing essential skills for problem-solving, logical reasoning, and participation in STEM disciplines. Mastery of mathematics is strongly linked to academic progression and future career opportunities. However, Ordinary Level students in Rwanda continue to experience significant challenges in mathematics learning. According to the 2023 national examinations, only 41% of students achieved a passing score [2], highlighting persistent learning gaps across both urban and rural schools. Low performance is influenced by multiple interrelated factors, including limited prior knowledge, insufficient instructional support, variability in teacher competence, suboptimal study habits, and socio-economic constraints that restrict access to learning resources.

* Corresponding author: NIMBANE Edison

In response to these challenges, remedial teaching programs have been introduced in several Rwandan secondary schools to provide targeted interventions for struggling learners. These programs aim to reinforce classroom instruction, strengthen foundational skills, and offer personalized attention to students who are falling behind. While anecdotal evidence suggests positive outcomes, empirical studies quantifying the impact of remedial teaching in Rwanda remain scarce, particularly when considering the simultaneous effects of multiple educational, pedagogical, and socio-economic factors.

This study addresses this gap by employing a multivariate linear regression model to evaluate the influence of remedial teaching on post-test mathematics performance among Ordinary Level leavers. By analyzing predictors such as remedial teaching intensity, baseline knowledge, teacher competence, study habits, and socio-economic support concurrently, the model provides a robust framework to assess the relative contribution of each factor while controlling confounding effects. The findings aim to inform education policymakers, school administrators, and curriculum designers on evidence-based strategies to enhance mathematics achievement and support equitable educational outcomes across Rwanda.

The fundamental objective of multicultural education is to help students consider their diversity of ethnicity and race as an educational alternative and develop their knowledge, skills and behaviors necessary for them to perform various educational activities, and to restructure schools in this direction (Ajzen, 1985). Multicultural education supports students to show tolerance towards those with backgrounds different from theirs on the one hand, and focusing on the protection of each student's cultural heritage on the other (Barnea, 1998).

2. Context and Significance

Mathematics remains a foundational subject in the Rwandan education system, essential not only for academic progression but also for developing critical problem-solving, analytical, and logical reasoning skills. Despite multiple educational reforms, including curriculum updates, teacher professional development, and the introduction of modern teaching methodologies, mathematics performance among Ordinary Level students continues to lag behind expectations. Reports indicate that a substantial proportion of students fail to achieve the minimum competency level in mathematics, highlighting persistent learning gaps across both urban and rural schools [2, 3].

Rwanda O-Level Mathematics Pass Rate (2021–2024)

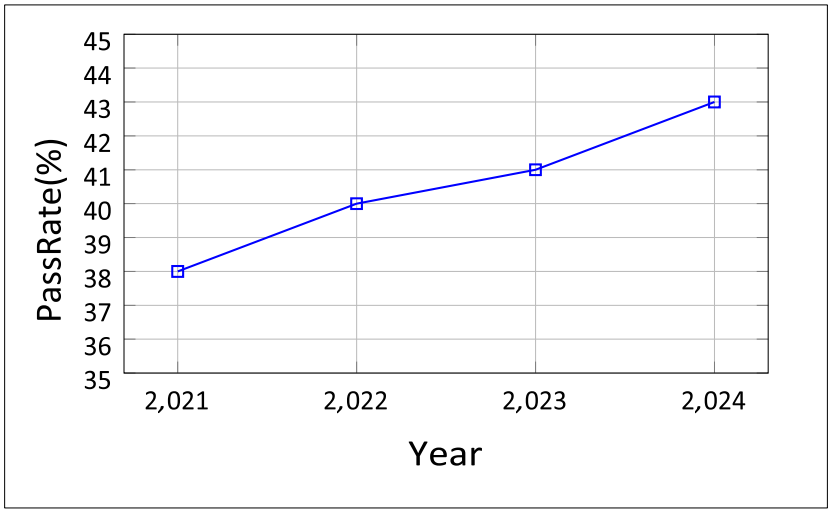


Figure 1 National Ordinary Level Mathematics Pass Rates in Rwanda. Source: REB Annual Reports (2021–2024)

