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Repercussion of Higher Education Reform: In the Case of Mathematics Department Students before and after the reform in One of the Universities in Ethiopia

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Abstract

This study sought to examine how mathematics department students of public universities in Ethiopia were affected by recent reforms in higher education. A descriptive survey design was used to carry out the investigation. A total of 86 mathematics students participated in the study. It filled out achievement test questions, 30 of whom joined the department after taking the new reform's freshman course in 2020 and 30 and 26 of whom joined the department before the new reform's freshman course was delivered in 2019 and 2018, respectively. A 40-item achievement test on elementary concepts of algebra in mathematics was used as an instrument for the study. Out of 40 concepts, the mean scores reported by students who joined the Department of Mathematics after and before taking their freshman course were 19 and 15 respectively. Moreover, there was a significant difference in students who joined the Department of Mathematics after and before the new reform and took the freshman course regarding understanding and solving elementary algebraic concepts of mathematics with equal variances, not assumed to be $p = 0.040$ less than $p = 0.05$ level of significance. It is therefore recommended that it is essential to improve mathematics success for all students and that the new freshman course reform plays a significant role in increasing students' mathematics success rate. This study has proven that they are trainable, and therefore, the new reform of freshman courses has to be nurtured for all students.

1 Introduction

1.1 Background of the Study

Ethiopia, officially known as the Federal Democratic Republic of Ethiopia (FDRE), is one of Africa's most populous nations, with a population exceeding 115 million (Boateng, 2020). Over the past two decades, the country has experienced substantial expansion in its education sector. While this expansion significantly increased access to schooling at all levels, questions regarding instructional quality, graduate competence, and institutional effectiveness have become central to national discourse.

Globally, education is widely recognized as a catalyst for economic transformation and social progress. However, as noted by Vasquez-Martinez *et al*. (2013), the central concern is not merely the implementation of reform, but rather its effectiveness, sustainability, and measurable outcomes. In Ethiopia, similar concerns have prompted a comprehensive review of the higher education system.

For more than twenty years, Ethiopia's education policy emphasized expansion. However, according to Mengisteab (2021), this quantitative growth was not always accompanied by improvements in quality. In response, the government introduced a na-

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tional Education Development Roadmap (Roadmap, 2020) designed to address structural weaknesses and refocus the system on competence, accountability, and relevance. The reform particularly emphasizes strengthening foundational knowledge in higher education institutions, which serve as the primary producers of skilled manpower. Ashcrof and Rayner (2011a; 2011b) previously identified systemic challenges affecting quality assurance in Ethiopian higher education. The new reform initiative seeks to address such concerns by restructuring curriculum design, instructional methods, and student preparation mechanisms.

Within this broader transformation, mathematics education occupies a critical position. Mathematics underpins scientific and technological development and requires strong conceptual foundations. The introduction of a reformed freshman mathematics course was intended to reinforce logical reasoning, symbolic literacy, and essential algebraic structures before students proceed to departmental specialization (MOSHE, 2020).

Thus, evaluating whether this curricular reform has produced measurable improvements in students' foundational mathematical competence is both timely and necessary.

1.2 Statement of the Problem

The Ethiopian government has consistently prioritized science, technology, engineering, and mathematics (STEM) disciplines as drivers of national development. Nevertheless, low achievement in mathematics remains a persistent challenge across educational levels. Improving student outcomes requires not only curriculum reform but also a careful understanding of students' prior knowledge and preparedness.

Research highlights the importance of background knowledge in determining academic success (Bekele, 2019; Prescott, 2022; Starke, 2021). Students entering higher education without sufficient mastery of elementary mathematical concepts often encounter difficulties in advanced coursework. Belina (2012) also emphasizes that prior knowledge significantly influences learning effectiveness and conceptual integration.

Before implementation of the new reform, admission patterns into mathematics departments sometimes resulted in students enrolling without adequate foundational competence. In some cases, students demonstrated weaknesses in algebraic manipulation, logical reasoning, and symbolic interpretation. Such gaps hinder progression in higher-level mathematics courses. To address these concerns, the Education Development Roadmap (Roadmap, 2020) proposed a structural shift toward strengthening foundational learning. The reform called for an educational framework grounded in critical thinking, ethical responsibility, and competence-based preparation aligned with national development goals.

