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Research Article

The Effects of Competitive, Cooperative, and Individualistic Classroom Interaction Models on Learning Outcomes in Mathematics in Nigerian Senior Secondary Schools

E. O. Oloyede,[1] O. F. Adebowale,[2] and A. A. Ojo[3]

[1] *Department of Special Education and Curriculum Studies, Faculty of Education, Obafemi Awolowo University, Ile-Ife, Nigeria*
[2] *Department of Educational Foundations and Counselling, Faculty of Education, Obafemi Awolowo University, Ile-Ife, Nigeria*
[3] *Department of Mathematics, College of Education, Ikere, Ikere-Ekiti, Nigeria*

Correspondence should be addressed to O. F. Adebowale, oluadefat@oauife.edu.ng

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The study sought to find out the relative effectiveness of three classroom interaction strategies which are known to affect students' learning outcomes in Mathematics. 484 senior secondary school three (SSSIII) students randomly selected through judgmental and stratified random sampling from government-owned secondary schools in Ikere and Ado-Ekiti local government areas of Ekiti state participated in the study. The instrument was a self-constructed one, validated and used for collecting data and titled "Mathematics Achievement Test (MAT)." The experimental treatment lasted for four weeks, and the data collected were analyzed using one-way ANOVA, ANCOVA, two-way ANCOVA, and Tukey HSD post hoc pairwise comparisons analysis. The findings showed that the students' learning outcomes in Mathematics were better promoted by the cooperative and competitive strategies but rather minimally by both individualistic and conventional strategies.

1. Introduction

The importance of Mathematics to human development attracted different comments, for instance, Cangiano [1] described it as the queen of science and the language of nature and argued that its importance should be clear to any reasonable person. In fact, the early philosopher, Plato thinks that people who are good in mathematics will do well in any other field of knowledge:

> "*Those who have a natural talent for calculation are generally quick at every other kind of knowledge; and even the dull, if they have had an arithmetical training, although they may derive no other advantage from it, always become much quicker than they would otherwise have been and anyone who has studied geometry is infinitely quicker of apprehension than one who has not.*" [Anon [2] pp.188-189].

Brown and Porter [3] posited that the study of mathematics can satisfy a wide range of interests and abilities. It develops the imagination and trains learners in clear and logical thought. According to them, it also develops a range of language and insights, which may then be applied to make crucial contributions to our understanding and appreciation of the world, and our ability to find and make our way in it.

Considering the paramount importance such subject constitute to human life, the subject was made an essential choice of learners throughout their educational sojourn in Nigeria. In fact, it is an essential consideration for successful outing in certificate examinations like the Secondary School Certificate Examination (SSCE) conducted by the West African Examinations Council (WAEC) and the National Examination Council (NECO) as well as placement examinations like the Unified Tertiary Matriculations Examination (UTME) conducted by the Joint Admission and Matriculation Board (JAMB). Based upon reports from these examination bodies, performances of Nigerian learners in this subject have not been encouraging, making some curriculum and pedagogical pundits to beam their searchlights on teaching

methods, curriculum contents, instructional materials, and other ancillary factors which they believe may influence the ability of the learners to want to learn more.

Different teaching techniques have been adopted by pedagogues in order to shore up students' performance in Mathematics ranging from some teacher-centred techniques to other learner-centred methods. In this part of the world, the commonest type of teaching technique seems to be the teacher-centred whole-classroom teaching referred to in this study as conventional teaching strategy (CTS). This technique requires that the learners sit and listen to the teacher as he presents the content of the day's lesson, with students asking few questions when necessary and supplying responses when asked to do so by the teacher.

Another popular approach used in teaching Mathematics is the cooperative learning strategy (CLS). Cooperative and collaborative learning are instructional contexts in which peers work together on a learning task, with the goal of all participants benefiting from the interaction. Cooperation and collaboration can be treated as synonymous, as a truly cooperative context is always collaborative [4]. She highlighted three types of cooperative interaction strategies. The scripted cooperation in which partners work together to learn text material, broken down into sections such that both partners read the first section and one partner summarizes the material for his or her partner, who in turn provides a critique of the summary. They then alternate roles for the second section of the text, continuing in this way until they have completed the reading.

