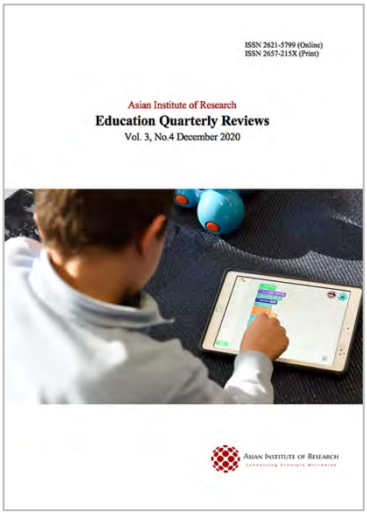

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Students' Academic Achievement in Secondary-School Quantitative Economics: Effect of Feedback with Remediation

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Abstract
Empirically investigated in this study is the effect feedback with remediation has on academic achievement in quantitative economics among students' of secondary school. The design of the study was quasi experimental. 164 Senior Secondary 3 (SS3) students offering economics in the three co-educational schools consisted of the study sample. The three schools were purposely selected from Nnewi Education Zone of Anambra State in Nigeria and allocated to 2 experimental groups and 1 control group. Students' responses to two instruments titled Diagnostic Quantitative Economics Skill Test (DQEST) and Test of Achievement in Quantitative Economics (TAQE) constituted relevant data used in the study. ANCOVA was used for data analysis. Results show that feedback with remediation has a significant effect in enhancing students' achievement in quantitative economics. Nevertheless, gender and treatments did not interact to influence achievement in quantitative economics. Teachers need to focus not just on continuous testing but going further to assist students using feedback with remediation on any type of test given to them.

Keywords: Achievement, Feedback, Quantitative Economics, Quantitative Skill, Remediation

1. Introduction

Mathematics and statistics are a prominent part of the economics curriculum. Economics as a subject involves mathematical and theoretical analyses, requires thinking, and reasoning especially in relation to the aspects that involve calculations. Though an increase in the number of economics students was noted, achievement in economics has dropped since more features of mathematics were integrated in the economics syllabus (quantitative economics) (Adu, Ojelabi, & Hammed, 2009; Ugan, 2017). Facts and figures for May/June 1996 – 2010, Senior School Certificate Examination (SSCE) results in economics of which less than 50% of the candidate had credit and above (A1- C6) serves as a backing to this claim. This situation can be attributed to the negative views or feelings which students have for mathematics or subjects requiring quantitative skill.

Furthermore, the West African Examinations Council (WAEC) Chief Examiners noted that most economics candidates could not attain high marks on questions involving calculations (mathematical/quantitative aspects of economics) (WAEC, 2012; 2013; 2014; 2015; 2017; 2018). Specifically in 2010, the Chief Examiner's report revealed candidates' weakness to be inability to carry out simple substitution of variables into an equation. In 2012 and 2013, the Chief Examiners' report showed that some examinees are not able to compute values from graphs. This weakness resulted in their poor achievement especially in questions where such analyses were required. Also in 2014 and 2015, the Chief Examiners' report showed that the greatest part of the examinees who recorded low grades in the economics questions is deficient in simple quantitative skills. This deficiency is displayed in their incompetence to carry out simple statistical applications. In WAEC 2017 and 2018, most candidates could not obtain the high marks in questions involving calculations (WAEC, 2012; 2013; 2014; 2015; 2017; 2018). The Chief Examiners noted that only few of the candidates could interpret demand function answers and that most candidates who attempted the question on balance of trade were unable to calculate it; hence they could not obtain high marks. This situation has actually drawn the attention and interest of economics educators, scholars, psychologists, school administrators and parents from WAEC participating countries like Nigeria (Ajayi, & Muraina, 2011; Amuda, Ali, & Durkwa, 2016).

