African Research Review

An International *Multidisciplinary Journal, Ethiopia*
Vol. 5 (6), Serial No. 23, November, 2011
ISSN 1994-9057 (Print) ISSN 2070--0083 (Online)

DOI: http://dx.doi.org/10.4314/afrrev.v5i6.22

"Team Pair Solo" Cooperative Learning and Personality Type as Determinants of Students' Achievement and Attitude to Chemistry *(Pp. 259-276)*

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Abstract
This study determined the effects of "Team Pair Solo" (TPS) cooperative learning strategy and students' personality type on achievement and attitude to Chemistry. 175 SS2 Chemistry students from eight schools constituted the sample for the study. Three hypotheses were tested using ANCOVA within a 2x3 factorial setting and a pretest-posttest control group quasi-experimental design. The TPS instruction was significantly ($F_{(1,168)}$ = 16.45; p<.05) more effective (adjusted mean score = 9.23) than the conventional instruction (mean = 7.59) on students' achievement. Extroverts obtained significantly ($F_{(2,168)}$ = 6.59; p<.05) higher adjusted achievement score (mean = 9.77) than the ambiverts (mean = 8.08) and introverts (mean =7.79). Also, the TPS favoured the extroverts than the ambiverts and introverts. It was recommended that Chemistry teachers should adopt the TPS strategy with effective supervision for the maximum benefit of all students irrespective of their personality type.

Key Words: Team Pair Solo, Cooperative Learning, Personality Type, Chemistry.

Background and literature

There is increasing concern among practitioners and educational researchers about the effectiveness of teaching. To teach successfully, one must know how to facilitate a positive learning experience of students. One of the limitations of learning is the method of instruction which falls short of learners' needs. According to Adepitan (2003) and Okoronka (2004), science subjects are not being taught in Nigeria schools to students' maximum benefit, because science instructions are mostly teacher-centered. Indeed, some science teachers fail to realize that the nature of science is subject to shifting and there is the need for a shift from the old methods to routine practical learning.

The school science laboratory offers unique learning environment in which students can work cooperatively in small groups to investigate scientific phenomena and relationships. For instance, Hofstein and Lunetta (1982) and Lazarowitz and Tamir (1994) suggest that laboratory activities have the potential to enhance constructive social relationships as well as positive attitudes and cognitive growth. The social environment in a school laboratory is usually less formal than in a conventional classroom. This situation needs to change as the laboratory presents opportunities for productive interactions among students and with the teacher who has the potential to promote an especially positive learning environment. This new thinking offers unique opportunities for students and their teacher to engage in collaborative inquiry and to function as a classroom community of scientists (Hofstein & Lunetta, 2002). Such experiences offer learning opportunities for solving scientific problems and developing their understanding in a cooperative environment in the laboratory.

In the Chemistry curriculum currently in use in Nigerian schools (FME, 1985), the concept of Acids, Bases and salts is prominent both conceptually and in the requirement for practical skills. Acid-base titration which is the basis for volumetric analysis covers about 40% of the Chemistry practical examination. For the poor performance of students in Chemistry over the years (Ogunleye, 2002; 2009) based on WASSCE results 1999-2009, poor practical skills have been blamed consistently (Chief Examiners Reports, 2000-2009). Students require ability to measure acidity and alkalinity of solutions using the pH scale during volumetric analysis and this is basic to good performance in practical Chemistry. In 1909, Soren Peer Lauritz Sorenson (1868-1939) suggested that the concentration of H_3O^+ ions should be expressed on a logarithmic scale, named the pH scale. The pH of a

solution is defined as the negative logarithm of the hydroxonium ion concentration in mol dm^{-3} of the solution while pOH is the negative logarithm of the hydroxide ion concentration in mol dm^{-3}.

