



Mathematics Learning of Rwandan and South African Grade 6 Learners

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Abstract: *A substantial body of literature exists on learning and how it is related to learners' backgrounds and the type and quality of teaching they experience. Most studies compare the learners' test results before and after an intervention or a period of teaching (Aungamuthu & Christiansen, 2013). Yet, differences in scores cannot be understood without also considering what Aungamuthu and Christiansen refer to as the 'stability' of their answers. The data used in this paper were collected in 2009 and 2013 in South Africa and Rwanda respectively, and has been analyzed using the Excel and SPSS software packages. In the Rwandan context, 638 grade six learners participated on both pre- and post-tests at the beginning and at end of the school year, whereas 1211 South Africa learners participated on the same Tests. The results show that Rwandan learners did better at the beginning of grade 6 than the South African learners, in the more basic numeracy questions which fall into the second and third SACMEQ numeracy levels. The Rwandan learners improved their scores substantially more than the KwaZulu-Natal (KZN) learners with 9.2. and 2.9 percentage points improvement respectively, which implies that the Rwandan learners learnt more in their grade six studies compared to their South African counterparts. It could be feasible to interrogate teaching in both countries in our coming papers to understand more about these differences in learning improvements.*

Keywords: *Grade 6, Mathematics performance, Learning gain, Learner performance, South Africa, Rwanda; stability of answers*

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1. Introduction

Whereas Southern and Eastern Africa Consortium for Monitoring Educational Quality SACMEQ conducts regular studies of learner performance across a number of African countries, and some African countries take part in Trends in International Mathematics and Science Study TIMSS and The Programme for International Student Assessment PISA studies, Rwanda has not been part of such studies, nor has conducted any of its own. Thus, we set out to conduct such a study, using the same instruments and methods that were used in the earlier KwaZulu Natal (KZN) grade 6 mathematics learning study (Aungamuthu, Bertram, Christiansen, & Mthiyane, 2010), in order to allow for comparisons between the two cohorts. The method we used to get a sense of mathematics learning in the above-mentioned countries is

described in this paper. The post positivist researchers believe that there is always a cause for a given event to occur (Plack, 2005). In the view of post positivist researchers, the meaning of our study could be to interrogate the causes behind the differences in learning between the two countries. However, researchers were not interested in the cause and effect relationship, we do recognise that learners' performances are influenced by various factors (Carnoy, Chisholm, & Chilisa, 2012). Class size is one factor among these which have been put forward by (Alrabai, (2016) and Diaz, (2003) as having an impact on learners' achievement. In the Rwandan context this cannot be ignored. Even though the new Rwandan policy of education for all, coupled with the construction of new classrooms, has reduced the number of learners per teacher, some classrooms, especially in public schools where education is free, have considerable

numbers of learners, which makes class management difficult for teachers, especially in remote, rural area. Alrabai, (2016) also posits that parental factors i.e. the way learners' parents perceive education related to their level of schooling; and learners teachers' knowledge are also factors worth considering while investigating learning gain. Diaz, (2003) noted that all these factors are to be related to the context in which they are applied as they vary from one context to another (here, we note school location, availability of learning facilities within schools etc.). This is in line with what Hwang and Chang (2011) and Gordon, Dwayne, and Melvyn, (1994) argued that learners' previous schooling is also a factor in learning achievements. This factor may be significant in developing countries like Rwanda and South Africa in which the majority of children might not have access to quality pre-primary education (Maniraho & Christiansen, 2015).

2. Literature Review

The way learners accommodate new information, known as learning preference (Reid, 1995), has been considered as a factor which can influence learners' performance. Some learners are visual, other are verbal; write/read; kinaesthetic and multimodal learners (Fleming & Mills, 2001) which implies that the method used by teachers in classroom settings should not be ignored while investigating learners' performance. To reiterate, even if this paper does not investigate learners' performance, it has allowed for an exploration of learning gains by making sense of the differences in the performances of Rwandan and South African learners' pre-and post-test mathematics results. With regard to the above, researchers acknowledge that assessing learning is not a simple task, mainly due to the way in which researchers perceive it. Some scholars conceive learning in line with the Oxford Dictionary where it is taken as the acquisition of knowledge or skills through study, experience, or being taught, whereas others understand it as performance gains considered as progress in test scores over time (Christiansen & Aungamuthu, 2013). However, the challenge arises when some of the learners may answer some of the multiple choice questions correctly in the pre-test, but fail to answer the same questions correctly during the post-test (Christiansen & Aungamuthu, 2013). Even if someone may think that it may point to the way examiners set the pre-and post-tests, the modification of multiple choice items done by Kettler et al., (2011) in their work showed that there was no meaningful difference in reliability between tests in the original item condition and the modified item condition. Besides, they do not ignore the fact that on one hand one change can make an item simpler and more understandable, while on the other hand the same change can have the reverse result when used on a different item. This challenge has made researchers wonder if learners

