# Effects of two modes of student teams – achievement division strategies on senior secondary school students' learning outcomes in chemical kinetics

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# Contents



# Abstract

Research results have shown that cooperative learning methods enhanced understanding of many difficult concepts. Different kinds of cooperative methods and their efficacy have been researched into but the results of such studies have been inconclusive. Chief examiners reports of external chemistry examinations in Nigeria secondary Schools had indicated that students found chemical kinetics difficult to understand. This study therefore investigated the efficacy of two modes of student teams- achievement divisions (STAD), a kind of cooperative learning on senior secondary school two chemistry students learning outcomes in chemical kinetics. A pretest post-test control group quasi experimental design was adopted for the study. A total of three hundred (110 male and190female) subjects drawn from six secondary schools in Epe division of Lagos State, Nigeria, took part in the study. Intact classes were used in all the selected schools. Four validated instruments used for the study were cooperative learning guide, achievement test on chemical kinetics, (r = 0.84); students' attitude to chemical kinetics questionnaire (r = 0.79); and lesson notes on chemical kinetics. Analysis of covariance (ANCOVA) was used to analyze data collected. The result revealed that there was significant main effects of treatment on students achievement (F = 190.58; P<.05) and attitude (F=379.275; P<.05). STAD without competition was the most enhanced strategy for achievement while STAD with competition was the most enhanced strategy for attitude. Based on the findings, it was recommended that

STAD without competition should be used to teach chemistry in Nigerian Secondary Schools as compare to cooperation with inter-team competition goal structuring method.

# Introduction

Poor academic achievements and unhealthy attitude towards understanding of science and technology have been reported in literature (Ajewole, 1991, Nwagbo, 2002). Nwagbo (2002) pointed out the following as the main constraints facing Nigerians in the understanding of science Education (i) Over crowded laboratory (ii) Lack of adequate textbooks (iii) lack of cooperation by school administrations (iv) the pressure of external certificate examination (v) the use of archaic teaching methods. Literature has repeatedly drawn attention to the fact that teaching in secondary school science classes is very often highly teacher-centered and is characterized by a lack of variety in the teaching methods (Johnson and Johnson, 1983; Adesoji, 1991; Becker, 1994; Agbeyewa, 1996;Adeoye, 1991; Poepping and Mella, 2001).

Ajelabi (1998) was of the opinion that the teaching method adopted by the teacher in order to promote learning is topmost importance. Hence, he concluded that there is the need to introduce, adopt or adapt the latest instructional, techniques that are capable of sustaining the interest of the learners.

There have been concerted efforts at getting learners more actively involved in the learning process and solving the problem of large class size through the development of methods and approaches that promote student-Student interaction. The development of varieties of cooperative learning methods was the result of concerted efforts at getting. Students more involved in the learning process.

Cooperative learning (CL) is a general term for various small groups in which students work together to maximize each others' learning (Johnson and Johnson, 1994, 1999). Numerous studies on CL have demonstrated the promotion of students' learning and social relations relative to more traditional whole class methods of teaching (Okebukola, 1984; Ojo, 1989; Alebiosu, 1998; Fuyunyu, 1998; Esan, 1999; and Adeyemi, 2002).

There has been considerable debate as to whether the positive outcomes of CL in promoting higher academic achievement more than other methods result from cooperation within learning teams or from competition between learning teams (kohn, 1992, Warring, Johnson, Maruyama, and Johnson, 1985). Some theories (Julian and Perry, 1976, shaw 1958) predicted higher motivation and quality of performance in inter-term competition conditions than intra-team cooperation conditions and emphasized the potential significance of inclusion of inter-team competition as an important feature of cooperation. Other theories (Deutsch, 1962, Johnson and Johnson, 1975) asserted just the opposite. Several studies have been set up in the last three decades in an attempt to substantiate these claims and assertions. Results of limited research done in traditional classrooms suggest that inter-team competition may not only be necessary for intra-team cooperation to build group cohesiveness, but may negatively influence achievement and productivity, and actually do social harms through the inter-team tensions that inter-team competition inevitably generates (Johnson,et-al 1983; Warring,etal 1985; Funyunyu, 1998).