In reciprocal peer tutoring (RPT), students work together to teach one another, and they alternate between the roles of student and teacher. This technique combines elements of both motivational and cognitive approaches to collaboration. The technique also promotes cognitive processing by using a structured approach to teaching and learning within a tutoring context. In contrast to scripted cooperation and reciprocal peer tutoring, guided peer questioning technique is explicitly intended to promote knowledge construction through higher-order thinking. It involves a process of question asking and answering, which is guided by the provision of question starters, students pick a few of the question starters, generate questions that fit the form of the starter, and then ask questions of their peers and answer their peers' questions. Because these questions require complex answers, peers must probe their own understanding of material in order to answer.

Beachy [5] raised the issue of whether the collaborative work will be done "in class" or "out of class." He claimed that the "out of class" works best in upper level and graduate courses by giving some hard problem sets (which might be called projects in other fields) and giving the students a week or more to work on them. Cooperative interaction strategy as used in this study is where students work in subgroups. Members of each subgroup work towards mutual goals and complete class assignments and exercise together. Each student's achievement is based on the group performance. Different studies have highlighted the merits of cooperative learning over the traditional or conventional approach. For instance, Felder et al. [6] stated:

> *"Studies have shown that relative to students taught traditionally,... cooperatively taught students tend to have better and longer information retention, higher grades, more highly developed critical thinking and problem-solving skills, more positive attitudes toward the subject and greater motivation to learn it..."*

Competitive learning exists when one student goal is achieved but all other students fail to reach that goal [7]. Competitive learning can be interpersonal (between individuals), or intergroup (between groups), where a group setting is appropriate. This strategy has been described as the most appropriate when students need to review learned material [8]. However, there have been many criticisms of this type of learning, including promoting high anxiety levels, self-doubt, selfishness, and aggression. It may also promote cheating and interfere with learners' capacity to problem-solve [7]. Competitive interaction strategy as used in this study is where students work in subgroups. Members of each subgroup work strictly on his/her own, strive to be the best in the subgroup for price or reward.

Individualistic learning exists when the learning or achievement of one student is independent and seperete from the achievements of the other students in the class [7]. This type of learning can be described as teacher-centered; that is, the teacher provides the major source of information, assistance, criticism, and feedback. Students work alone and are not expected to be interrupted by other students. In this regard, students may be seated as far from each other as space permits. Learning resources and materials need to be organised so that each student has immediate access to the appropriate materials [8]. Individualistic interaction strategy as used in this study is where each student in a class work strictly on his/her own and is evaluated based on his or her individual contribution.

Literature evidence concerning the relative effectiveness of and practical preferences of pundits among these teaching techniques have been varied and mixed. In a study carried out by Dowell [9] on the effectiveness of a competitive and cooperative on the comprehension of a cognitive task, he stated that the students in the cooperative learning environment perform better than they did in a competitive environments. Alebiosu [10] was of the view that students exposed to cooperative learning strategies performed significantly better in all the skills than their counterparts exposed to competitive or individualistic learning strategies. D. Johnson and R. Johnson [11] contended that achievement outcomes were actually more accepted in competitive settings for high self-concept children than in the cooperative settings. Esan [12] was of the view that individualistic setting showed a positive attitude towards mathematics than both cooperative or competitive setting. Okebukola and Ogunniyi [13] opined that the cooperative arrangement was better for promoting achievement while the competitive arrangement was better for practical skills. Ojo and Egbon, [14] were of the view that the cooperative learning environment was found to be more conducive to learning than the competitive setting. Okediji et al. [15] found that cooperative learning strategy

Table 1: Descriptive analysis of posttest scores.

Classroom interaction strategies	N	Mean	Std. deviation	Maximum	Minimum
Cooperative strategy	120	59.4167	8.93730	40.00	75.00
Competitive strategy	120	49.5333	11.64166	33.00	75.00
Individualistic strategy	120	41.3417	12.44990	20.00	75.00
Total	360	50.0972	13.32449	20.00	75.00

Table 2: Test of difference in the posttest scores via ANOVA.