were answering the multiple choice test questions simply by guessing, as observed by inconsistency in answers. This is in line with what has been posited by McNamara, (2011) and Dempster (2007) that learners had different strategies reflecting guessing while answering the given multiple choice test, namely: rejecting answers containing unfamiliar words, selecting answers that contain words that are also in the question or selecting an answer based on the pattern of choices in preceding items, which is in support of the argument raised by Christiansen and Aungamuthu (2013) that when researching learner performance on multiple choice tests, researchers must always consider that guessing is a probable action. However, it is also known that learners may tend to improve in their educational outcomes over time, often due to increasing maturity (Marsden & Torgerson, 2012). This also needs to be taken into account.

Different authors put forward various factors which can control students' learning gain (Maniraho, 2017). Such factors include but not limited to students' background in their lives to mean their social economic status, their teachers' declarative knowledge and to their teachers' practical pedagogical content knowledge.

Taking into consideration the data from SACMEQ III, it was observed discrepancies within students' results (Spaull, 2013). Those, were related to the fact that, South Africa was exhibiting two school schemes in one, that is a group of affluent people against the remaining ones.

In Rwanda, Maniraho, (2017) in his work, noted that 43.5% of the learners' family were living in their own houses. Even if learners reported that 74% had electricity, 70.7% with TV sets and 31.9% with computer/laptop, only 24.5% informed that they had internet access in their homes. Again, almost half of the learners informed that they did not have books to read in their families. Researchers inform that, for Rwanda side, the number of private schools was 29.9% of the sampled schools (ibid.). The expectation was that electricity possession, computer or internet access at learners' homes would have a link with learners' learning gain but that was not the case for Rwanda side (Maniraho, 2017). In that same study, it was found that the age of the learners matters in their learning because learners who were younger performed well compared to the older ones.

Regarding the teachers' declarative knowledge, in Rwanda, no link found between teachers' content knowledge and their learners' learning gain (Maniraho, 2017). However, a weak but significant correlation was found between teachers' pedagogical content knowledge and their learners in the administered pre-test.

Some classroom teachers' practices had positive correlation with learners' learning gain, whereas other practices had negative correlation with learners' learning gain (ibid.). This has been the case of types of

mathematics connections made by teachers when teaching. On one hand, it has been posited that making connections in teaching mathematics helps in learners' learning gain. On the other hand, process feedback was negatively correlated to learners' learning gain.

3. Methodology

The research on which this paper is based falls into the concurrent triangulation design which allows the use of two different data collection methods in one study (Creswell et al., 2008). Researchers have collected a variety of data including learner tests results at both the beginning and towards the end of the school year, as well as having administered a learner questionnaire, a teacher questionnaire and a teacher test including content knowledge and pedagogical content knowledge questions. Furthermore, video-recording lessons was taken of at least one lesson with each teacher who participated in the study.

3.1 Sample

Using random stratified sampling, 20 primary schools across seven districts in Rwanda were selected and 39 primary schools were selected in KwaZulu-Natal province of South Africa. The sampling took into account the socio-economic situations of the schools in both countries. However, researchers would like to clarify that the South African sample included only public schools, whereas the Rwandan one included both public and private schools. This is due to the sample selection method used.

3.2 Data collection

Before starting data collection, ethical clearance was obtained by researchers from the University of KwaZulu-Natal. Researchers also requested and were granted permission from the Ministry of Education in Rwanda to collect data in Rwandan primary schools. In reference to ethical issues, allowing for their anonymity ensured the protection of our research participants. Numerical codes were used to protect the identities of participants as well as the names of schools sampled in this research.