Specifically, the newly designed freshman mathematics course for natural science students provides systematic coverage of logic, set theory, number systems, functions, trigonometry, and analytic geometry (MOSHE, 2020). The underlying assumption is that reinforcing fundamental concepts at entry level will enhance performance in subsequent departmental studies. However, despite policy optimism, empirical assessment of this reform's effectiveness remains limited. Therefore, this study investigates whether measurable differences exist between students who entered the mathematics department before and after the implementation of the freshman reform course. Accordingly, to see the influence of this reform on students' achievement in the department of mathematics in the narrow sense of assessing its impact, this study was guided by the following general and specific objectives.

1.3 Objectives of the Study

The objective of this study is to see the repercussions of higher education reform on students who join the mathematics department.

Specific objectives

- To investigate the achievement of freshmen students on the basic language of mathematics concepts before and after the reform;
- To exhibit the significant difference in basic mathematics achievement results of freshman students before and after the reform that joined the mathematics department for the bachelor's science program.

1.4 Hypothesis

N_1: There is a significant difference in the basic mathematics achievement results of freshmen students who joined the mathematics department for the Bachelor of Science program before and after the reform.

1.5 Significance of the study

Over the past 27 years, Ethiopia has achieved substantial quantitative expansion in education; however, qualitative improvement has lagged behind (Yadessa & Shemelis, 2022). The higher education sector continues to face challenges related to instructional quality, academic rigor, and learning outcomes. As Hui-Ling and Chien (2017) suggest, sustainable educational reform requires careful evaluation of school effectiveness and institutional impact. Similarly, Vasquez-Martinez *et al*. (2013) argue that the true value of reform lies in its observable outcomes rather than its theoretical aspirations. Given the strategic importance of mathematics in national development and scientific advancement, assessing the effectiveness of reforms in mathematics education is particularly critical. The long-term impact of educational change is often difficult to detect immediately after implementation. Therefore, early evaluation studies play an essential role in guiding policy adjustments and instructional improvements. By examining differences in foundational mathematical achievement between pre-reform and post-reform cohorts, this study contributes empirical evidence to ongoing national discussions regarding the effectiveness of the Education Development Roadmap. The findings may inform curriculum refinement, instructional strategies, and departmental placement practices.

2 Research Methodology

2.1 Sample and Population

This study was conducted on students who joined the department of mathematics at one of Ethiopia's universities. The study population consists of mathematics department students. By convenience sampling techniques, there were 86 mathematics students, of whom 30 joined the department after taking the new reform's freshmen course in 2020 were categorized in one group, 30 students who joined the department in 2019 and another 26 students who joined the department in 2018 (both groups joined the department before the new reforms were categorized in another group), and all participated in the study at entry point to the department, *i.e*., department placement.

2.2 Design of the Study

The researchers devised a quantitative case study to investigate the effects of the new higher education reform on mathematics students at a single Ethiopian university. "Quantitative data was analyzed based on descriptive and inferential statistics. Descriptive statistics" were examined to get the percentage, mean, and standard deviation; inferential statistics were examined by using the t test to determine whether there was a significant difference between two groups on basic elementary mathematical concepts. A "significant difference between two groups has been tested at the 0.05 level of significance because of the possibility of a level of significance between 0.01 and 0.1". This study was designed to indicate the extent of the repercussions of new reforms in higher education on mathematics students at one Ethiopian university.

According to Anderson and Krathwohl's Taxonomy (2001), understanding different types of functions means constructing meanings of activities and graphic messages by writing, exemplifying, classifying, inferring, comparing, or summarizing (Anderson & Krathwohl, 2016). Based on this taxonomy and the researcher's understanding of basic elementary mathematics concepts, the researcher prepared the achievement test question from the Mathematics Review Manual (Lovric, 2009) and from other related studies. Two of the researcher's colleagues had examined the validity of a test prepared by the researcher using basic elementary mathematics concepts. A retest was performed in a 30-minute interval to determine the reliability of test instruments, and its correlation was 0.998, indicating that the test instrument is reliable. The prepared test has been delivered for 2018 and 2019 entries to the mathematics department to examine their background knowledge of basic mathematics, and then, having the results of the previous two groups as one group, the achievement test was adopted for 2020 entry students that joined the department after the new reform of the refresher

course in 2020.