As averred by Anazia (2019) and Ugan (2017), the poor achievement of students at WAEC causes a lot of curiosity to the general public as to the prospect of education in these West African countries. Different researchers (Adu et al., 2009; Chudi, 2013; Ugan, 2017) have identified so many factors as accountable for the low achievement of WAEC candidates particularly in economics. These factors include among others a lack of skills in quantitative economics (Adu et al., 2009; Anazia, 2019; Chudi, 2013). Quantitative economics is the aspect of economics that involves mathematical/statistical analysis. It requires solving problems involving numerical economics quantities. Whereas, quantitative skills are mathematical skills, it involves capability to use figures and mathematical signs analytically; to interpret the meaning of numbers in mathematics (Varian, 2013; Williams, 2011). Quantitative skill is a student's capability to use the understanding of mathematical perceptions and codes and associate mathematical words (Boyle, 2019; Wilder 2020). The skill of using numbers to represent the values of attributes. Quantitative skill is manifested by a student's capability to answer arithmetical questions easily. It also consists of arriving at numerical solutions to a question, as well as the ability of adding, subtracting, multiplying and dividing of numbers (London School of Economics and Political Science (2016). In order to develop their skills, knowledge and understanding in quantitative economics, secondary school students need to have acquired competence in the quantitative sub-skills that are relevant to the subject content (Riley, 2015).

Several studies in education literature had established the importance of quantitative skills in aiding students to be successful in their study of economics as a subject. In 2003, Bachan and Reilly proved that mathematics test scores had a significant effect on achievement in the economics subject. They posited that students' achievement in SSCE mathematics has a solid impact on their achievement in economics. They also noted that secondary school students' quantitative skill might be a sign of success in university education. Later research by Chudi (2013), Joyce et al (2006), Pozo and Stull (2006), and Wilder (2020) indicated that a link exists amid students' accomplishment in completing economic subjects and mathematics/quantitative proficiency as well as students' numeracy abilities in learning accounting. Lacking quantitative economics skill has resulted in economics

students' inability to answer SSCE questions involving calculations. This is evident in WAEC Chief Examiners' reports of 2012, 2014, 2017 and 2018. The Chief Examiners of WAEC suggested that candidates of all gender need to be stimulated to develop quantitative skills in economics prior to examinations.

Students' low performance in economics was also attributed to the current trend or pattern of constant testing with no feedback, and or feedback without remediation by classroom tutors during the evaluation process. Additionally, students are sometimes given test feedback when final examinations on the subject have been written (Ajogdeje & Alonge, 2012; Boyle, 2019). Such delayed test feedback barely has an impact enhancing the student's achievement in economics. It then turns out to be vital for tutors of economics to have sufficient understanding of quantitative economics and teach it with the required sequence, steadiness and assimilation to their students' specific strengths and weaknesses. The present pattern of constant testing with no feedback and no feedback with remediation by quantitative economics teachers needs to be replaced for an improved achievement in quantitative economics. Economics teachers could seek a comprehensible instructional assessment procedure which comprises diagnoses of students' specific errors in quantitative economics, provision of feedback of students' results and a corrective measure-remediation.

The effectiveness of feedback and remediation in the evaluation process has been emphasized by different researchers. In the study conducted by Ajogbeje and Alonge, they observed that students do have the opportunity to go through the correct answers when given feedback, or feedback with remediation. Students thereby have additional insight on the test content which in-turn can enhance their performance in future attempts. Consequently, a student may develop interest in a subject and may like to discover new ways he/she can do better in future tests if the information of his/her previous successful test result is provided to him/her. Knowledge of a negative test result can also influence a student positively. It may motivate the student to try to do well on future tests (Boyle, 2019; Silva, 2020; Zhao, 2013). Boyle, Silva and Zhao argued that if test feedback can diagnostically describe a student's strength and weakness in a subject, it will go a long way to advance teaching and learning outcomes. Non feedback (lack of knowledge of test result) has been linked with partial learning of what was taught, and low in recalling what was learnt (Haghani, Khorami & Fakhari, 2016; Silva, 2020). On his part Boyle claimed that lack of knowledge of test results can increase nervousness in a student, as the student could not assess his or her capacity and know-how on the test.

It is therefore hoped that when quantitative economics teachers provide students with the knowledge of their test result in quantitative economics and proper remediation of their weak learning points given their skill in quantitative economics will improve. It can as well lead to an improved performance in the quantitative aspect of economics. Therefore, this current research is intended to examine how students' academic achievement in secondary school quantitative economics is affected by feedback, and or feedback with remediation. Furthermore, studies have equally indicated that gender influences student's academic achievement (Ajogbeje and Alonge, 2012; Amuda, Ali, Durkwa, 2016; Atsumbe et al, 2018; Dania, 2014). In this study, the possible effect of gender on students' achievement in quantitative economics was also determined. To carry out the study, the researchers tested the following formulated research hypotheses for rejection or otherwise at 5% level of significance:

1. There is no significant difference amid the mean achievement test scores in quantitative economics of students in experimental groups and control group.
2. There is no significant effect of gender on students' achievement in quantitative economics.
3. There is no significant interaction effect of treatment and gender on students' achievement in quantitative economics.