For the purpose of this paper production, researchers used the data collected through pre- and post- learner tests. The test, which was used, included forty multiple-choice questions focusing on the grade five and six content materials/ syllabi. To enable comparisons, apart from a few changes like place names within the questions; the test was the same in both Rwanda and South Africa. However, the two national curricula are not identical, so there were items included in the Rwandan study which South African learners were unlikely to

have encountered, even by the end of grade 6. It was an individual learner test, where each learner was supposed to answer all the questions individually without assistance and without the use of electronic materials.

Even if English was not the mother tongue of most of the learners who participated in this study, the fact that it is the language of instruction in both Rwanda and South Africa meant that the test was composed in English. However, researchers acknowledge potential language-related disadvantages, which might have arisen for learners in both countries. As posited by Christiansen and Aungamuthu (2012) that in South Africa there is a considerable link between language and learners' performance and taking into account the recent change of the language of instruction in Rwandan schools from French to English (Gahigi, 2008, Kagwesage, 2013).

3.3 Data Analysis

The data pertaining to both countries was captured into an Excel spread sheet, and it was coded based on the eight numeracy levels from SACMEQ studies, to allow for a comparison of how learners answered every question in the test. However, in the test given, there were no questions on level eight and only two questions on geometry, which fell into level one and, seven of the SACMEQ levels. Due to these being the only questions relevant to the above levels in the test, we opted not to generalize the results from those questions to the respective levels.

4. Results and Discussion

The Rwandan learners, in both private and public schools, outscored the South African learners on SACMEQ level two and three, as well as slightly on level five and six questions. When it comes to basic operations at the lower SACMEQ levels, 72% - 86% of the Rwandan learners gave the same answer in the two tests, indicating substantial learning retention, whereas amongst the South Africa cohort, only 40% -53% of the learners did the same. Researchers also considered the performance on the different curricular topics, following the five outcomes in the South African curriculum as a guideline, but with sub-divisions of learning outcome 1 (number). The Rwandan learners performed much better on basic operations, word problems, and somewhat better on number pattern and measurement questions. Researchers also found that the Rwandan learners exhibited higher stability of their answers on these topics. Researchers note that there was one question which showed its self as an outlier where 10.5% of the learners selected the correct answer on the pre-test but then 94.0% of those students selected the same answer during the post-test.

Looking at the questions where 75% or more of the learners who selected the correct answer in test 1 selected

the same answer in test 2, there were 16 such questions amongst the Rwandan learners, but only two such questions for the South African learners. Similarly, 89% of the Rwandan learners who chose the correct answer on a basic operations question in test 1 maintained the same

answer, compared to only 57% of the South African learners. Referring to Table 1 and taking into consideration the improvement that occurred in the tests, the Rwandan learners improved their scores substantially more than the KwaZulu-Natal learners.

Table 1: Test score improvements

	Mean in test 1	Mean in test 2	Percentage point improvement	Relative improvement
South-Africa	29.6	32.5	2.9	9.8%
Rwanda	41.1	53.3	9.2	20.8%

In Rwandan schools, the improvement was greater in the private schools with a mean improvement of 11.5 percentage points compared to a mean improvement of 8.2 percentage points in the public schools. This average does however disguise huge differences between schools, ranging from 2.4 percentage points to 58.4 percentage points. In the KwaZulu-Natal study, only 45% of the learners improved their score by more than one mark between the two tests, while this was the case for 68% of the Rwandan learners in the study. More than a quarter of the KZN learners lost marks between the two tests, while the same applied to only 14% of the Rwandan learners. This implies that more Rwandan learners learned more even if some still appeared to have “unlearned or it possibly a reflection of the guessing tactics of some learners.

The Rwandan learners learned more on the middle SACMEQ levels and appeared to learn more of the content covered in the grade. This was shown by their development in numbers sense questions during grade six and their minor improvement in word problems, fractions, and in the private school also on data handling. The Rwandan learners’ improvement in basic operations was modest, in part because they already did well in this in their first test. However, the learning gains in geometry were low for both cohorts.

In the test, there was one question on order of operations where all the Rwandan learners improved immensely. In

test 1, most Rwandan learners picked the answer that would have been correct if they had simply worked from left to right. In test 2, almost all the learners provided the correct answer. This topic is only covered in grade 6 in Rwanda, and so the results indicate that it was taught across all schools, and was learned by most of the learners.

