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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

Asnake Muluye Bekele*

* Department of Mathematics, Dilla University, 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, a country in the Horn of Africa, is surrounded by Kenya in the south, Sudan and South Sudan in the west, Somalia in the east, Eritrea in the north, and Djibouti in the northeast. Ethiopia's formal name is the Federal Democratic Republic of Ethiopia, and it is a federal parliamentary republic with twelve regional states and two city administrations (FDRE). Ethiopia is the second most populous nation in Africa, with a population of about 115 million (Boateng, 2020). Amharic is the country's official working language. It has 90 different languages or dialects (Boateng, 2020). The strategic role of education as a tool for a nation's growth and social advancement is well acknowledged. Not this point, but the effects and results of reform in terms of economic and social development policies, as well as implementation, financing, quality, and effectiveness, which are all desired by all the actors involved in this transformative vision, are the main topics of discussion on a global scale(Vasquez-Martinez *et al*., 2013).

Ethiopia is currently engaged in an ambitious reform process to guarantee the sustainability of its economic development and prosperity. The country's expanding need for skilled laborers was not able to be met by the education strategy, which

* Email: snkmuluye14@yahoo.com; asnakemuluyebekele@gmail.com
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was in place for more than 20 years. The new reform may therefore aid in focusing efforts on reshaping the system and assuring quality above quantity (Mengisteab, 2021). This was due to a focus on quantity rather than quality. Among these reforms, education has been a foremost priority for the government since the coming to power of Prime Minister Abiy Ahmed in 2018. Though the concept of reforming the education sector had been a topic of discussion before his ascent, these reforms were initiated in earnest just over a year ago. As a starting point for the reforms, Roadmap, (2020)stated that the government accepted that previous attempts at educational reform had yielded mixed results.The reform, which is being introduced by the new government, has opened an opportunity to foster holistic development throughout the nation and will have a key role in producing competent professionals who can compete effectively in the labor market and equipping them with the skills needed to promote sustainable development (Mengisteab, 2021).

In addition, the reform has a key role in addressing gaps in higher educational institutions, which are the main sources of skilled and educated manpower. This gap has put a question mark on the country's ambitions for rapid industrialization, as rapid industrialization depends on the availability of highly skilled and competent manpower that can execute activities accordingly. In this regard, quality education is a foundation that can play a pivotal role in shuttering skill shortages and knowledge gaps. Educational changes necessitate a broad evaluation of their motivations, goals, implementation, and outcomes by people who work in the educational systems where they are implemented (Vasquez-Martinez *et al*., 2013).

Higher education in Ethiopia includes several positive aspects as well as some systemic, pervasive problems. The reports' limited ability to encourage development stems from the fact that they are currently confidential to institutions and the government (Ashcrof & Rayner, 2011). Reform's primary objectives are to assist students in connecting and applying these concepts to real-world contexts, as well as in better understanding the fundamental concepts and issues in a variety of courses. This calls into question the usefulness of change in the mathematical community. It is expected that the reform will progress to produce competent mathematicians. Reform may have the advantage of educating students about the typical steps involved in practicing mathematics, such as formulating hypotheses and seeking out counterexamples. It has also enhanced mathematics by promoting the use of real-world examples.

1.2 Statement of the Problem

The Ethiopian government prioritized science, technology, engineering, and mathematics (STEM) subjects. Since its inception, one of the principal goals of mathematics education has been to raise the interest of students in mathematics subjects, develop their capacities to engage in scientific inquiry, develop their problem-solving capacity, and teach them how to reason in a scientific context. Among many problems observed in the Ethiopian education system, students' low achievement in mathematics was the major one. The imperative in recent years about improving student outcomes is also about improving the quality of the teaching workforce. Students' quality itself is an important factor in determining gains in student achievement. The main motive for investigating students' background knowledge is to improve student outcomes. On the other hand, to improve students' quality, it is crucial tounderstand what their background knowledge involves.

Thus, this study focuses on students' background knowledge as a key factor in their performance in mathematics. Several studies (Bekele, 2019; Prescott, 2022; Starke, 2021) stress the importance of the background knowledge students hold. Before higher education reform, students joined the Mathematics Department as their last chance to stay in university. The mathematics departments are accepting such uninterested candidates that they even have no awareness of the basic mathematical operations and concepts.