Most of these research works on the effects of inter-team competition on cooperative learning quoted above were done outside Nigeria. Considering the situation in Nigeria, where competition is very much part of the education culture, a study of the effects of inter-team competition on students' learning outcomes is therefore desirable. It is against this background that the present study was carried out to investigate whether inter-team competition is necessary for fulfilling many of the reported beneficial characteristics of cooperative learning or not. This is done by determining the effects of two modes of student teams- achievement divisions (STAD) learning strategies (with and without inter-team competition) in promoting students' academic achievement in and attitude to chemical kinetics, a concept in chemistry that secondary school students found difficult to understand.

Chemistry as a subject has many concepts; some of which are abstract in nature. Secondary school students often find the abstract concepts difficult to understand (Ahiakwo, 1991). Chemical kinetics is an important concept in chemistry and it refers to the rates of chemical reaction. This is the time it takes a particular reaction to go into completion. Finding the rate at which the reactions are used up or the rate at which products are formed can measure the rate of reactions. This concept has long been identified by researchers (Ahiakwo, 1984; 1991; Akinmade and Adisa, 1984; Osborne, 2001) to be a much dreaded one by secondary school students.

Taylor and Francis, 1991 found out that there are widespread misconceptions among students and teachers in areas related to the predictions of equilibrium conditions, rate and equilibrium, applying equilibrium principles to daily life situation and to acid -base and ionic solutions in water. Gltekin,2010 also identified students lack of understanding thermodynamics and chemical equilibrium as major factors influencing their conceptions about chemical kinetics. West African Examination Council Chief Examiners' reports of 1999 to 2004 had also indicated that senior secondary school chemistry students found chemical kinetics difficult to understand. The present study is therefore interested in finding out if the treatment conditions will enhance students understanding of the concept.

It has been shown that students' attitude is directly related to the popularity of the subject and to students' cognitive achievement (Johnson, et al 1978; Simpson, et al 1994; Noest, 1995). The present research is therefore interested in finding out the effects of the treatment conditions on the subjects' attitude to chemical kinetics.

## Statement of the problem

Research results have shown that cooperative learning methods enhance learning more than the individualized or competitive methods. However there is the need to find out whether this positive outcomes of cooperative learning results from cooperation within learning teams or competition among learning teams. This study therefore determined the effects of two modes of student teams- achievement Divisions (STAD) learning strategy (STAD with inter-team competition and STAD without inter-team competition) on senior secondary school two (SS2) chemistry students' learning outcomes (achievement and attitudes ) in chemical kinetics.

## Hypothesis

The following null hypotheses were tested at 0.05 level of significance.

Ho1. There is no significance main effect of treatment on students' achievement in chemical kinetics.
Ho2. There is no significant main effect of treatment on students' attitude towards chemical kinetics.

# Research Methodology

## Design

The study adopted a pretest, post-test control group quasi experimental design using 3 x 2 factorial matrix (campbell and Stanley, 1971). The design is shown structurally as follows.

| | | | |
|---|---|---|---|
| O1 | X1 | O2 | E1 |
| O3 | X2 | O4 | E2 |
| O5 | X3 | O6 | C |

Where

O1, O3 and O5 represent pretest observations.
O2, O4 and O6 represent post-test observation
X1 is experimental treatment of STAD, (with inter-team competition)
X2 experimental treatment of STAD 2 (without inter-team competition)
X3 is the conventional lecture method (control)

# Variables in the study

The variables are summarized in table I below.

| Independent variable | Dependent variables |
|---|---|
| Instructional strategy manipulated at three levels | Cognitive achievement in chemical kinetics |
| STAD with inter-team competition | Attitude to chemical kinetics |
| STAD without inter-team competition | |
| Conventional lecture method | |

**Table 1:** Variables in the study.

# Population

The target population for the study consisted of all the senior secondary ii (ssii) chemistry students in the five local government and development areas of Epe division of Lagos State Nigeria.

**Schools and subjects**: - Six senior secondary schools in Epe division of Lagos State were selected for the study based on purposive sampling technique. The six schools were selected based on the following criteria.

1. The schools had well equipped chemistry laboratories.
2. The schools' chemistry teacher is a graduate from faculty of Education
3. The subject for the study must have been taught basic and pre-requisite concepts such as types of chemical reactions, energy changes in chemical reactions and chemical equilibrium necessary for the understanding of chemical kinetics.