$pH = -\log [H_3O^+(aq)]$

$pOH = -\log [OH^-(aq)]$

The acidity and alkalinity of substances are measured using a scale of numbers from 0 to 14, called the pH scale. A solution with a pH value of 7 is neutral, a solution with a pH value less than 7 is acidic, while one with a value more than 7 is alkaline. Very often, it is not convenient to calculate the pH of a solution by finding how much hydrogen ions there are in a solution. Instead, the universal indicator (simply called pH paper) and the pH meter are used to measure the pH of a solution directly.

Universal indicator is a mixture of dyes which shows different colours at different pH. A piece of filter paper soaked with universal indicator is called pH paper. Finding the pH of a solution involves adding a few drops of the indicator to the solution and matching the colour of the indicator with the colour chart. Similarly, if pH paper is used, a few drops of the solution under test are added to the pH paper and the colour of the paper is matched with standard colour chart. This gives a rough estimation of the pH of the solution.

Wong, Wong, Onyiruka and Akpanisi (2002) state that an accurate method to measure the hydrogen ion concentration of a solution is to use the pH meter. A glass electrode which is sensitive to H_3O^+ concentration is put into the solution together with a reference electrode. At different concentrations, the electromotive forces (e.m.f.) between the two electrodes are different. As the e.m.f. generated has already been calibrated by the concentration of hydrogen ions, the pH of the solution can be read directly on the pH meter. A digital pH meter can record pH values up to 2 decimal places. pH values play an important role in daily life. In the human body, an acidic medium is required for digestion of food in the stomach while an alkaline medium is needed for digestion in the small intestine. The pH of normal human blood is about 7.4. For the body to function properly, the body fluids must be maintained at the correct pH values. Deviations from these values indicate ill health (Ababio, 2007).

Instructional strategies such as cooperative learning can be used to transform classroom instruction into series of rich memorable experiences and thus

reduce boredom and forgetfulness in students' learning of Chemistry. Cooperative learning is a successful strategy in which small teams, each with students of different abilities, use a variety of learning activities to improve their understanding of a subject (Kagan, 1994). When effectively implemented, cooperative learning improves information acquisition and retention of higher-level thinking skills, interpersonal and communication skills and self-confidence (Johnson, Johnson & Smith, 2006).

Wong and Wong (2004) describe cooperative learning as small groups of students organized for study. Members of the group work cooperatively together to find solutions to hypothetical or real life problems. The strategy has been proven to be effective for all types of students, including the academically gifted, the average students and the slow learners, because it promotes learning and fosters respect and friendship among diverse groups of students (Colorado, 2007). One of the elements in the classroom for positive interdependence is cooperation which results in promotion of interaction and encouragement of students' efforts to learn (Johnson, Johnson & Holubec, 1998).

The assumptions of social interdependence theory are that cooperative efforts:

1. are based on intrinsic motivation generated by interpersonal factors in working together and joint aspirations to achieve a significant goal.
2. focus on relational concepts dealing with what happens among individuals.

Teachers' role in a cooperative learning classroom involves a careful design of meaningful tasks that require active participation of each student in the group towards a common end. At the beginning of a cooperative lesson, the teacher's role, often in cooperation with the class, is that of "task setter." As groups work on tasks, the teacher acts as a facilitator moving from group to group to monitor the learning process. The teacher also provides students with regular feedback and assessment of the group's progress.

Students can learn science in three different ways; learn in cooperative groups, work alone in competition with each other or work individually without ties to other students in the classroom. There are a number of activities that have therefore been developed around cooperative learning. The most common activities are Jigsaw, Think Pair Share, Three Step

Interview, Round Robin Brain Storming, Numbered Heads Together, Circle the Sage and Team Pair Solo (TPS). Most of these have been developed by Dr. Spencer Kagan (Colorado, 2007; Johnson, Johnson & Holubec, 1994; Kagan, 1994).