2.3 Data Analysis Technique

The researcher distributed the prepared tests, which were then gathered for analysis. Thus, "the collected data were organized, interpreted, and analyzed using a percentage, mean, standard deviation, and independent t test" followed by analyses from which summaries and conclusions were drawn. The associated values of the degree of agreement were multiplied by a number. The rating was calculated by dividing the total number of respondents by the sum of the products of value and frequency. The ground mean was then calculated by adding all rating means within a category and dividing the result by the total number of cases. "An interpretation was made based on the ground mean, and conclusions were drawn on the fundamental questions". The "standard deviation" used to indicate how far responses had been scattered from the grade mean. To assess the significant difference between two groups' achievement of basic elementary mathematics concepts, a t-test was conducted and a detailed analysis was made.

3 Results

The "analyses of the data took place based on two sta- tistical methods: descriptive statistics (percentage, mean, standard deviation (ST. DV), skewness, and kurtosis) and inferential statistics (t test)". Then, the interpretation of hypotheses regarding the differences in basic mathematics achievement results between students who joined the department before the reform (i.e., 2018 and 2019 entries) and those who joined after the reform (i.e., 2020 entries) was used. The descriptive frequency and percentage of statistical findings from students who understood the fundamentals of mathematics on those chosen topics were reported as follows:

To explore the "baseline of students' background knowledge of those selected" basic concepts of mathematics, students were made to take the test question at the first class of the school year of their first membership in the Mathematics Department.

Descriptive statistics were used to examine students' background knowledge on selected basic concepts of mathematics as follows:

Table 1: Descriptive statistics: students' test questioner result on selected basic concept of mathematics out of 40

Group	Mean	N	Std. Dv	Variance	Kurtosis	Skewness
After the New Reform	18.9149	30	9.82196	96.471	-.776	-.034
Before the New Reform	15.0385	56	8.59996	73.959	-.922	.266
Total	16.8788	86	9.35717	87.557	-.844	.168

Table 1 shows "the means, standard deviations, skew- ness, and kurtosis" for test questions by class. As the table shows, there is a mean difference between the two groups with the data distributions being skewed on the left side (-.034), indicating that Mean < Median < Mode, whereas the data distributions are skewed on the right side (.266), indicating that Mean > Median > Mode. Although the two groups' kurtoses are -0.776 and -0.922, indicating that the distribution of the result is relatively flat.

To test the Hypothesis

N_1: "There is a significant difference in the basic mathematics achievement results" of students who join the department mathematics before and after the new reform.

The Levene test of the test questioner is detected (Sig = 0.475), which indicates no violation of homogeneity between the two groups. If "the p-value is significant (less than 0.1 at a 90% confidence level), the variance of the subgroups is not homogeneous and is estimated using Tamhane's T2". (Gupta, 1999), but because the data is homogeneous, an Independent Samples Test was performed using equal variances rather than the assumed Sig (P) = 0.040, which supports the alternative hypothesis that there is a significant difference in the basic mathematics achievement results of the study.

Table 2: Independent Samples Test

		Levene's Test for Equality of Variances		**$t-test$ for Equality of Means**						
									95% CI of the Difference	
		F	$Sig.$	t	df	$Sig.$ (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
G345	Equal variances assumed	.514	.475	2.094	97	.039	3.88	1.85	.20157	7.55
	Equal variances not assumed			2.080	91.99	.040	3.88	1.86	.17417	7.57