All the 300 chemistry students in senior secondary two classes (ssii) in the six schools were the subjects of the study. Intact classes were used.

# Research instrument

Three instruments were used for the study

1. The cooperative learning guide. This contains the roles of the teachers and the students in a cooperative learning situation. Two experts in the field of Educational psychology with knowledge in cooperative learning did the content and face validity while the language editing of the instrument was done by an expert in English Education. The purpose of this instrument is to make the subjects aware of their roles during a cooperative learning situation.
2. Achievement test on chemical kinetics (ATCK). This was made up of 2 sections. Section A, was made up of 30 items multiple choice questions. Section B was made up of 10 short unanswered questions. All the questions were to be answered by the subjects in 1 hour 15 minutes. Face and content validity of the instrument was done by four science education lecturers in the University and two senior secondary school chemistry teachers. The reliability coefficient of the test was calculated to be 0.84, using

Kuder-Richardson formula 20 (KR20).This instrument was used to measure the subjects' achievement in chemical kinetics.

3. Students' attitude to chemical kinetics questionnaire (SACKQ). This was a twenty item questionnaire used to measure the subjects' attitude to chemical kinetics. The items were rated on a four-point likert type interval scales ranging from strongly agree (SA) to strongly disagree (SD). Face and content validity of the instrument was done by four experts in test construction. The instrument was administered on a sample of senior secondary ii chemistry students (SSII) in Ijebu-Ode Ogun State. The data gathered were used to compute the cronbanch coefficient alpha of the instrument which yielded a value of 0.79.
4. Lesson notes on chemical kinetics: - There were six lesson notes, which were prepared on weekly basis for the six weeks of treatment for the study. The duration for each lesson was 80 minutes (double periods).The essence of this instrument is to guide the research assistants (teachers) on the steps and procedure to follow during treatment.

# Research procedure

Permission was first of all obtained from the school principals of the participating teachers and students. The training of participating teachers and students followed this. The training programme lasted for two weeks. The training of the teachers focused on the use of student teams Achievement Divisions (STAD) cooperative learning techniques and the different treatment conditions.

The students for the study were subjected to orientation activities on cooperative learning guide. The students were taught the social skills and principles guiding intra-team cooperation in cooperative learning.

### Procedure for data collection

The procedure for data collection was in three main phases and it lasted for eight weeks. The phases were;

1. pre test for the first one week
2. treatment for the next six weeks
3. post test for the last one week of the eight weeks

# Pre test

The instruments were administered in the following order; students attitude to chemical kinetics questionnaire, followed by the achievement test on chemical kinetics. The attitude questionnaire was administered first in order to avoid the influence of the chemistry achievement test on students' attitude.

**The treatment groups for the study**

*Treatment 1: (student teams- achievement divisions with inter team competition)*

Treatment in this group involved the following steps:

- Teacher presented the topic in form of lecture, demonstration and discussion
- Students in five-member heterogeneous teams within the group engaged themselves in intensive cooperative study of the learnt material, by studying worksheets, performing experiments, checking and drilling each other.
- Each student in all the teams was given a worksheet to be submitted in order to asses each student contribution to the team's effort.
- Teacher gave questions on the topic to the students in form of quiz
- Students worked in teams to provide answers to the questions.
- Students in each team provided a common answer to the questions.
- Teachers recognized and rewarded the best three teams.
- Teachers gave take home assignment.

*Treatment 2: (Student Teams – Achievement Divisions without inter-team Competition)*

Treatment in this group involved the following steps:

- Teacher presented the topic in form of lecture, demonstration and discussion
- Students in five member heterogeneous teams within the group engaged themselves in intensive cooperative study of the learnt material, by studying worksheets, performing experiments, checking and drilling each other.
- Teacher gave questions on the topic to the students in form of quiz
- Students answered the questions individually without assistance from their teammate.

- Teacher recognized and rewarded students that score above 50% in the quiz.
- Teachers gave take home assignment

*Treatment 3: Conventional Method (control)*

Here students sat individually throughout the lesson
The treatment for each lesson involved the following steps:

- The teacher presented the lesson in form of lecture and demonstrations.
- Students listened to the teacher and wrote down chalkboard summary.
- Students asked the teacher questions on areas of the topic that is not clear to them.
- Students answered the teacher's questions individually.
- Students-students interaction is limited and not encouraged by the teacher.
- The students were given take home assignments.