	Sum of squares	Df	Mean square	F	Sig.
Between groups	19659.572	2	9829.786	79.614	.000
Within groups	44078.025	357	123.468		
Total	63737.597	359			

groups in Mathematics performed significantly better than their noncooperative counterparts, but found no significant difference in performance between competitive and noncompetitive learning strategy groups. There was also no significant interaction effect of cooperation and competition. Also, Kolawole [16] posited that cooperative learning strategy was more effective than competitive learning strategy in teaching of Mathematics at secondary school level.

2. Purpose of the Research

In view of the varied and mixed findings about the relative effectiveness of the three classroom interaction approaches, this study would examine the classroom interaction strategies with a view to finding their relative efficiency and effectiveness at improving learners' performance in Mathematics. As a result, the study looked at two research objectives. It sought to determine which of the interaction strategies will improve students' performance in Mathematics. Specifically, this research investigated the following research hypotheses.

Hypothesis 1. There is no significant difference in the posttest scores of students exposed to cooperative, competitive, and individualistic interaction strategies.

Hypothesis 2. There is no significant difference in the mean score of students exposed to each of the experimental classroom interaction approaches and those exposed to the conventional approach.

Hypothesis 3. There is no significant difference between the scores of male and female students exposed to each of the experimental classroom interaction strategies.

3. Methodology

The research design used for the study is pretest-posttest experimental design with a control group. It involves the manipulation of independent variables to establish a cause-effect relationship of the independent variable (teaching strategies) on the dependent variables (Students' academic performance in Mathematics). The sample consisted of 484 SSSIII students drawn through stratified random sampling technique from 4 secondary schools that have up to three classes of SSSIII offering Mathematics. In each of the four schools, the four interaction strategies (cooperative interaction strategy (CPIS), competitive interaction strategy (CMIS), individualistic interaction strategy (ILIS), and conventional interaction strategy (CNIS) were randomly assigned to the four intact SSSIII classes. CPIS, CMIS, and ILIS were the experimental groups while the CNIS served as the control group. The regular Mathematics teachers of these schools were the experimenters. They were trained on how to utilize the strategies using lesson plans prepared by the researchers. Before the treatment commenced, the pretest was administered to the participants. Eight lessons of one hour each were taught for four weeks.

The instrument used was a self-constructed 30-item multiple choice achievement test titled "Mathematics Achievement Test" (MAT). Judgmental content validity procedures were undertaken by two experienced Mathematics education experts in the Department of Special education and Curriculum Studies of the Obafemi Awolowo University, Nigeria to ascertain clarity of expressions, appropriateness to the class level, and readability. Item analysis of MAT gave average difficulty and discrimination indices of 0.51 and 0.64, respectively. The reliability index of MAT using Kuder Richardson formula-21 was 0.83 and Cronbach's Alpha of 0.89.

Before the teachers started the treatment in each of cooperative interaction strategy group, the students were divided into mixed abilities subgroups. There were six students in each subgroup. Members of each subgroup were instructed to share ideas together, work towards mutual goals, render assistance to one another, work together as a team, provide answers to questions by consensus, and seek assistance primarily from the team mates whenever the teachers asked questions during the lesson or gave a take home assignment. Each student's achievement in the lessons or assignments was evaluated based on the performance of his/her subgroup and not on individual contributions.

Students in the competitive interaction strategy group were divided into subgroup of eight students each. Members of each subgroup were instructed to compete with each other and seek to outperform others in any given task.

Table 3: Multiple comparison test.

(I) Exptalgrp	(J) Exptalgrp	Mean difference (I−J)	Std. error	Sig.
Cooperative	Competitive	9.88333*	1.43450	.000
	Individualistic	18.07500*	1.43450	.000
Competitive	Cooperative	−9.88333*	1.43450	.000
	Individualistic	8.19167*	1.43450	.000
Individualistic	Cooperative	−18.07500*	1.43450	.000
	Competitive	−8.19167*	1.43450	.000

Table 4: Descriptive analysis of students' raw scores.