Graphical representation of the distribution of two groups is shown as follows

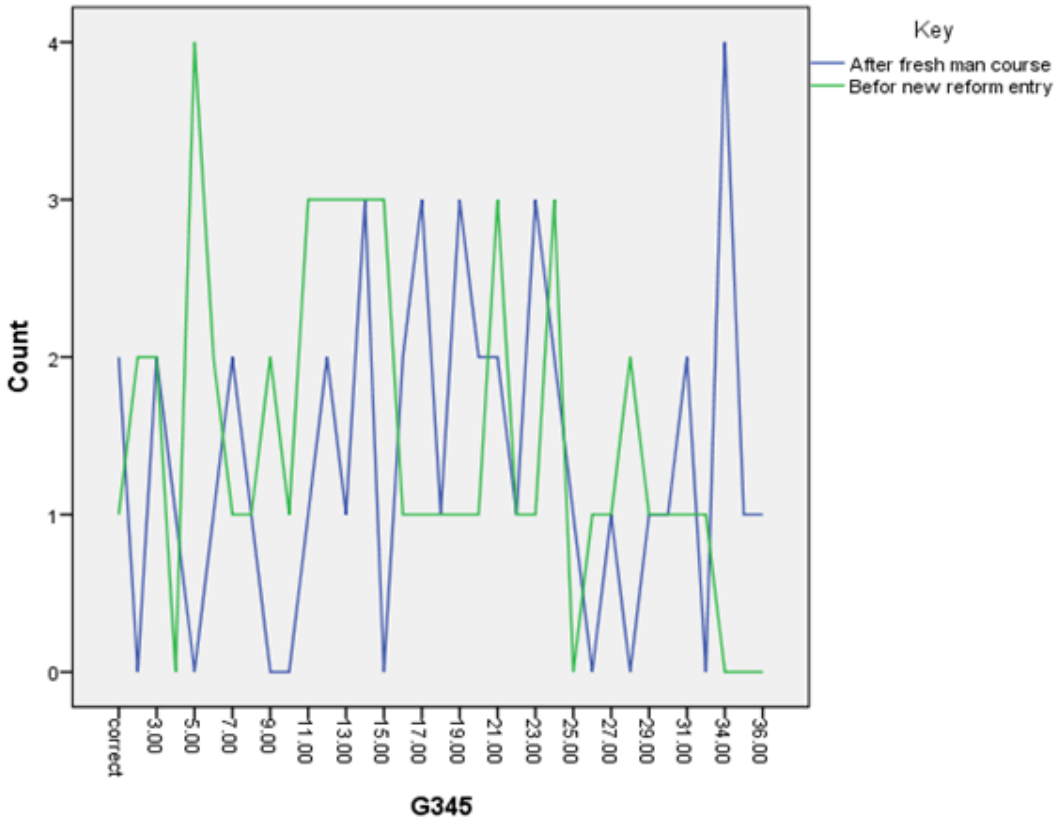

Figure 1: Distribution of two groups

4 Discussions

The current study contains an analysis of the repercussions of higher education reform on students who join the mathematics department. As table 1 shows, from the definition of skewness and kurtosis: Brown (2011) explains that "skewness characterizes the symmetry of a distribution, whereas kurtosis provides information about the relative peakedness or flatness compared to a normal distribution". This occurs when mean < median < mode is used. "If the distribution of data is skewed toward the right, we call it positively skewed." When mean > median > mode, this occurs (Brown, 2011). According to Brown (2011), "kurtosis gives information about the group distribution of peakedness or flatness

compared to the normal distribution". Whereas the distribution of positive numbers is relatively peaked, the distribution of negative numbers is relatively flat (Brown, 2011).

As can be seen from above, the data distributions are skewed on the left side (-.034), indicating that Mean < Median < Mode, whereas the data distributions are skewed on the right side (.266), indicating that Mean > Median > Mode. Although the two groups' kurtosis is negative, indicating a relatively flat.

We presented some of the students' work below to triangulate the achievement of students in the two groups, *i.e*., before and after the reform, respectively. Errors were mainly seen when adding, subtracting, and exponentiating the power of zero of exponential expressions in a term. Students who had not taken the freshman course prior to the reform were more affected than students who had taken the freshman course after the reform. Students who had not taken the freshman course had difficulties with both operation and direction signs and demonstrated too many misunderstandings when working with signs. The researcher realized the impact of the new reform refreshment course on some concepts in mathematics. The following are samples of five students' work before and five students' work after the new refreshment reform to demonstrate the problem of computations in simple mathematical language from both sides, presented below.

The impact of the reform on students can be seen in some of the simple mathematical computations selected from the above two images.

From table 2, the significance level is Sig (P) = 0.040, which is less than 0.05, which supports the alternative hypothesis that there is a significant difference in the basic mathematics achievement results of the study. Figure 1 also shows the distribution of results for the two groups.