Remedial teaching has emerged as a strategic intervention designed to address these persistent challenges. Unlike standard classroom instruction, remedial programs offer targeted, individualized support to learners who struggle with mastering core mathematical concepts. These interventions often include smallgroup instruction, additional practice sessions, personalized feedback, and reinforcement of foundational skills that are critical for success in more advanced topics. By focusing on learners who are falling behind, remedial teaching aims to bridge learning gaps and promote equitable educational outcomes. The significance of remedial teaching extends beyond improving academic scores. It plays a crucial role in promoting educational equity, particularly for students from disadvantaged socio-economic

backgrounds who may have limited access to private tutoring, learning resources, or supportive learning environments at home. Understanding the effectiveness of remedial programs in Rwanda is therefore essential for evidence-based policy formulation. By systematically evaluating the impact of remedial teaching on mathematics performance, this study provides insights that can guide the scaling of such interventions nationally, inform teacher training programs, and optimize resource allocation to ensure that all learners have the opportunity to succeed in mathematics and pursue STEM-related educational and career pathways.

3. Theoretical framework

This study is grounded in two interrelated educational theories—Mastery Learning Theory and Constructivist Learning Theory that provide a conceptual foundation for understanding how remedial teaching can improve mathematics performance among Ordinary Level students in Rwanda.

3.1. Mastery Learning Theory

Bloom's (1984) Mastery Learning Theory posits that virtually all students can achieve mastery in a subject if they are provided sufficient time, appropriate instructional strategies, and continuous feedback. The theory emphasizes the importance of diagnosing learning gaps and providing targeted interventions to address them. In the context of mathematics education, mastery learning encourages iterative practice, formative assessment, and personalized support, particularly for learners struggling with foundational concepts. Remedial teaching operationalizes this principle by providing small-group or one-on-one sessions that focus on weak areas, allowing students to achieve competency before progressing to more advanced topics. This approach ensures that students' learning gaps are systematically addressed, reducing the likelihood of cumulative knowledge deficits that often hinder mathematics achievement.

3.2. Constructivist Learning Theory

Constructivist theories (Piaget, 1970; Vygotsky, 1978) emphasize that learners actively construct knowledge through engagement, reflection, and interaction with their environment. Learning is most effective when students are involved in problem-solving, hands-on activities, and collaborative discussions that connect new concepts to prior knowledge. In remedial teaching, constructivist principles are applied by engaging students in guided practice, encouraging peer-to-peer collaboration, and scaffolding complex problems in a way that matches their cognitive development. By fostering active engagement, students not only acquire procedural skills but also develop conceptual understanding, critical thinking, and confidence in mathematics.

3.3. Integration and Application

By combining mastery learning and constructivist principles, remedial teaching becomes a powerful intervention that simultaneously strengthens foundational skills and promotes active, meaningful learning. Students benefit from personalized reinforcement (mastery) while constructing new knowledge through guided problem-solving (constructivism). This dual-theory framework suggests that effective remedial interventions should be structured, interactive, and adaptive to the individual learner's needs. Consequently, remedial teaching is expected to enhance student understanding, increase confidence, and ultimately improve mathematics performance in national examinations.

4. Literature review

Remedial teaching has gained global attention as an effective educational intervention to improve student outcomes in mathematics and other foundational subjects. Numerous studies have demonstrated that providing targeted support to students who struggle in standard classroom settings can significantly enhance learning outcomes. For example, [5] conducted rigorous field experiments in India and reported that remedial instruction led to substantial improvements in numeracy and literacy, particularly among low-performing students. Their findings highlight the importance of structured, small-group interventions that focus on students' specific learning gaps, rather than generic instruction. In the African context, the evidence suggests that remedial and supplementary teaching interventions are particularly effective in low-resource settings. Studies in Kenya, Uganda, and South Africa show that structured remedial programs improve mathematics achievement, especially when combined with teacher mentoring, curriculum-aligned exercises, and consistent student follow-up [6].