Exptalgrp	Mean	Std. deviation	*N*
Cooperative	59.4167	8.93730	120
Competitive	49.5333	11.64166	120
Individualistic	41.3417	12.44990	120
Conventional	38.3500	13.62749	120
Total	47.1604	14.32231	480

They were told not to seek help from themselves but from the teachers as the best student in each of the subgroup will be rewarded. The students were evaluated based on their individual contributions and their scores were always compared in order to determine the best ones.

The students in the individualistic interaction strategy group were instructed to work on their own and seek help from the teachers when in difficulty. They were told that the performance of an individual will be independent of the other students. The teachers also made sure that the students sat widely apart.

In conventional interaction strategy group, the students were not given any special treatments. The teachers taught students the eight lessons with the conventional approach utilized by most of the secondary school teachers in Ekiti state. Thus, the lessons were predominantly teacher-centred with the teachers talking while the students paid attention, contributed minimally, and jotted points in their notebooks. The researchers occasionally supervised the lessons in each of the interaction groups to ensure that the teachers effectively implemented the instructions.

At the end of the treatment a posttest was administered to all the students. Pretest-posttest sensitization was controlled by renumbering the items used for the pretest and producing same for use in the posttest. Data were analysed using one-way analysis of covariance (ANCOVA) and Scheffe's post hoc analysis test, all analyses were carried out at 5% probability level of significance that is, ($P = 0.05$).

4. Results

Hypothesis 1. There is no significant difference in the posttest scores of students exposed to cooperative, competitive, and individualistic interaction strategies.

In order to test this hypothesis the posttest scores of the students were subjected to a test of differences via analysis of variance and the result was as presented in Tables 1 to 3.

Table 1 above shows that the participants were equally distributed over the interaction strategies. It also shows the minimum, maximum, and mean scores of students in each of the interaction strategy groups with their standard deviations.

Table 2 shows that $F_{2:357} = 79.614$ at $P = 0.000$. Since the P value is less than 0.05, the null hypothesis cannot be accepted, hence we reject the null hypothesis and we can conclude that there is a significant difference in the posttest score of the student participants. A multiple comparison test was also carried out via Tukey HSD to determine the direction of the difference. The result was as shown below.

Table 3 shows that the performances of all the learners were all significantly difference. The largest mean difference (18.075) was found between cooperative and individualistic interaction strategies in favour of cooperative strategy. The performance of learners in cooperative strategy was also significantly better that in competitive strategy with a mean difference of 9.88, although competitive strategy also proved to be better than individualistic strategy as a significantly higher mean was found, giving a mean difference of 8.192 in favour of competitive strategy.

Hypothesis 2. There is no significant difference in the mean score of students exposed to each of the experimental classroom interaction approaches and those exposed to the conventional approach.

In order to test this hypothesis, the students' scores under each of the teaching methods were subjected to test of difference via analysis of covariance. This is done in order to remove the effect of previous knowledge as measured by the pretest. The result was as presented in Tables 4 to 6.

Table 4 shows the raw unadjusted means of the scores of students exposed to different classroom interaction techniques. Learners in the cooperative interaction group seem to perform best scoring a mean of 59.42, those in competitive group had a mean score of 49.53, learners in the individualistic group had 41.34 and those in the conventional approach had 38.35 mean score. These were in their posttest scores and hence one has not been able to see if there was any contribution of the learners' residual knowledge to the observed scores. As a result, the scores were subjected to analysis of covariance (ANCOVA) treating the pretest as a covariate and by so doing finding out the contribution of learners' residual knowledge on one hand and removing it on the other hand. The result was as presented in Table 5.

In the table, it can be seen that although there was a significant difference in the student performance across

Table 5: Test of difference after removing difference attributable to previous knowledge.

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected model	67276.605[a]	4	16819.151	257.879	.000
Intercept	31443.459	1	31443.459	482.105	.000
Pretest score	35197.282	1	35197.282	539.661	.000
Exptalgrp	31794.532	3	10598.177	162.496	.000
Error	30980.043	475	65.221		
Total	1165827.000	480			
Corrected total	98256.648	479			

[a] R Squared= .685 (Adjusted R Squared= .682).