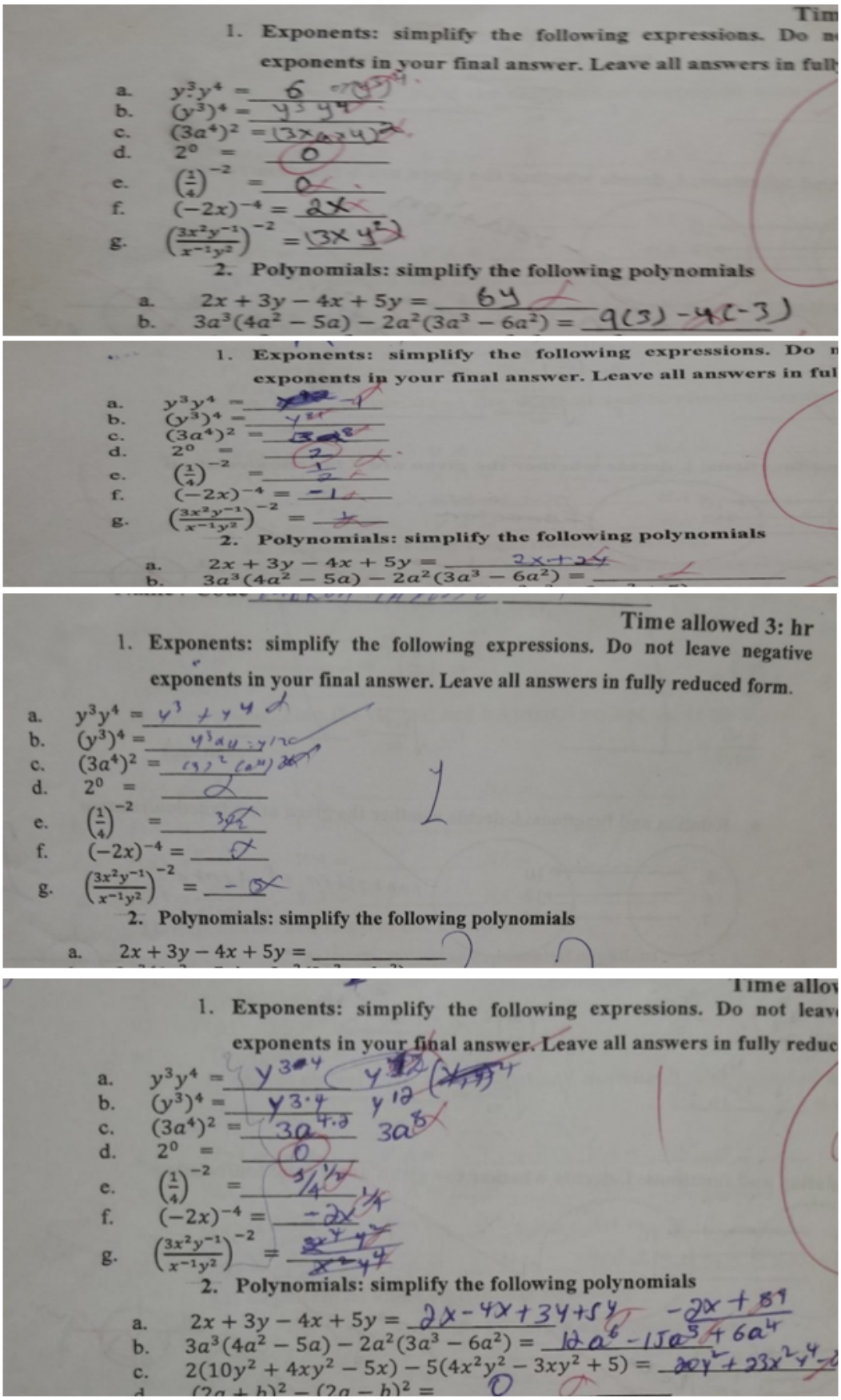

Figure 2: Five students work before new reform

Let us see some of students work from the second group (among the students after the reform)