In recent years, it has become increasingly difficult to recruit and retain qualified BSc Mathematics students. There is also concern about attracting high-achieving and motivated candidates to BSc mathematics programs. To overcome the mentioned problems in teacher education in hard science courses

like mathematics in particular and the education system in general, the Ethiopian government prepared the Roadmap with the purpose of: fostering holistic development in all citizens; equipping citizens with confidence and competence; promoting critical thinking; producing competent professionals to compete effectively with their counterparts in the global marketplace; spurring entrepreneurship and innovation within a framework of social responsibility; and building a citizenry with strong ethical and moral values based on the pursuit of justice, peace, and unity in diversity (Roadmap, 2020).

More specifically, the roadmap recommends a fundamental shift in the way that education is administered and practiced in the country, calling for an educational system founded on indigenous knowledge that is supportive of national development goals and encourages civic engagement (Roadmap, 2020). Though the Roadmap's ambitions and implementation are still in their infancy, the course it charts is welcome news for an educational sector, particularly for mathematics in need of reform and mathematics desperate to unleash the untapped potential of its best and brightest. In order to alleviate the problem fundamentally, examine its implications for the instructional process, and derive evidence-based suggestions for educational policy, it is necessary to conduct a study on the impact of the currently underway reform of higher education from wider or narrow perspectives. .

In any study of mathematics, the language of mathematics plays a vital role (Thangarajah, 2020), which is intended to provide a comprehensive and rigorous account of the basic concepts and materials from mathematics that necessitate a good foundation to treat fundamental mathematical tools in science. The newly launched Ethiopian higher education reform, the first-year freshmen mathematics course for natural science, rigorously discusses the basic concepts of logic and set theory, the real and complex number systems, mathematical induction, least upper bound and greatest lower bound, functions and types of functions, polynomial and rational functions, logarithmic and exponential functions, trigonometric functions, hyperbolic functions and their graphs, and analytic geometry (MOSHE, 2020). 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

$N1$: 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

It is important to see the impact of the new higher education reform in Ethiopia, even though over the past 27 years, education in Ethiopia has made progress in quantitative but not qualitative terms (Yadessa & Shemelis, 2022). The higher education system is fraught with challenges and issues bordering on quality. The common goal is to create a healthy educational environment for students (Hui-Ling & Chien, 2017). And nobody would deny the strategic nature of education as a vehicle for development and social progress. The focus of global discourse on the topic is not this particular point, but rather the quality and effectiveness of the reform's effects and consequences, which are what all the parties involved in this transformative vision want to see (Vasquez-Martinez *et al.*, 2013). The advantages of reforms and the degree

to which they will be advantageous are often unclear. Many students of mathematics suffer greatly from this uncertainty. It appears crucial to evaluate the relative advantages of reform in mathematics improvement. Above all, there's a big difference in timing between when the original educational reform is implemented and when it becomes clear whether or not the change will have the desired effects.

2 Research Method

2.1 Population and Sample

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 re-form'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 reform's 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 research was designed to investigate 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 was used to show 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 statistical 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, skewness, 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