TPS is a strategy of cooperative learning whereby students are grouped into teams. First, they solve problems as a team, then with a partner, and finally on their own i.e. individually. Team works a problem to completion and then splits into pairs. Pairs work a similar problem together and then split into solo students who individually work the same type of problem (Kagan, 1994). This strategy builds confidence when attempting more difficult content material. It has also been recently advocated that when teaching students a skill, they should try it first as a team, again in pairs and finally on their own (Spring, 2007).

In addition to the possible effects of the cooperative learning strategies on the academic performance and attitudes of students in Chemistry, the study also considered one learner characteristic, personality type, which has been identified to be of great influence on students' learning outcomes (Okoruwa, 2007). The trait of extroversion-introversion is a central dimension of human personality. According to Jung (1971), introversion and extroversion refer to the direction of psychic energy. If a person's psychic energy usually flows outwards then he or she is an extrovert while if the energy usually flows inwards, the person is an introvert. Both introversion and extroversion are directions of cognitive activity in individuals.

Extroversion focuses on the outside world (Derlega, Winstead, & Jones, 2005). Extroverts tend to be enthusiastic, talkative, assertive and gregarious in social situations. They take pleasure in activities that involve large social gatherings such as: parties, community activities, public demonstrations, business and political groups (Jung, 1971). Introversion is the focus on the internal representative of experiences. According to Derlega, Winstead and Jones (2005), introverts tend to be more reserved and less outspoken in large groups. An introvert is likely to enjoy time spent alone and find less reward in time spent with large groups of people, though they may better enjoy interactions with a small group of close friends. Ambiversion is a term used to describe people who fall more or less directly in the middle and exhibit tendencies of both groups. An ambivert is normally comfortable with groups and enjoys social interaction, but also relishes time alone and away from the crowd (Jung, 1971). While Borg and Shapiro (1996) reports the superiority of

introverts over extroverts, Ziegert's (2000) findings support extroverts. In another study, chowdhury (2006) did not find any significant difference between the two classes of students.

Statement of the problem

The need for cooperation in the teaching and learning of science subjects in schools is no more in doubt. The current concern is, however, the persistent poor performance of students in school science especially Chemistry. Considering the possibility of learning Chemistry in the laboratory setting which hitherto has remained individualistic, thereby limiting the skills acquired by students who could otherwise work together as teams, in pairs and ultimately on individual basis. The interactions offered in teamwork promise greater results both in achievement and attitude to Chemistry. This study therefore, determined the effect of Team pair solo and personality type on students' achievement and attitude in the subject.

Hypotheses

1. There is no significant difference in students' achievement and attitude towards Chemistry after exposure to Team Pair Solo cooperative learning strategy and control.
2. There is no significant difference in the students' achievement and attitude towards Chemistry among students of different personality types exposed to the treatment and control.
3. There is no significant interaction effect of treatment and students' personality type on students' achievement and attitude towards Chemistry.

Methodology

The study adopted the pretest- posttest control group quasi-experimental design. The schematic representation of the design is:

O_1 X_1 O_3 (Experimental group of TPS)
O_2 X_3 O_4 (Control group of conventional instruction)

The design also employed the 2 x 3 factorial matrix.

The independent variable is the mode of instruction varied at two levels: TPS and Conventional Strategy. The moderator variable considered is the students' personality type at three levels: Introversion, Ambiversion and Extroversion. The dependent variables in the study are students' performance in and attitude towards selected concepts in Chemistry.

175 Chemistry students from eight senior secondary schools purposively selected from Akinyele Local Government area of Oyo state constituted the sample for this study. One intact class was randomly selected from the SS2 arms in each of the eight schools and randomly assigned to the treatment and control groups.

Five instruments were developed and used in this study.

1. Teachers' Instructional Guide for TPS Strategy (TIGUT).
2. Teachers' Instructional Guide for Conventional Strategy (TIGCO).
3. Students' Performance in Chemistry Test (SPICTE).
4. Attitude Towards Chemistry Scale (ATCHES).
5. Personality Type Questionnaire (PETYQ).