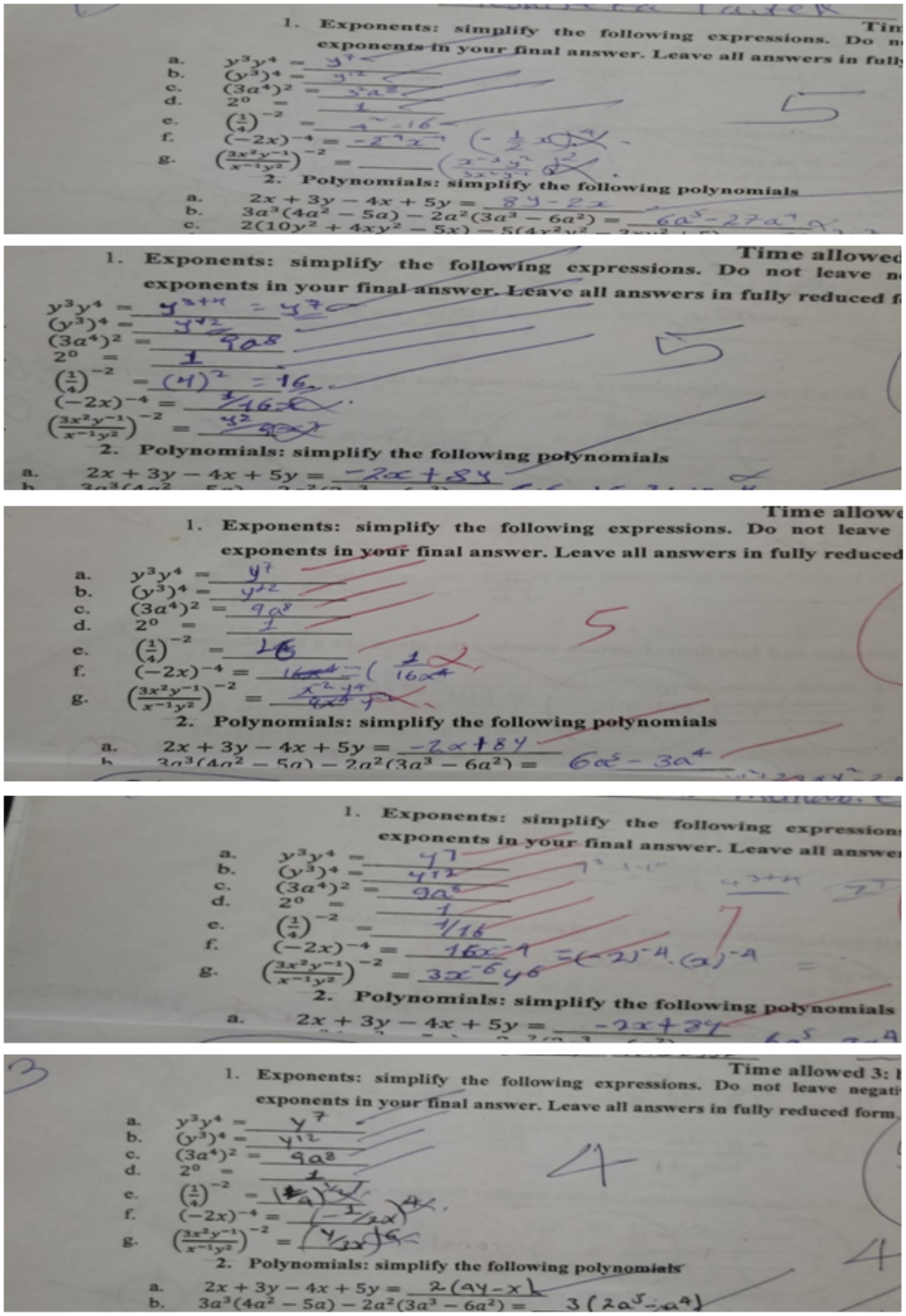

Figure 3: Five students work after they took new reform course

5 Conclusion

The extent of achievement of students who took the freshman reform course versus those who entered university before the freshman program launched and did not take the freshman reform course towards the basic language of mathematics concepts on their first day at university was investigated in this study.

Groups that took the reform refreshment course outperformed those who did not and who joined the mathematics department before the reform refreshment course. Students who took the refreshment course in the new governmental reform performed better than those who didn't have the opportunity to pass through the reform's freshmen course.

The finding specifically indicates that students who took the mathematics refresher course (Math. 101) performed better than those who did not take the basic language of mathematics course in their freshman year.

As a result, the key contribution of this finding is that:

1. the new reform of the freshman course plays a significant role in improving the success of all students in mathematics.
2. to increase the success rate of students in mathematics, this study has proven that they are trainable [not clear], and therefore, the teachers who give new reforms to freshman courses have to nurture all students.

References

Anderson, L., & Krathwohl, D. (2016). *Anderson and Krathwohl- Understanding th eNew Versions of Bloom's Taxonomy*. Retrieved, from http://www4.uwsp.edu/education/lwilson/curric/newtaxonomy.htm (2001, 2005), revised 2013 & 2016

Ashcrof, K. & Rayner, P. (2011b). *An Analysis of the Strengths and Weaknesses of Ethiopian Higher Education*. WENR.

Ashcrof, K., & Rayner, P. (2011a). Ethiopian Higher Education; Expansion, Dilemmas and Quality. *ARCHIVE*, 7.