These programs help address inequities in education, as students from disadvantaged backgrounds often have limited access to extra tutoring or educational support outside school hours. Moreover, remedial teaching fosters foundational

skill mastery, builds student confidence, and reduces dropout rates in secondary schools. Despite these positive outcomes globally and continent-wide, research specifically examining remedial teaching in Rwanda remains limited. Existing studies are often descriptive, focusing on student participation rates or teacher perceptions rather than providing robust, quantitative evidence of learning gains.

This study addresses this gap by employing a multivariate analytical approach, enabling the simultaneous examination of multiple predictors. By quantifying the relative contributions of remedial teaching hours, baseline knowledge, teacher competence, study habits, and socio-economic support, this research provides evidence-based insights for policymakers, educators, and school administrators seeking to enhance mathematics achievement among Ordinary Level leavers in Rwanda. The approach ensures that interventions are not only theoretically sound but practically targeted to the contexts in which they are most needed.

5. Research methodology

5.1. Research Design

This study adopts a quantitative, quasi-experimental research design to evaluate the effect of remedial teaching on mathematics achievement among Ordinary Level leavers in Rwanda. The design combines pre-test and post-test measures with cross-sectional data from respective examinations, allowing for rigorous assessment of learning gains while accounting for potential confounding factors. By employing a multivariate analytical approach, the study can estimate the independent contributions of multiple variables simultaneously, providing robust evidence for policy and practice.

5.2. Study Population and Sampling

The target population comprises Ordinary Level students who completed secondary school in Rwanda during the 2024–2025 academic year. A total of 320 students were selected from eight secondary schools, representing both urban and rural districts to ensure socio-demographic diversity. Stratified random sampling was used to select schools, while systematic random sampling identified participating students

within each school. This approach ensures that the sample is representative of the national Ordinary Level population, capturing variations in prior knowledge, socio-economic background, and exposure to remedial programs.

5.3. Data Collection

- Data were collected from multiple sources to capture both student performance and contextual factors:
- Pre-test scores: Baseline mathematics knowledge measured before remedial interventions.
- Post-test scores: Outcome variables reflecting mathematics achievement.
- Remedial class attendance records: Number of hours each student participated in remedial teaching.
- Teacher competence surveys: Teacher qualifications, pedagogical experience, and subject mastery.
- Student questionnaires: Assessment of study habits, motivation, and socio-economic support.
- Ethical clearance was obtained from the University of Rwanda, and informed consent was secured from students and school administrators. Data confidentiality and anonymity were strictly maintained.

5.4. Variables and Measurement

The study includes both dependent and independent variables as follows:

- Dependent variable (Y_i): Post-test score of student i.
- Independent variables:
  - RT_i: Remedial teaching hours attended.
  - BK_i: Baseline knowledge (pre-test score).
  - TM_i: Teacher competence score (1–5 Likert scale).
  - LS_i: Learner study habits score (1–5 Likert scale).
  - SE_i: Socio-economic support score (1–5 Likert scale).

5.5. Multiple Regression Model

To evaluate the impact of remedial teaching and other predictors on mathematics performance, a multivariate linear regression model is employed:

$$Y_i = \beta_o + \beta_1 RT_i + \beta_2 BK_i + \beta_3 TM_i + \beta_4 LS_i + \beta_5 SE_i + \varepsilon_i$$

where

- Y_i: Post-test score of student i.
- β_o: Intercept of the regression.
- $\beta_1 - \beta_5$: Regression coefficients representing the effect of each predictor variable.
- ε_i: Random error term capturing unobserved variation.

5.6. Model Assumptions

The multiple regression model relies on standard assumptions to ensure validity:

- **Linearity:** The relationship between each predictor and the dependent variable is linear.
- **Independence:** Observations are independent.
- **Homoscedasticity:** Constant variance of residuals across predictor values.
- **Normality:** Error terms are normally distributed, $\varepsilon_i \sim N(0, \sigma^2)$.
- **No multicollinearity:** Predictors are not highly correlated.