$N1$: 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

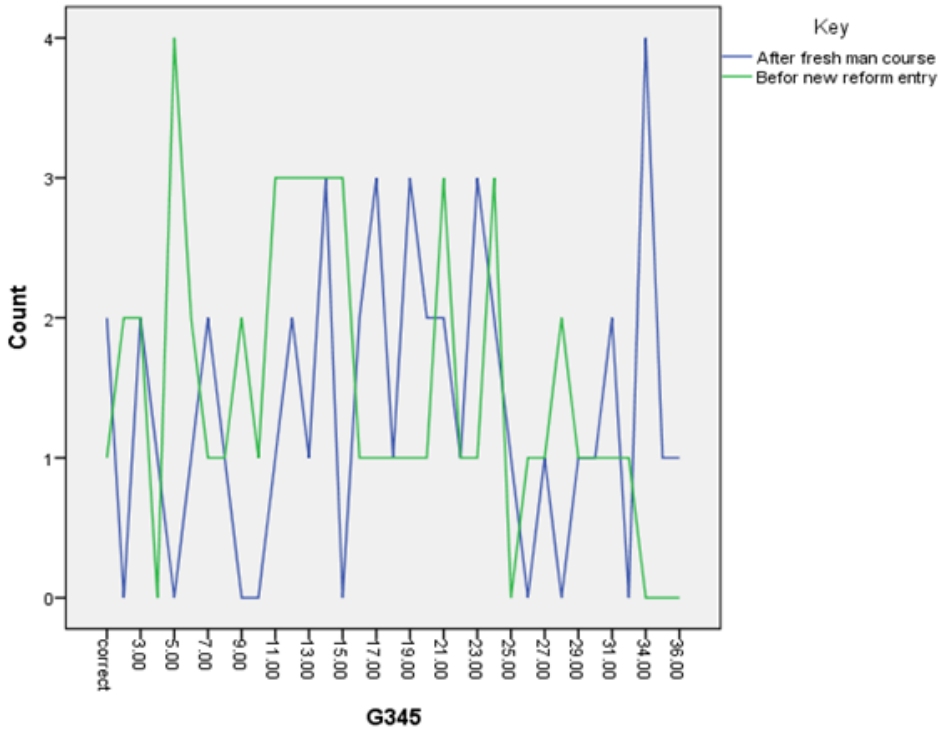

Figure 1: Distribution of two groups

4 Discussion

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: "Skewness" characterizes the symmetry of the collected data distribution. If the distribution of data is skewed to the left, we call it negatively skewed. 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.