2. Conceptual Framework

The conceptual framework for this study proposed that there are key components - achievement test, diagnostic test, feedback and remediation which academic achievement of students in quantitative economics could be improved. Generally, application of diagnostic test as pointed out by "Evaluation and enrichment" (n.d) provides feedback which is to direct the teacher in preparation of materials for remediation of different specific learning weaknesses faced by the students. While application of diagnostic tests aids the teacher to investigate student's

learning difficulties and the reasons for this, its follow up leads to remediation. That is, actions that may help to circumvent reoccurring of students' learning difficulties. The teacher undertakes this kind of probe or diagnoses into the performance of students to ensure the quality of learning and to know what specific action should be taken to obtain the desired learning outcomes and to facilitate goal attainment. This specific action to be taken is in the form of corrective measure, termed remediation.

In using feedback and remediation, the students should be compelled to do exercises in the relevant area of difficulty as indicated in the feedback until mastery is achieved. Then an achievement test should be administered to ascertain the current state of students' mastery or to assess the impact of remediation. This framework is what this study is built on as it seeks to find out the effect of feedback and remediation on students' achievement in secondary school quantitative economics. The framework of the study is illustrated further in Figure 1.

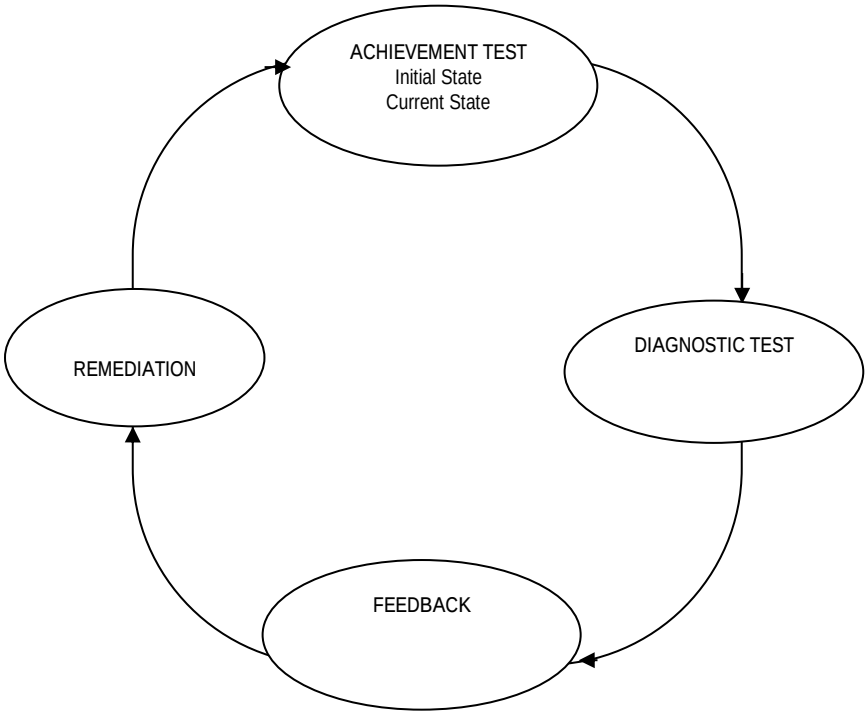

Figure 1: Framework showing the relationship between diagnostic test, feedback and remediation in evaluation process.

3. Method

This study is quasi experimental using 2x3 factorial pretest-posttest designs. The 165 Senior Secondary 3 (SS3) economics students -62 males and 103 females- from three coeducational secondary schools in Nnewi education zone, Anambra State, Nigeria constitute the study sample. These three schools were selected from different Local Government Areas using purposive sampling technique while simple random sampling technique was used to allocate the three schools to the three experimental groups. Group I was given a diagnostic test with feedback and remediation, Group II was given a diagnostic test with feedback treatment, and the control group - Group III was given diagnostic test only treatment.