Table 6: Adjusted means for students' scores on the basis of interaction strategies.

Exptalgrp	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
Cooperative	59.462[a]	.737	58.013	60.910
Competitive	49.295[a]	.737	47.846	50.743
Individualistic	41.506[a]	.737	40.057	42.954
Conventional	38.380[a]	.737	36.931	39.828

[a] Covariates appearing in the model are evaluated at the following value: pretest score = 37.9646.

the groups in the pretest ($F_{3,475} = 539.66$, $P < .05$), a significant difference was also observed in the mean score due to variation in the classroom interaction strategies adopted ($F_{3,475} = 162.496$, $P < .05$). The adjusted mean was as shown in Table 6.

Table 6 shows that the significant difference found in the posttest scores of the learners on the basis of the interaction strategy adopted spans throughout. Students with cooperative learning technique still performed best with mean score of 59.46, followed by those taught with competitive learning and the individualistic method, all of them are better than those in the conventional strategy group. We can then conclude that students in the experimental interaction strategy were better than those in the conventional method after controlling for residual knowledge.

Hypothesis 3. There is no significant difference between the scores of male and female students exposed to each of experimental classroom interaction strategies.

To test this hypothesis the scores of the learners were subjected to a two-way ANCOVA to determine if there were difference on the basis of gender, teaching techniques, and on the basis of an interaction between gender and learning techniques to predict performance, after controlling for residual or previous knowledge. The result was as shown in Tables 7 to 11.

Table 7 shows the mean scores of the students in the posttest on the basis of learning techniques and on the basis of gender. Generally, both male and female students performed better in cooperative strategy (mean score = 59.42) than in competitive strategy (mean score = 49.53). Mean scores of learners in the individualistic and conventional strategies were 41.34 and 38.35, respectively. Also male students performed generally better (mean score = 47.92) than female students (mean score = 46.09). In order to determine if the difference observed were significant and if there was any interaction between teaching techniques and gender, the scores were subjected to a two-way ANCOVA. The result was as presented in Table 8.

Table 8 shows that there was a significant difference in the pretest scores ($F_{3,471} = 524.77$, $P < .05$) of the learners and the effect of this on the posttest scores was removed. After controlling for residual and previous knowledge, there was still a significant difference in the mean scores of the learners on the basis of the interaction strategies ($F_{3,471} = 158.47$, $P < .05$) but there was none on the basis of gender ($F_{3,471} = 3.096$, $P > .05$). Also there was no significant interaction between learning techniques and gender ($F_{3,471} = 0.085$, $P > .05$). The adjusted mean scores of the learners (estimated marginals) on the basis of interaction strategies after controlling for residual knowledge was as shown in Table 9.

Table 9 shows that students under the cooperative interaction strategy still performed best (mean = 59.37), those in the competitive interaction group also performed better (mean = 49.21) than those in the individualistic (mean = 41.42) and conventional interaction strategy groups (mean = 38.22), after controlling for residual knowledge. The adjusted mean scores of the learners (estimated marginals) on the basis of gender after controlling for residual knowledge was as shown in Table 10.

Table 10 shows that male students still performed better (mean score = 47.71) than their female counterparts (mean score = 4639), after controlling for residual knowledge. The adjusted mean scores of the learners (estimated marginals) on the basis of interaction between gender and classroom interaction strategies after controlling for residual knowledge were as shown in Table 9.

Table 11 shows that male students in cooperative interaction strategy performed better those male students under competitive interaction strategy. This trend was also

Table 7: Raw means of student by interaction strategies and gender.