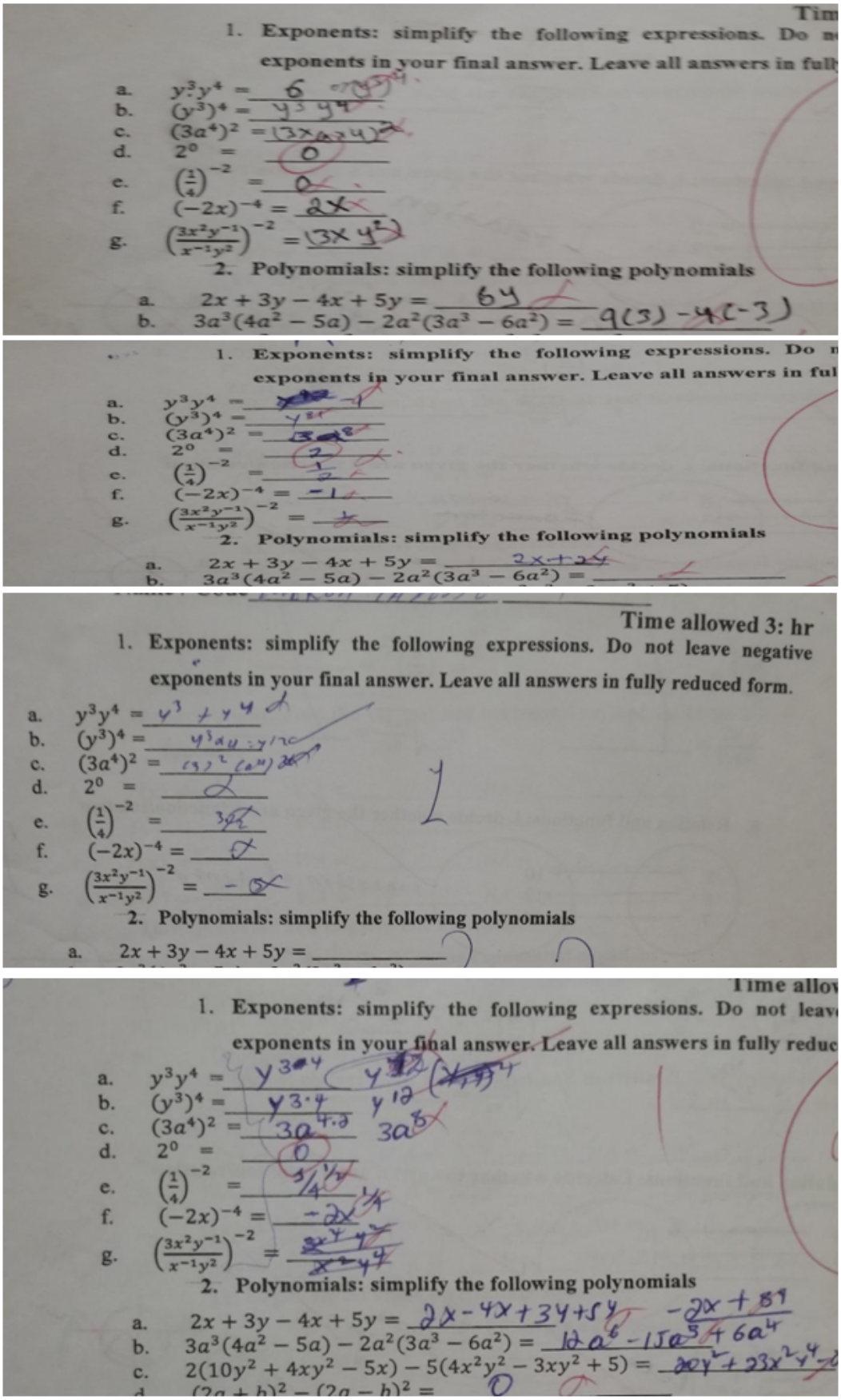

Figure 2: Five students work before new reform

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

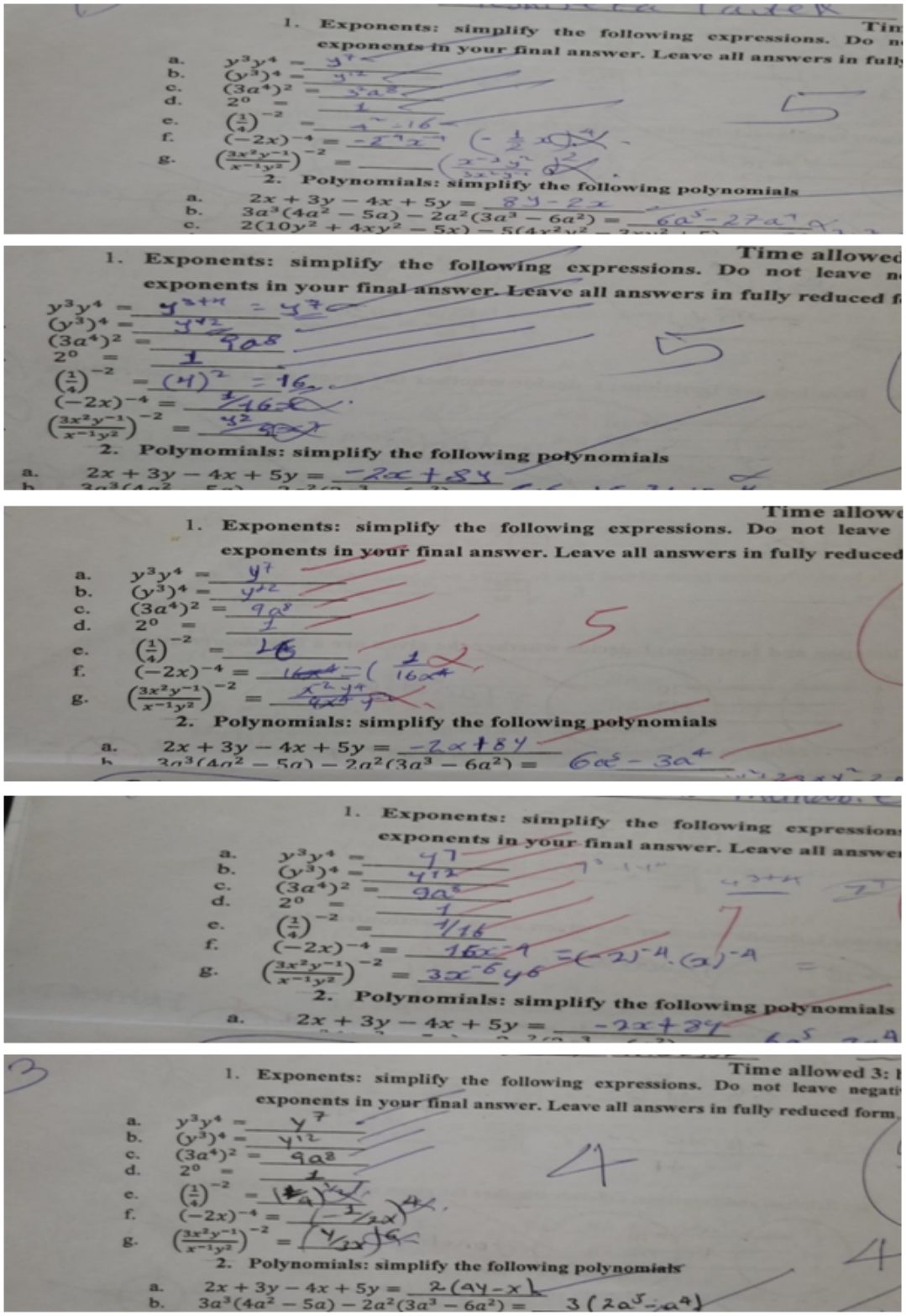

Figure 3: Five students work after they took new reform course

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.

5 Conclusions

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.