TIGUT is a teaching guide on the use of TPS cooperative learning strategy in presenting the selected content. The steps involved are clarification of the objectives of the lesson, presentation of the problems, formation of teams, problem solving at the three stages of team, pair and individualistic activities and teacher's intervention. TIGCO outlines classroom activities for participating teachers in the conventional group. The two guides were subjected to peer/expert review which involved practitioners in the field of science education generally and Chemistry education specifically who are knowledgeable in both content and cooperative learning strategies.

SPICTE is a 10-item multiple-choice objective questions of four options A to D. The items covered the concepts selected from the senior secondary school Chemistry curriculum (FME, 2007). It was designed to measure students' performance in Chemistry. 50 SS2 Chemistry students outside the study sample attempted the test and item analysis was carried out using the Kuder-Richardson formula 20 via scorbat computer software programme and a range of difficulty indices of 0.43 to 0.61 with reliability coefficient of 0.87 were obtained. This test was complemented with students' reports of measurements made during class activities as well as the tables they constructed on Acid-Base titrations. These attracted 10 marks making the maximum obtainable score to be 20.

ATCHES consists of 20 positively-worded item statements on students' disposition, feelings, opinions, beliefs, values, likes and dislikes in relation to their learning of Chemistry. It is a 4-point Likert Scale of Strongly Agree, Agree, Disagree and Strongly Disagree which were scored 4, 3, 2 and 1

respectively. The instrument was validated through peer/expert review and Cronbach formula which yielded an alpha value of 0.84.

The PETYQ is a psychometric scale constructed by the researcher in line with the Likert format of Very Much Like Me, Like Me, Unlike Me and Very Much Unlike Me to measure the personality of the Chemistry students. It contains 21 item statements and scores obtained by students on this scale was used to categorize them into the 3 compartments of introversion (0-49), ambiversion (50-98) and extroversion (99-147). The instrument was validated through expert advice and the use of Cronbach's method which yielded 0.79.

Research procedure

Training: Eight teachers purposively drawn from the selected schools were trained using the TIGUT and TIGCO.

Pretest: SPICTE, ATCHES and PETYQ were administered.

The treatment implementation lasted for four weeks with a double period of eighty minutes per week. The contents treated are: Measurement of acidity and alkalinity; Ph scale; indicators and acid-base titrations.

Experimental group

The steps involved are:

Step 1: Clarification of the objectives

The teacher states the conditions for effective cooperative learning. The teacher also presents and clarifies the objectives of the TPS strategy.

Step 2: Presentation of the problem

The teacher presents the concept to be learnt to the students, gives a brief explanation of the concept, introduces and discusses the basic concepts giving their clear definition to the students.

Step 3: Team formation

The teacher helps in the formation of the cooperative learning teams of four or six members.

Step 4: Problem solving

- The students work as a team to solve problems or accomplish a task.

- The teams break into pairs and work on either the same problem or on a related one.
- The pairs break up and the students work individually to complete the same or a related task.

Step 5: Teacher's intervention

The teacher summarises the whole concept of learning, emphasizes the main points and shed more light especially on areas where students' effort is not good enough.

Control group
The presentation of each lesson involved the following steps:

Step 1: Statement of the topic to be taught

Step 2: Review of previous knowledge and link with new topic

Step 3: Listing of instructional objectives

Step 4: Teaching the content of the lesson step by step

Step 5: Entertainment of students' questions and

Step 6: Evaluation.

Posttest: SPICTE and ATCHES were administered.

Data analysis
ANCOVA was employed in testing hypotheses 1-3; Scheffe Multiple range test was used to determine the sources of significant effect of personality type on the dependent variables and line graph was used to interpret the significant 2-way interaction effect.

Results
Ho1a: There is no significant difference in achievement of students exposed to TPS cooperative learning strategy and control.

Table 2 shows that there is significant effect of treatment ($F_{(1,168)} = 16.45; p < .05$) on students' achievement in Chemistry. This implies that students in the TPS instructional group and their counterparts in the control group differ based on their achievement score. The direction of this difference is traced using Table 3.