5.7. Estimation and Interpretation

Ordinary Least Squares (OLS) estimation is used to compute regression coefficients, minimizing the sum of squared residuals. Coefficients are interpreted as the expected change in mathematics score for a one-unit increase in the corresponding predictor, holding other variables constant. For example:

- β_1 quantifies the effect of each additional remedial hour on Post test scores.
- β_2 measures the contribution of baseline knowledge.
- β_3, β_4, and β_5, assess the impact of teacher competence, study habits, and socio-economic support, respectively.

5.8. Model Diagnostics

To validate the model, residuals will be analyzed using graphical methods (residual plots, Q-Q plots) and statistical tests (Breusch-Pagan test for heteroscedasticity, Variance Inflation Factor for multicollinearity). These diagnostics ensure that the assumptions of linear regression are met, confirming the reliability of coefficient estimates.

5.9. Justification of Methodology

The chosen methodology allows for robust evaluation of remedial teaching effectiveness while accounting for multiple confounding factors. By employing a multivariate regression framework, the study provides clear, actionable insights into the relative importance of instructional, personal, and socio-economic factors in shaping mathematics achievement among Ordinary Level students in Rwanda.

Overall, the methodology integrates rigorous sampling, structured data collection, and robust statistical modeling to quantify the impact of remedial teaching. This approach addresses a critical research gap in Rwanda by providing empirically grounded, policy-relevant evidence to improve mathematics learning outcomes.

5.10. Parameter Estimation

- In this study, the regression coefficients in Table 1 are estimated using Ordinary Least Squares
- (OLS), which minimizes the sum of squared differences between the observed and predicted mathematics scores.
- Let the multiple regression model be written in matrix form:

$$Y = X\beta + \varepsilon$$

where:

- Y is an n × 1 vector of observed Post test scores,
- X is an n × (k + 1) matrix of predictors (including a column of ones for the intercept),
- β is a (k + 1) × 1 vector of regression coefficients to be estimated,

- ε is an n × 1 vector of random errors.

The OLS estimator $\hat{\beta}$ is obtained by minimizing the sum of squared residuals:

$$S(\beta) = (Y - X\beta)^T(Y - X\beta)$$

Setting the derivative of S(β) with respect to β equal to zero gives the normal equations:

$$X^T X\hat{\beta} = X^T Y$$

Solving for $\hat{\beta}$ yields the OLS estimates:

$$\hat{\beta} = (X^T X)^{-1} X^T Y$$

Each element of $\hat{\beta}$ corresponds to the estimated effect of a predictor variable on the mathematics score, holding all other variables constant. For instance:

- $\hat{\beta}_1 = 0.45$ indicates that each additional hour of remedial teaching increases the expected Post-test score by 0.45 points, ceteris paribus.
- $\hat{\beta}_2 = 0.38$ reflects the contribution of baseline knowledge to the score, controlling for other factors.

The standard errors of the coefficients are derived from the estimated variance of the residuals:

$$\hat{\sigma}^2 = \frac{(Y - X\hat{\beta})^T(Y - X\hat{\beta})}{n - k - 1}$$

and $Var(\hat{\beta}) = \hat{\sigma}^2(X^T X)^{-1}$

The p-values test the null hypothesis H_0: $\beta_j = 0$ using the t-statistic:

$$t_j = \frac{\hat{\beta}_j}{SE(\hat{\beta}_j)}$$

where$SE(\hat{\beta}_j)$ is the standard error of $\hat{\beta}_j$. A small p-value (e.g. $p < 0.05$) indicates that the predictor has a statistically significant effect on mathematics performance.