Instruments for data collection were Diagnostic Quantitative Economics Skill Test (DQEST) and Test of Achievement in Quantitative Economics (TAQE). The two instruments were existing instruments developed by Esomonu and Eleje (2017) and Eleje and Esomonu (2018) respectively. In this study, DQEST which consisted of fifty multiple choice questions from the nine sub-skills of secondary school quantitative economics contents was divided into four sections and used as treatment. The twenty multiple choice questions of TAQE served as pretest and posttest to the study. The collected data were subjected to Analysis of Covariance (ANCOVA) to test

the rejection or otherwise of the stated hypotheses at 5% level of significance. When a null hypothesis was rejected, Bonferroni's Post Hoc analysis was conducted to determine where the significance lies, that is the treatment condition that caused the rejection.

3.1 Experimental procedures

The entire process lasted for 10 weeks. The first week was for training the research assistants (economics class teachers), the second week for pretest, then seven weeks of 14 sessions for treatment proper, and the last week was for posttest.

3.1.1 Training of research assistants. The experimental procedure involved the identification and training of three research assistants one for each school so as to evade class disturbance and remove the Hawthorne effect. The researchers organized three days training for the three research assistants, a day for each research assistant. These research assistants were normal economics teachers in the selected experimental schools. The aim of the training was specially to instruct them concerning the conception, purpose, relevance and guidelines for application of diagnostic quantitative economics skill test, feedback and remediation. Feedback is but part of the teaching, learning and evaluation process and is that which occurs second after a student has responded to initial instruction or task (Silva, 2020; Hattie & Timperley, 2007). Thus, feedback in this study was a consequence of performance in a diagnostic test. The use of feedback in this study was to affirm the correctness or incorrectness of students' responses to the test given, and to reinforce students' learning outcome in quantitative economics.

The trained economics class teachers administered the pretest (TAQE) to the three experimental groups to determine the level of students' achievement before starting the treatment on the experimental groups. The treatment was systematically implemented for seven weeks during the school normal periods by the research assistants with the researchers monitoring and supervising. One week after the treatments, posttest (TAQE) was administered to the students. The pretest and posttest were similar except that posttest item numbers were reordered. Posttest was administered to the students at the same time.

The experiment did not include the teaching of quantitative economics, since the quantitative economics sub-skills in secondary school are embedded in SS1 first term to SS2 third term curricula. Thus, SS3 economics students used in this study had completed more than 90 percent of the teaching and learning of quantitative economics by the end of their third term in SS2. The treatment packages that were used for the three experimental groups are described as follows.

3.1.2 Treatment package for diagnostic testing with feedback and remediation group (Experimental Group I). Each section of DQEST was administered to the students, followed by the knowledge of their test result which was offered to them during the session subsequent to the test administration. Students' knowledge of his or her test result helps them to affirm a correct response, pinpoint and correct mistakes. After feedback comes remediation. That is, (I) after feedback was provided; (II) items were divided into two or three, based on the number of sub-skills in a section; (III) any of the students with good performance in each sub-skill of DQEST sections were allowed to lead the class discussion; (IV) students engaged in class discussion to solve and to detect the key to each item of a sub-skill in the section; (V) students were allowed to query on hard part; (VI) the research assistant asked inquisitive queries; (VII) students were encouraged to offer responses to the queries amid themselves; (VIII) a new student was named to lead the following sub-skill. The steps in (IV)–(VI) are repeated; (IX) the research assistant (economics teachers) offers assistance wherever needed; and (X) the teacher solves more examples on students' weak learning points in a sub-skill. That is, learning points in which forty percent (40%) of the students have poor performance.

The remediation given to students in this study was to adjust, correct or improve their deficiency in quantitative economics. That is, to close the gap between what a student know and what a student is expected to know in quantitative economics. After the discussion (remediation), answer scripts were gathered from the students before progressing to testing of DQEST next section. The remediation exercise for each section was carried out before the administration of DQEST, feedback and remediation for the next section. In providing the testing of each section of DQEST, there existed no stiff law about the time permitted for the testing of each section in each

group. This was necessary since there were differences in abilities within the group. Thus there occurred an adequate treatment in each group. The treatment in each group was given by the research assistant (i.e., the economics class teacher) in each school in accordance with the guidelines in the treatment manual. The research assistant was also closely monitored by the researchers.