Table 3 shows that the TPS instruction was more effective (students' adjusted mean score=9.23) than the conventional instruction (mean=7.59).

Ho1b: *There is no significant difference in attitude of students exposed to TPS cooperative learning strategy and control.*

Table 4 shows that there is no significant Effect of treatment ($F_{(1,168)}$=1.42;p>.05). Hypothesis 1b is, therefore, not rejected.

From Table 5, the TPS instruction was slightly potent (mean=36.13) than the control (mean=34.39).

Ho2a: There is no significant difference in the achievement of students of different personality types exposed to the treatment and control.

From Table 2, students' personality type has significant effect on achievement in Chemistry ($F_{(2,168)}$=6.59;p<.05). Hypothesis 2a is rejected and Table 3 shows that extroverts obtained higher adjusted achievement score (mean=9.77) than the ambiverts (mean=8.08) and introverts (mean=7.79).

Table 6 further shows the scheffe pairwise test results on attitude.

From Table 6, extroverts (mean=9.77) significantly differ from the ambiverts (mean=8.08) as well as the introverts (mean=7.79). This implies that only the extroverted students are in a class of their leaving introverts and ambiverts to stand together in a different class.

Ho2b: *There is no significant difference in the attitude of students of different personality types exposed to the treatment and control.*

Table 4 shows that personality type has no significant effect on students' attitude to Chemistry ($F_{(2,168)}$=1.58;p>.05). Therefore, hypothesis 2b is not rejected. Table 5 further shows, however, that ambiverts had higher adjusted means attitude score (mean=37.35) than extroverts (mean=36.65) and introverts (mean=33.15).

Ho3a: *There is no significant interaction effect of treatment and students' personality type on students' achievement in Chemistry.*

Table 2 shows that there is no significant interaction effect of treatment and personality type on students' achievement in Chemistry ($F_{(2,168)}$=.44;p>.05). Hypothesis 3a is, therefore, not rejected.

Ho3b: *There is no significant interaction effect of treatment and students' personality type on students' attitude to Chemistry.*

Table 4 shows a significant interaction effect of treatment and personality type on students' attitude to Chemistry ($F_{(2,168)}=5.47;p<.05$). On this basis, hypothesis is rejected. Figure I explains the nature of this interaction.

The figure shows that the extroverts were mostly favoured by TPS instructional mode (mean=41.22) followed by the ambiverts (mean=33.67) and the extroverts (mean=24.00). In the control group, however, the three classes of students cluster around the group mean (37.98): introverts (mean=37.52), ambiverts (mean=38.89) and extroverts (mean=38.24).

Discussion

The TPS instruction was more effective than the conventional strategy in terms of students' achievement. This is attributable to the advantage of collaboration in a team to carry out learning activities required. This ensured their learning together and sharing ideas. Indeed, the teamwork most often led to their success rather than failure on the learning tasks. They also carry out the same set of activities as pairs with the exclusive benefit of greater involvement of each student in the learning activities. All these preliminary provisions in the TPS could not but translate into great dexterity in the performance of tasks by the individual student. This finding is in line with the assumptions of Kagan (1994) and Johnson, Johnson & Smith (1998) that cooperative learning improves information acquisition and retention, higher-level thinking skills, interpersonal and communication skills and self-confidence.

The effectiveness of the TPS may also be as a result of experiences and ideas which students were sharing with one another in a warm and friendly atmosphere (Cowie, 1995). This finding is related to earlier findings of Esan (1999), Adeyemi (2002) and Adeyemi (2008). This study also revealed that the extroverts performed better than the ambiverts and introverts in that order. This could be as a result of the fact that TPS requires students to mingle together, liase, discuss and share knowledge. Hence, the extroverts who tend to enjoy human interactions and are general enthusiastic, talkative, assertive, and gregarious in social situations found the strategies likeable as well as embrace the activities which favour their personality. This is in line with Ziegert (2000) that extroverts performed significantly better than introverts, also according to Barrett and Connot (1986) who found that

introverted students are least involved in school activities and have lower academic achievements.