## Post-test

After six weeks of treatment, post – test was administered on all the three groups. Students' attitude to chemical kinetics questionnaire, and the achievement test on chemical kinetics were re-administered again.

# Data analysis

Analysis of covariance and multiple classification analysis were used to analyze the data.

| Source of variance | Hierarchical Method. | | | | |
|---|---|---|---|---|---|
| | sum of squares | df | Mean squares | f | sig |
| covariates | 1267.081 | 1 | 1267.081 | 17.161 | .000 |
| Main effects (combined | 30197.93 | 5 | 6039.589 | 81.800 | .000 |
| Treatment | 28133.26 | 2 | 14066.63 | 190.518 | .000* |
| Model | 34899.69 | 18 | 1938.872 | 26.210 | .000 |
| Residual | 20747.28 | 281 | 73.834 | | |
| Total | 55646.97 | 299 | 186.110 | | |

* $P < 0.05$ significant result.

**Table 2:** Summary of ANCOVA of post-pest achievement scores of students' by Treatment.

Table 2 shows that there is a significant main effect of treatment on students' achievement in chemical kinetics ($F [2, 281) = 190.518$; $P < 0.05$). This implies that the post-test scores of students in chemical kinetics differ significantly across the two experimental groups and control. Hypothesis 1 was therefore rejected. To determine the magnitude of the mean scores of each of the three groups, the multiple classification analysis (MCA) was computed and presented in Table 3.

| Treatment + category | N | Unadjusted | Adjusted for factors and covariates | Unadjusted deviation | ETA | Adjusted for factors and covariates development. | BETA |
|---|---|---|---|---|---|---|---|
| TREATMENT | | | | | | | |
| 1 coop/comp | 100 | 40.8400 | 38.98 | - 12.65 | 0.657 | - 14.51 | 0.754 |
| 2. coop | 110 | 50.1636 | 61.16 | 6.67 | | 7.67 | |
| 3. control | 90 | | 60.23 | 5.89 | | 6.74 | |
| Multiple R | | | | | | | 0.752 |
| R2 | | | | | | | 0.565 |

**Table 3:** Multiple classification analysis of post-test achievement scores according to treatment.

From Table 3 students' exposed to STAD ii (without competition) obtained the highest mean achievement score in chemical kinetics (x = 61.16). Those in the control group scored next to them (x = 60.23) while the students in STAD I with competition had the lowest achievement scores (x = 38.98). In probing further into the source of the significant difference observed in table 3 Scheffee post-hoc analysis was carried out. The result was presented in table 4.

| Treatment | X | 1.STAD I (Comp) | 2. STAD ii (without comp) | 3. control |
|---|---|---|---|---|
| 1. STAD I (with competition) | 38.98 | | * | * |
| 2. STAD II (without competition ) | 61.16 | * | | |
| 3. Control | 60.23 | * | | |

* Pairs of groups significantly different at P <. 05.

**Table 4:** Scheffe post-Hoc. Analysis of treatment effects on students' achievement.

From table 4, results showed that the achievements of students differ significantly when those in group I (STAD with competition) was compared with group ii (STAD without competition) with mean scores 38.98 and 61.16 respectively. Also students' in group I (x = 38.98) differ significantly from those in the control group (x = 60.23). These results revealed that STAD ii without competition and control group were quite close in mean achievement scores of students and the pair did not contribute to the .significant effect of treatment.

Table 5, revealed that there was a significant main effect of treatment on students attitude to chemical kinetics (F (2, 281) = 379.25; P < .05). The result implied that the post-test attitude scores of the students exposed to the different treatment conditions were significantly different. Hence hypothesis 2 was rejected.

| Source of variance | Hierarchical Method. | | | | |
|---|---|---|---|---|---|
| | sum of squares | df | Mean squares | f | s.g |
| Covariates | 7713.561 | 1 | 7713.561 | 111.294 | .000 |
| Main effects (combined | 53404.05 | 5 | 10680.81 | 154.106 | .000 |
| Treatment | 52573.69 | 2 | 26286.84 | 379.275 | .000* |
| Model | 63566.09 | 18 | 3531.449 | | |
| Residual | 19475.58 | 281 | 69.308 | 50.953 | .000 |
| Total | 83041.67 | 299. | 277.731 | | |