Bekele, A. (2019). *Investigating the Influence of Pre- Calculus Mathematics Refreshment Module to First Year Engineering Students in an Ethiopian University: With Special Reference to First Year Engineering Students*. Retrieved from https://uir.unisa.ac.za/bitstream/handle/10500/25761/thesis_asnake%20muluye%20bekele.

Belina, R. G. (2012). Prior or Background knowledge. *The University of Oklahoma*. (pp. 1-12). http://www.ncrel.org/sdrs/areas/issues/students/learning/lr100.htm (Accessed at 6/7/2017: Mid - continent comprehensive center (MC 3) regional ELL/CCSS Task Force.

Boateng, F. (2020). Higher Education system and Institution, Ethiopia. *Research Gate*, DOI: https://www.doi.org/10.1007/978-94-017-9553-1_449-1.

Brown, S. (2011,). *Measure of shape: Skewness and Kurtosis*. Retrieved, from https://www.scribd.com/document/180694167/SkewStatSignif-pdf.

Embassy of Ethiopia, L. (2020). *google* . Retrieved, from https://www.ethioembassy.org.uk/ethiopias-new-education-development-roadmap-charting-a-course-to-a-brighter-future

Gupta, V. (1999). *SPSS for beginners*. Congress: VJBooks.

Hauser, L. (2015). *Precalculus Students' Achievement When Learning Functions: Influences of Opportunity to Learn and Technology from a University of Chicago School Mathematics Project Study*. Florida: Scoholar Commons; Graduate Theses and Dissertations.

Hui-Ling, P. & Chien, Y. (2017). Educational Reforms with Their Impacts on School Effectiveness and School Improvement in Taiwan, R.O.C. *School Effectiveness and school Improvement*, 72-85.

Kastberg, S. E. (2002). Understanding mathematical concepts: the case of the logarithmic function. Dissertation, Athens, Georgia.

Kastbery, R. K. (2017). Links in learning logarithms. *Australian senier Mathematical Journal*, 27(1) (Accessed in 15/08/2017), 1-20.

Lovric, M. (2009). Mathematics Review Manual. Hamilton, Ontario, Canada L8S 4K1: Miroslav Lovric: Department of Mathematics and Statistics McMaster University 1280 Main St. West.

Mengisteab, T. (2021). Ethiopia: Progressive Education Reform to Radical Change. *The Ethiopian Herald* (Addis Ababa), 1-6.

MoE. (2008). Educational statistics annual abstract: *Education Sector Development Program*, 35.

Mohammed Karim, D. L. (2010). Precalculus Algebra: Original Purpose – Its Relevancy to Students' Needs – and Some Suggestions. *KBM Journal of Science Education*, (2010), 1(2), 19-23.

Mohammed, K. D. (2010:19). Pre-calculus algebra: Original purpose-its relevancy to students' needs- and some suggestions. *KBM Journal of Science Education* 1(2), 19-23.

MOSHE. (2020). Basic Mathematics for Natural Sciences. Addis Ababa, Ethiopia.

Roadmap, E. N. (2020, Feb 4). Ethiopia's New Education Development Roadmap:Charting a Course to a Brighter future. Retrieved from https://www.ethioembassy.org.uk/SPSS. (2004). *Base user guide*. Chicago: South Wacker Drive.

Starke, K. (2021). The Importance of Background Knowledge in Understanding Text. Retrieved from https://www.teachhub.com.

Thangarajah, P. (2020, DEc 21). *Introduction to the Basic Language of Mathematics*. Retrieved from google: https://math.libretexts.org/Courses/Mount_Royal_University/MATH_1150%3A_Mathematical_Reasoning/1%3A_Basic_Language_of_Mathematics/1.0_%3A_Introduction_to_the_Basic_Language_of_Mathematics.

Vasquez-Martinez, C., Giron, G., Luz-Arellano, I., & . Ayon-Bañuelos, A. (2013). The Effects of Educational Reform. *Education Policy, Reforms and School Leadership*, 254-258.

Weber, K. ([Sa]). *Students' understanding of exponetial and logarithmic functions*. Murray, KY 42071. U. S. A.: Murray State University.

Yadessa, M. & Shemelis, M. (2022). In-depth analysis of primary schools performance, financial strength and challenges in Bench-Sheko, Kafa and Sheka Zones, Ethiopia. *Heliyon*, 8(3), 1-7. https://doi.org/10.1016/j.heliyon.2022.e09116.