3.1.3 Treatment package for diagnostic testing with feedback group (Experimental Group II). After application of each section of the DQEST, the knowledge of each students' test results were offered to them during the session subsequent to the test administration. That is, before starting the testing of DQEST in the next section. Although in the class with the students, the research assistant did not attend to any queries from the students while giving the feedback. Immediately the feedback ends, answer scripts were gathered from the students before progressing to testing of DQEST, feedback and remediation for the next section. No provision was made for any remediation.

3.1.4 Treatment package for diagnostic testing only group (Experimental group III -control group). Each section of DQEST was administered on the students. They received neither feedback nor remediation.

4. Results

The data collected based on the stated hypotheses were analyzed and the resulting outcomes presented. The purpose of hypothesis 1 was to ascertain the effect treatment had on quantitative economics achievement. To achieve this aim, ANCOVA was calculated. The gains in mean scores in TAQE are shown in Table 1. The Table 1 presents the gains in mean scores in TAQE of students in experimental groups I, II, and control group.

Table 1: The Gains in Mean Scores in TAQE for the Three Treatment Groups

Groups	**N**	**Pretest Means**	**Posttest Means**	**Gains in Means Scores (Difference in Means)**
EXPG I	60	5.88	8.55	2.67
EXPG II	62	5.08	5.98	0.90
EXPG III (Control group)	43	5.14	5.67	0.54

Note: EXPG = Experimental Group

As seen in Table 1, posttest means for the three experimental groups improved, but the gain in mean scores for students in group one who received feedback with remediation treatment was greater when compared to that of the other groups. The result of the ANCOVA is shown in Table 2.

Table 2: Summary of ANCOVA Result for Comparing Posttest Mean Scores in TAQE Based on Treatment and Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	348.485[a]	6	58.081	15.042	.000	.364
Intercept	461.491	1	461.491	119.515	.000	.431
Pretest	65.390	1	65.390	16.934	.000	.097
Treatment	191.667	2	95.834	24.819	.000	.239
Gender	2.513	1	2.513	.651	.421	.004
Treatment * Gender	.912	2	.456	.118	.889	.001

Error	610.097	158	3.861
Total	8670.000	165	
Corrected Total	958.582	164	

R Squared = .364 (Adjusted R Squared = .339)$_a$

The ANCOVA result as seen in Table 2 shows that the difference between the mean achievement test scores in quantitative economics of students exposed to treatments (DQEST, feedback and remediation, DQEST and feedback, and only DQEST) remained significant ($F(2, 164) = 24.819$, p-value < 0.05). Therefore, we rejected the null hypothesis. It then means that main effects of treatments on students' achievement in quantitative economics were significant. Bonferroni's Post Hoc analysis was conducted to decide which treatment condition triggered the rejection of the null hypothesis, and the result is presented in Table 3.

Table 3: The Pair-wise Comparison (Post hoc) of the Treatment Main Effects

GROUPS (I)	GROUPS (J)	Mean Difference (I-J)	Std. Error	Sig.^{b}
EXPG I	EXPG II	2.331*	.387	.000
	EXPG III	2.609*	.417	.000
EXPG II	EXPG III	.277	.394	1.000

Note: EXPG = Experimental Group

As seen in Table 3, DQEST with feedback and remediation treatment provided to the experimental group I caused the rejection of hypothesis 1. It then means that, test together with feedback and remediation was significantly effective in improving students' achievement in quantitative economics. Also, Table 3 indicates a non-significant difference between the posttest mean scores in TAQE of students given tests with feedback alone, and tests only (control group).

Hypothesis two aimed at ascertaining whether gender significantly effects on students' achievement in quantitative economics. Thus, male students and female students' posttest mean achievement scores were compared using ANCOVA. The ANCOVA result for comparing their posttest mean scores in TAQE is displayed in Table 2. The summary of the ANCOVA result reveals that gender did not significantly affect students' academic achievement in TAQE ($F(1, 164) = 0.651$, $p > 0.05$). Thus, the null hypothesis is not rejected.

Hypothesis three intends to check if treatment interaction with gender to affect students' academic achievement in quantitative economics. The ANCOVA result gotten from checking the interaction is also displayed in Table 2. The result reveals that ($F(2, 164) = 0.456$, $p > 0.05$). The null hypothesis is therefore not rejected. This implies that there is no significant interaction between treatment and gender to influence students' achievement in TAQE. This means that gender did not associate with treatments to increase or decrease performance in quantitative economics.