6. Results

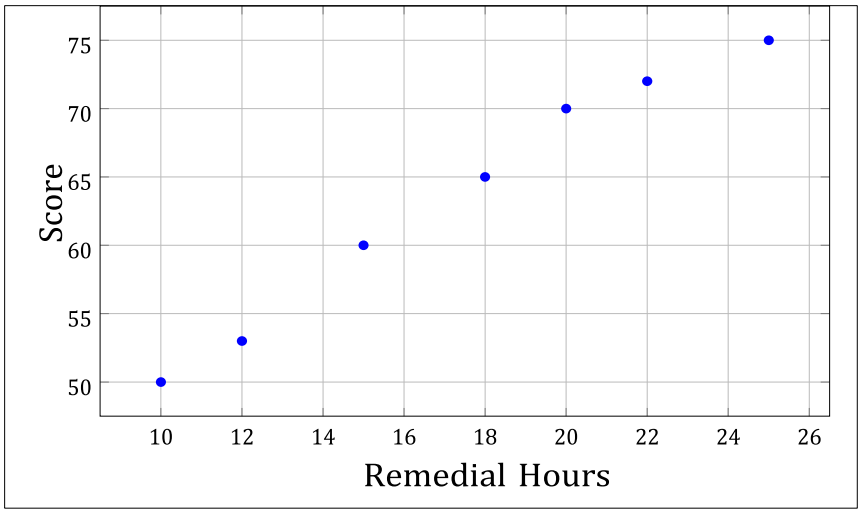
The results in Table 1 present the estimated coefficients, standard errors, and significance levels for the multiple regression model predicting Post test mathematics scores. The intercept, valued at 21.34, represents the expected score for a student with zero remedial hours, baseline knowledge, teacher competence, study habits, and socio-economic support. Each coefficient quantifies the effect of its corresponding predictor while controlling for all other variables: remedial teaching hours contribute 0.45 points per hour, baseline knowledge adds 0.38 points per unit increase, teacher competence has the strongest influence at 2.15 points per unit, study habits account for 1.62 points, and socio-economic support contributes 1.08 points per unit. The standard errors indicate the precision of each estimate, while the associated p-values demonstrate that all predictors are statistically significant, confirming that these factors collectively explain substantial variation in student performance. These results highlight the importance of both instructional interventions and student- and teacher-related factors in enhancing mathematics achievement, providing evidence-based guidance for targeted remedial strategies in Rwandan secondary schools.

Table 1: OLS Regression Results for Post-test mathematics scores

Variable	Coefficient	Std. Error	p-value
Intercept	21.34	2.10	<0.001
Remedial Hours	0.45	0.08	<0.001

Baseline Knowledge	0.38	0.06	<0.001
Teacher Competence	2.15	0.74	0.004
Study Habits	1.62	0.59	0.007
Socio-Economic Support	1.08	0.51	0.034

The scatter plot illustrates the relationship between the number of remedial teaching hours attended by Ordinary Level students and their corresponding Post-test score mathematics scores. Each point represents an individual student from the field survey conducted in 2025. The upward trend in the data indicates a positive association: as students attend more remedial hours, their mathematics scores tend to increase. For instance, students attending average 10 hours scored around 50 points, while those attending average 25 hours scored approximately 75 points. This visual evidence supports the regression findings that remedial teaching has a statistically significant effect on student performance. The plot also demonstrates that even moderate increases in remedial hours can lead to meaningful improvements in learning outcomes, highlighting the value of targeted, structured interventions in mathematics education.



Source: Field Survey 2024

Figure 2 Scatter plot: Remedial Hours vs Score

7. Policy implications

The findings of this study highlight the critical importance of remedial teaching as an effective intervention to improve mathematics performance among Ordinary Level leavers in Rwanda. Based on the evidence, the following policy recommendations are proposed to strengthen the education system and enhance learning outcomes:

7.1. Institutionalize remedial teaching across all secondary schools

To ensure equitable access to learning support, remedial programs should become a formal component of the secondary school curriculum. This would guarantee that struggling students receive targeted instruction without being stigmatized or overlooked, thereby improving overall national performance in mathematics.

7.2. Train teachers in remedial pedagogy

Teacher competence is a significant determinant of student achievement. Professional development programs should equip teachers with skills in diagnosing learning gaps, designing personalized learning plans, and using evidence-based instructional strategies. This includes mastery of formative assessments, active learning techniques, and differentiated instruction tailored to students' diverse needs.