Descriptive statistics				
Dependent variable: posttest score				
Interaction strategies	Gender	Mean	Std. deviation	*N*
Cooperative	Female	60.0392	9.91960	51
	Male	58.9565	8.18074	69
	Total	59.4167	8.93730	120
Competitive	Female	47.7170	10.75135	53
	Male	50.9701	12.18789	67
	Total	49.5333	11.64166	120
Individualistic	Female	40.5319	12.36554	47
	Male	41.8630	12.56131	73
	Total	41.3417	12.44990	120
Conventional	Female	35.4000	13.78997	50
	Male	40.4571	13.20703	70
	Total	38.3500	13.62749	120
Total	Female	46.0995	14.91845	201
	Male	47.9247	13.85373	279
	Total	47.1604	14.32231	480

Table 8: Test of difference and interaction between interaction strategies and gender.

Tests of between-subjects effects					
Source	Type III sum of squares	df	Mean square	*F*	Sig.
Corrected model	67496.035[a]	8	8437.004	129.186	.000
Intercept	31062.698	1	31062.698	475.625	.000
Pretest score	34272.577	1	34272.577	524.774	.000
Exptalgrp	31048.428	3	10349.476	158.469	.000
Gender	202.226	1	202.226	3.096	.079
Exptalgrp * gender	16.715	3	5.572	.085	.968
Error	30760.613	471	65.309		
Total	1165827.000	480			
Corrected total	98256.648	479			

[a] R squared= .687 (adjusted R squared= .682).

Table 9: Adjusted mean scores on the basis of interaction strategies.

Classroom interaction strategy	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
Cooperative	59.365[a]	.746	57.899	60.832
Competitive	49.218[a]	.743	47.759	50.678
Individualistic	41.419[a]	.756	39.934	42.904
Conventional	38.224[a]	.748	36.753	39.694

[a] Covariates appearing in the model are evaluated at the following value: pretest score = 37.9646.

Table 10: Adjusted means of learners on the basis of gender.

Gender	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
Female	46.397[a]	.571	45.276	47.519
Male	47.716[a]	.484	46.764	48.667

[a] Covariates appearing in the model are evaluated at the following values: pretest score = 37.9646.

Table 11: Test of interaction between interaction strategies and gender.

Classroom interaction strategies	Gender	Mean	Std. error
Cooperative	Female	58.725[a]	1.133
	Male	60.006[a]	.974
Competitive	Female	48.556[a]	1.111
	Male	49.881[a]	.988
Individualistic	Female	41.021[a]	1.179
	Male	41.816[a]	.946
Conventional	Female	37.288[a]	1.146
	Male	39.159[a]	.968

observed for female students. But male students performed better across different interaction strategies confirming the absence of any interaction between gender and classroom interaction strategies.

5. Discussion

This study was designed to determine which of the modern classroom interaction will best suit learners' superlative achievement in Mathematics given the record of previous abysmal performance attributable to strategies adopted by its teachers. As soon as the posttest scores were obtained the researchers attempted to see if a significant difference existed between the performance of the students allocated to the experimental interaction strategy groups—cooperative, competitive, and individualistic. The result showed that a significant difference existed, giving the impetus to go on with the other stages of the study. Furthermore, the three experimental groups were compared to each other and the control group—the conventional interaction strategy. The result indicated that the learners in the experimental groups all performed better than those in the control group. Those in the cooperative interaction strategy gave the best result, followed closely by those in competitive and the individualistic groups. However, among the three groups, learners in the individualistic group performed far poorly than those in the remaining two experimental groups. It could therefore be stated that although this method is good, it is not well suited for good learners' performance in mathematics. The researchers also investigated any possible interaction between the learners' gender and the classroom interaction strategies. The study found that although significant difference existed in learners' performance on the basis of the interaction strategies, no significant difference was found on the basis of gender. Also no significant interaction was found between gender and classroom interaction strategies.

This study showed that the cooperative interaction strategy brings about a significant difference in the achievement of students in mathematics when compared with those exposed to competitive, individualistic, and conventional interaction strategies of teaching and learning mathematics. This might be due to the interactiveness, friendliness, and teamwork that the cooperative strategy provides for the students. The competitive strategy when compared with the individualistic and conventional strategies yielded a better performance among learners. The reason for this may be due to the rewards attached and which might have motivated the students to perform better than their counterparts in the individualistic and conventional strategy groups. Individualistic interaction strategy and conventional strategy were found inferior to both cooperative and competitive strategies probably as a result of its teacher-centeredness, student's minimal contribution to the instruction, and lack of interaction among students in the classroom.