5. Discussion

The findings of this study reveals that only students exposed to feedback with remediation treatment had a significant improvement in their achievement in quantitative economics. This significant progress in quantitative economics could be attributable to the feedback with remediation which the students received after the testing. Application of feedback gives the students the chance to do an evaluation of the information in the feedback (Boyle, 2019; Haghani, Khorami & Fakhari, 2016; Silva, 2020). It also enables the students to observe and identify any error in their responses to the initial test given. Also, it builds in the students the hunger to

understand the correct response and the reason for it. No wonder Zhao in 2013 pronounced that once students are aware of their successful achievement in a test, they would start to cultivate interest in that subject. They can even try to discover possible ways to perform better in successive tests. Consequently, the student needs adjustments to their relevant knowledge, self-efficacy, interests, and goals, hence the need for remediation.

With remediation given to students in this study, they were probably able to adjust, correct or improve their deficient quantitative skills in quantitative economics, unlike the other two experimental groups where remediation was not administered. Thus, the finding of this study supports the role of remediation in the evaluation process. Accordingly, it is in line with an earlier conclusion drawn by The Understood Team (2017), which stated that remediation helps the low achievers to bridge the gap concerning what they should know and what they already know Feedback together with remediation can help economics students develop their skills in quantitative economics prior to external examinations as suggested by WAEC Chief Examiners in their reports. It then means that for an increased achievement in economics examinations conducted by WAEC, economics teachers should endeavor to administer feedback together with remediation in teaching, learning and evaluation of quantitative economics, since evaluation methods adopted by the teacher in the teaching and learning of quantitative economics is one of the factors for poor achievement in economics (Anazia, 2019; Chudi, 2013; Ugan, 2017).

The non-significant effect of gender on students' achievement in quantitative economics gotten in this study was in disparity with that of Amuda, Ali and Durkwa (2017). They observed that male students consistently outperformed the female students in the SSCE conducted by WAEC having recorded a higher percentage of A's, B's and C's than their female counterparts. Nevertheless, some researchers found no gender differences or mostly a minor difference. A study by Atsumbe, Owodunni, Raymond, and Uduafemhe (2018), revealed that gender made no significant difference in students' educational achievement. The result of a study investigated by Ajogbeje and Alonge (2012) also shows no gender difference in junior secondary school mathematics achievement. The results of his study also revealed that male students did not perform better than female students in their posttest scores. Consequently, in this study too, the probable effects of gender on the students' achievement in quantitative economics were not significant.

Furthermore, a non-significant interaction between treatment and gender was obtained following the analysis of covariance of students' mean posttest scores in TAQE in response to hypothesis 3. This result implied that gender had no significant interaction/association with treatment to influence the achievement of students in quantitative economics. In consonance with this finding is that of Ajogbeje and Alonge (2012). Although their results revealed a significant main effect of treatment on students' achievement in mathematics a quantitative subject, they recorded no significant interaction effect of gender and treatment on achievement in mathematics a numerical subject like quantitative economics. This study results are also in line to that of Okeke in 2018. Okeke's results revealed that there was no significant interaction effect of gender and treatment on student's retention.

Conversely, the outcome of the current investigation contradicts some earlier research results on the interaction effect of treatment and gender. Example is the study by Adeoye in 2010. His results show that females would attain superior than males once test items are built on subjects that entail little quantitative ability whereas the opposite occurs when the test is constructed on contents that need high quantitative ability like quantitative economics. Also the findings of Dania (2014) recorded that gender interacted with treatments in favour of boys to achieve significantly more than girls if it comes to numerical subjects like mathematics and quantitative economics. The findings of this study was surprising since in recent years more female students than male students in senior secondary 1, 2 and 3 choose economics as a subject (Eleje, 2019). The researchers expected female students to significantly outperform male students in quantitative economics since they are greater in number. The non-interaction effect could have arisen from constant testing experienced by all the students which had an equal impact or stimulation on both genders.

6. Conclusion

Based on the findings of this study, the researchers conclude that feedback with remediation has an important effect in improving students' achievement in quantitative economics. Teachers should therefore focus not just on continuous testing but going further to assist students with feedback and remediation on any type of test given to them. Also, gender and treatments did not interact to influence achievement in quantitative economics.

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