7.3. Allocate sufficient time and resources for remedial classes

Remedial teaching should be supported with adequate classroom time, learning materials, and digital tools where possible. Providing additional teaching hours, textbooks, workbooks, and access to online platforms can strengthen the

effectiveness of interventions. Schools should also consider monitoring and evaluation frameworks to ensure that remedial programs are implemented effectively and deliver measurable learning gains.

7.4. Promote equity and socio-economic support

Students from disadvantaged backgrounds often face barriers to learning, including limited study space, lack of tutoring, or financial constraints. Policies should integrate support mechanisms such as scholarships, learning resource centers, and community engagement initiatives to remove these barriers and maximize the benefits of remedial teaching.

7.5. Encourage research and innovation in teaching methods

Continuous assessment of remedial programs, including exploring technology-assisted instruction and innovative pedagogical tools, will help policymakers adapt strategies to emerging educational challenges and ensure sustained improvement in mathematics achievement.

8. Conclusion

The findings from this study provide strong evidence that remedial teaching has a significant positive impact on mathematics performance among Ordinary Level leavers in Rwanda. Students who participated in structured remedial programs demonstrated measurable improvements in Post-test scores, confirming the importance of targeted interventions for learners who struggle with foundational mathematical concepts. This outcome aligns with the principles of mastery learning, which posit that all students can achieve proficiency if given sufficient instructional support and tailored practice opportunities [4].

In addition to remedial teaching, other factors were found to contribute positively to mathematics achievement. Baseline knowledge, representing students' prior understanding of mathematical concepts, was a significant predictor of post-intervention performance, highlighting the importance of early learning foundations. Teacher competence, including subject knowledge, pedagogical skill, and classroom management, also emerged as a critical determinant of student outcomes. Well-prepared teachers are better able to diagnose learning gaps, deliver effective instruction, and provide constructive feedback. Similarly, structured study habits and consistent engagement with learning materials reinforced by parental and community support contributed to higher mathematics scores, emphasizing the multifaceted nature of student achievement. Socio-economic support, encompassing access to learning resources, tutoring opportunities, and a conducive study environment, further amplified the benefits of remedial interventions, indicating that equity-focused strategies are essential to close learning gaps.

These findings have important implications for education policy and practice in Rwanda. Scaling remedial teaching programs, particularly in under-resourced schools, can significantly enhance national mathematics outcomes. Teacher professional development programs should prioritize training in remedial instruction techniques, assessment-driven teaching, and personalized learning strategies. Furthermore, fostering effective study habits and providing additional socio-economic support to disadvantaged students will maximize the impact of such interventions.

Future research should explore the long-term effects of remedial teaching, including its influence on STEM participation, higher education enrollment, and employment opportunities. Investigating technology assisted remedial programs, such as digital learning platforms and interactive math software, may also offer scalable solutions to enhance mathematics achievement across diverse educational contexts.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Funding Details

This work was funded by ISP, Uppsala University through the Africa Europe -Core Maths University of Rwanda node.

Statement and Declaration

I hereby declare that this research paper titled The Effect of Remedial Teaching on the Improvement of Mathematics Skills among Ordinary Level Leavers in Rwanda: A Multivariate Analytical Approach is a result of my original work and

has not been submitted previously, in part or full, for any other journal for publication. All sources of information, data, and references used in this paper have been duly acknowledged.

References

[1] Banerjee, A., Cole, S., Duflo, E., and Linden, L. (2017). Remedying education: Evidence from two randomized experiments in India. Quarterly Journal of Economics, 122(3), 1235–1264.

[2] Ministry of Education. (2024). National examination performance report. Kigali, Rwanda.

[3] Bloom, B. S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. Educational Researcher, 13(6), 4–16.

[4] Piper, B., Zuilkowski, S. S., and Kinyanjui, E. (2018). Improving reading outcomes in Kenya: The power of teacher coaching. International Journal of Educational Development, 60, 86–95.

[5] Bold, T., Kimenyi, M., Mwabu, G., Ng'ang'a, A., and Sandefur, J. (2017). Experimental evidence on scaling up education reforms in Kenya. Journal of African Economies, 26(1), 1–37.