* Significant at <.05

**Table 5:** summary of ANCOVA of post-test attitude scores of students' according to treatment.

To find the magnitude of the post-test mean attitude scores of subjects exposed to the different treatment conditions, the multiple classification analysis (MCA) presented in table 6 was computed.

| Treatment + category | N | Unadjusted | Adjusted for factors and covariates | Unadjusted deviation | ETA | Adjusted for factors and covariates development. | BETA |
|---|---|---|---|---|---|---|---|
| TREATMENT | | | | | | | |
| 1, coop/comp | 100 | 52.3800 | 52.06 | 19.34 | .829 | 19.03 | .814 |
| 2. coop | 110 | 25.2909 | 25.23 | - 7.74 | | - 7.80 | |
| 3. control | 90 | 21.0000 | 21.41 | - 2.03 | | - 11.62 | |
| R | | | | | | | .858 |
| R2 | | | | | | | .736 |

**Table 6:** Multiple classification analysis of post-test attitude scores by treatment.

Table 6 revealed that Students in STAD 1 (with competition) group had the highest mean attitude score (x = 52.06) followed by those in the group treated with STAD 2 (without competition) (x = 25.23) while the control group obtained the lowest (x = 21.41).

In order to trace the source of significance observed in table 6, the scheffe post-hoc analysis was carried out in table 7,

| Treatment | X | 1.STAD I (Comp) | 2. STAD ii (without comp) | 3. control |
|---|---|---|---|---|
| 1. STAD I (with competition) | 52.06 | | * | * |
| 2. STAD II (without competition ) | 25.23 | | | * |
| 3. Control | 25.41 | * | * | |

* Pairs of groups significantly different at P <. 0.05

**Table 7:** Post-Hoc analysis of treatment effect on students' attitude to chemical kinetics.

It was obtained from table 7, that each of the three possible pairs of groups was significantly different from the other in students' attitude toward chemical kinetics.

# Discussion of findings

The result that treatment had significant effect on students' achievement and attitude towards chemical kinetics showed that the treatment conditions in this study had the potentials to improve students' learning outcomes in secondary schools.

The findings that STAD without competition was more effective as a teaching strategy than STAD with competition indicated that inter-team competition may negatively influence performance and productivity. This is evident in this study for the control group even performed better than the students in the STAD with competition. This result could be better understood from Bandura's (1956)

modeling theory that stressed the importance of social interaction for direct observations and imitation of successful behaviour from peers. This findings provided empirical support to earlier findings; McAuiliffe, (1970); Johnson and collegues (1981); Fuyunju, (1998); Uduosoro, (2000); Popoola (2002) that established that cooperation without inter-team competition promoted better achievement and productivity than cooperation with inter-team competition. In this study it was noticed during treatment that students in STAD with competition were concerned mostly on how to surpass other groups. This make them to be restless most of the time and therefore unable achieve maximally. This is contrary to the situation in the group of STAD without competition where group members share ideas and receive explanations on difficult concepts from their peers and then answer the quiz questions individually. The above conditions may probably accounts for why students in the STAD without competition achieved better than students in STAD with competition.

The finding that STAD with competition had better effects on students' attitude towards chemical kinetics in this study can be attributed to the fact that students in STAD with competition group did all the learning exercise together throughout the treatment period (i.e. treatment of worksheets and the answering of the quiz questions). This coupled with the healthy competition with members of other teams may probably be responsible for the students showing more positive attitude than students in other groups. This finding is at variance with that of Fu-yun-yu (1998) who found out that cooperation without competition promote better attitude than cooperation with competition.

## Conclusion and educational implication of findings

This study was necessitated by the concern arising from the need to find out if inter-team competition is necessary for fulfilling many of the reported beneficial characteristics of cooperative learning or not as well as providing avenue for effective instructional strategy for teaching chemistry. It was found out that cooperation without inter-team competition promoted better achievement and productivity than cooperation with inter-team competition. It was therefore not necessary to have one team competing against other teams in order to promote better achievement in a cooperative learning setting.

Based on the findings, of this study, it is recommended that to promote students' cognitive and effective development in a cooperative learning situation, student teams- achievements divisions (STAD) without inter-team competition is the preferred instructional strategy to adopt as compared to cooperation with inter-team competition goals structuring method.

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