6. Conclusion and Recommendations

It can therefore be concluded that although cooperative, competitive, and individualistic strategies can be used in teaching and learning processes, cooperative strategy was found to be the most effective because it facilitates the achievement of academic goals and is highly effective at producing harmony among students. It is therefore recommended that while satisfying the attempts to improve and develop appropriate classroom interactions, cooperative strategy should be adequately employed in Mathematics classrooms. The Mathematics curriculum should inculcate cooperative ideals that will allow meaningful classroom interaction patterns necessary for promoting academic achievement. Mathematics teachers should be exposed through conferences, seminars, symposium, and in-service training to the three strategies with special emphasis on cooperative strategy.

References

[1] A. Cangiano, "On the Importance of Mathematics," 2009, http://math-blog.com/2008/03/31/on-the-importance-of-mathematics/.

[2] Anonymous, "Plato's View on the Importance of Mathematics," 2005, http://faculty.kfupm.edu.sa/MATH/irasasi/PlatosView.pdf.

[3] R. Brown and T. Porter, "Why study Mathematics?" 1996, http://www.popmath.org.uk/centre/pagescpm/imahob95.html.

[4] A. M. O'donnell, "Cooperative and Collaborative Learning—Theoretical Perspectives on Collaboration, Collaborative Learning in Dyads and Groups, Group and Individual Performance," 2002, http://education.stateuniversity.com/pages/1885/Cooperative-Collaborative-Learning.html.

[5] J. A. Beachy, "Collaborative learning in mathematics: a personal perspective," Teaching Seminar, 2001, http://www.math.niu.edu/ beachy/teaching/talk.html.

[6] R. M. Felder, D. R. Woods, J. E. Stice, and A. Rugarcia, "The future of engineering education II. Teaching methods that work," *Chemical Engineering Education*, vol. 34, no. 1, pp. 26–39, 2000.

[7] D. Johnson and R. Johnson, *Learning Together and Alone*, Allyn & Bacon, Sydney, Australia, 3rd edition, 1991.

[8] J. Griffiths and M. Podirsky, "Types of learning," 2002, http://ehlt.flinders.edu.au/education/DLiT/2002/environs/scott/learntyp.htm.

[9] L. J. Dowell, "The effects of a competitive and cooperative environment on the comprehension of a cognitive task," *The Journal of Educational Research*, vol. 68, no. 7, pp. 274–276, 1975.

[10] K. A. Alebiosu, *Effect of two cooperative learning model on senior secondary school students' learning outcomes in chemistry*, Ph.D. thesis, University of Ibadan, 1998.

[11] D. Johnson and R. Johnson, *Cooperation and Competition: Theory and Research*, Interaction Book, Edina, Minn, USA, 1989.

[12] A. O. Esan, *Effect of cooperative and individualistic problem-solving strategies on students learning outcomes in secondary school mathematics*, Ph.D. thesis, University of Ibadan, 1999.

[13] P. A. Okebukola and M. B. Ogunniyi, "Cooperative, competitive and individualistic science laboratory patterns. Effects on students' achievement and acquisition of practical skills," *Journal of Research in Science Teaching*, vol. 21, no. 9, pp. 875–884, 1984.

[14] A. A. Ojo and F. O. Egbon, "Effects of classroom goal structures on students' academics achievement in mathematics among senior secondary schools," *Ikere Journal of Science Teacher*, vol. 2, no. 1, pp. 19–30, 2005.

[15] A. A. Okediji, U. J. Anene, and O. Afolabi, "Effects of cooperative and competitive learning strategies on students' performance in mathematics," *Nigerian Journal of Guidance and Counselling*, vol. 11, no. 1, pp. 60–69, 2006.

[16] E. B. Kolawole, "Effects of competitive and cooperative learning strategies on academic performance of Nigerian students in mathematics," *Educational Research and Review*, vol. 3, no. 1, pp. 033–037, 2008.