Looking at the questions individually, the South African learners generally did not change their score by much between the two tests. The exceptions were two questions, namely question 21 and 25 (Cfr, Maniraho, 2017), where the mean score improved by 11 and 10 percentage points, respectively. Comparing this to Rwanda, in 19 of the 40 questions the private school learners improved their score by more than 10 percentage points, and 3 of these questions showed an improvement of more than 20 percentage points. The results for the public schools were slightly less impressive, but they still improved their score by more than 10 percentage points on 13 questions, one of these by more than 20 percentage points.

The results also showed that the Rwandan learners gained more compared to the South African learners. Referring to Table 2, this was also enhanced by their reliability differences on their answers between the two tests.

Table 2: Illustration of learner performance changes**Table 2.** Illustration of learner performance changes

Score change between two tests		-5 or more	[-2,-4]	[-1,1]	[+2,+4]	>or=to 5
South Africa.	Number of learners	104	226	339	323	219
	Percentage of learners	8.6%	18.7%	28%	26.7%	18.1%
Rwanda.	Number of learners	23	57	121	173	264
	Percentage of learners	3.6	8.9%	18.9%	27.1%	41.3%

The inconsistency shown by some of the learners might be associated with what has been argued by Christiansen and Aungamuthu (2012) as being linked to home language - learners whose home language was not English showed more misconceptions in their answers. The majority of Rwandans (90.8%) speak Kinyarwanda at home (as their mother tongue), while 5.6% speak English, 2.6% speak French, and the remaining 0.8% communicates in other languages. Similarly. In South Africa only 7.4% of the population speak English as their home language whereas the majority i.e. 90.5% speak isiZulu at home (Christiansen & Aungamuthu, 2012). In relation to the above argument by Christiansen and Aungamuthu, it was then obvious that learners were likely to have misconceived or misunderstood the questions in some cases. This could also be justified by the fact that 27.3% dropped their score by -2 or more between two tests on the South African side, which was also the case for 12.5% of the Rwandan learners.

In a study of grade 6 mathematics learning in South Africa, it was found that a substantial number of learners actually changed their answers between the pre- and the post-test (Aungamuthu & Christiansen, 2013). On one hand taking into account the Pearson correlations between learner test results and learning gain in Rwanda, results showed that learners' pre-/post-test results were correlated with a correlation coefficient of 0.657, p-value = 0.000. The learning gain was negatively correlated to the results on the pre-test with a correlation coefficient of -0.301, p-value=0.000. This may mean that learners who performed well in the pre-test tended to have lower improvement in scores. On the other hand, learning gain was positively correlated with the post-test results with a correlation coefficient of 0.503, p-value = 0.000. This is not surprising as the learning gain is more linked to a good post-test result.

5. Conclusion and Recommendation

In this paper, we explored the learners' learning gain in Rwanda and South Africa. We interrogated on the stability of the learners' answers by taking into

consideration their responses in two tests. Some stability differences were observed in the two groups. Again as previously stated, we were not interested in the cause and effect relationship in this study. However, Darling-Hammond (2008) confirms that there is a positive correlation between learners' learning and their teachers' content knowledge. In this study the situation confirms that both teachers' Pedagogical Content Knowledge (PCK) and Content Knowledge (CK) are positively associated with learners' learning gains. The statistics showed the t-values of 3.359 and 3.414 are significant with p-values of 0.0008 and 0.0006 for teachers' PCK and CK respectively, which is not far from what Hill, Rowan, and Ball (2005) argued that teachers with good PCK are likely to transmit mathematics content efficiently.

In forthcoming papers researchers will address how teachers who participated in this study teach. This is in line with what has been confirmed by Hill, Rowan, and Ball (2005), that teachers' mathematical knowledge for teaching may forecast the learners' gains in mathematics achievement. In another way, the learners' gains or achievements may reflect their teachers' knowledge for teaching. In this study, as mentioned previously, the correlation between learners' gains and teachers' knowledge is positive and significant.

The results presented and discussed in this study are significant as they reflect and give an image of consistence in the thinking of grade six learners sampled from both countries, as one element, which reflects learning. The above results not only statistically show the learning gains but also illustrate some of the intrinsic elements like the changes in answers, which were not easily observable while considering the overall learning gains. Having collected huge data under the project which this paper is extracted from, researchers' next papers will interrogate other factors like learners' backgrounds including socio-economic status, which might be behind the learning gain differences in both Rwanda and South Africa. Future paper works will also

engage in a detailed analysis how the audio-visual recordings of teaching are related to learner performance.

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