Also, the TPS provided the extroverts with ample opportunities to actively discuss, lead discussion, share their ideas with other students. Indeed, they dominated the teams, influenced the work of the pair and subsequently had no problem working as individual. No wonder they surpassed their colleagues who are ambiverts and introverts in the TPS instruction. This is in line with Myers (1962) that extroverted students tend to prefer learning situation that afford interaction, while introverts tend to prefer individualized work or small groups. Above all, Sadker and Sadker (2000) in their research had shown that cooperative learning promotes both intellectual and emotional growth which has been explored in this particular study using the TPS instructional strategy.

Conclusion and recommendations

When actively engaged in learning activities through cooperative learning, learners are encouraged to participate in the learning process. Teachers should therefore adopt the TPS strategy which develops cooperative minds in the students, rather than competing with one another in a bid to outdo each other. They would then begin to share ideas and rub minds on pieces of information and experimental procedures.

Chemistry teachers should be provided with in-service opportunities in order for them to become aware of the procedures of Team-pair-solo cooperative learning strategies as well as the potentials inherent in it for the improvement of students' achievement and attitude in this important science subject. Educational bodies as well as government agencies should include the strategy in the list of recommended instructional strategies in the Chemistry curriculum. This would increase teachers' awareness in the use of the strategy to promote students' learning, academic achievement and retention, enhance students' satisfaction with learning as well as develop students' social skills, self esteem and positive peer relations.

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Table 1: Common Indicators and Colour Changes

Indicator	Methyl orange	Litmus	Phenolphthalein
pH range for colour change (colour in this range)	3.1-4.6 (Orange)	5.0-8.0 (Purple)	8.3-10.0 (Pale pink)
Acidic medium	Red	Red	Colourless
Alkaline medium	Yellow	Blue	Pink

Source: Ababio (2007)

Table 2: Summary of ANCOVA results of effect of treatment and personality type on achievement

Source of Variance		Hierarchical Method				
		Sum of Squares	df	Mean Square	F	Sig.
Covariates	PREACHT	317.37	1	317.37	35.69	.000
Main Effects	(Combined)	263.58	3	87.86	9.88	.000
	TREATMENT	146.26	1	146.26	16.45	.000*
	PERS TYPE	117.32	2	58.66	6.59	.002*
2-Ways Interactions	TREATMENT x PERS TYPE	7.81	2	3.91	.44	.645
Model		588.77	6	98.13	11.04	.000
Residual		1493.78	168	8.89		
Total		2082.55	174	11.97		

*significant at $p<0.05$

Table 3: Multiple Classification Analysis of Achievement by Treatment and Personality Type Grand mean = 8.42

Variable + Category		Predicted Mean		Deviation		Eta	Beta
		Unadjusted	Adjusted for Factors and Covariates	Unadjusted	Adjusted for Factors and Covariates		
TREATMENT	TPS	9.25	9.23	.83	.82	.24	.24
	Control	7.57	7.59	-.84	-.83		
PERS TYPE	Introverts	7.42	7.79	-.99	-.62	.34	.24
	Ambiverts	8.21	8.08	-.21	-.34		
	Extroverts	10.27	9.77	1.85	1.36		
R = .53							
R Squared = .28							

Table 4: Summary of ANCOVA results of effect of treatment and personality type on attitude

Source of Variance		Hierarchical Method				
		Sum of Squares	df	Mean Square	F	Sig.
Covariates	PREACHT	30748.316	1	30748.16	156.64	.000
Main Effects	(Combined)	899.19	3	299.73	1.53	.209
	TREATMENT	279.12	1	279.12	1.42	.235
	PERS TYPE	620.06	2	310.03	1.58	.209
2-Ways Interactions	TREATMENT x PERS TYPE	2147.39	2	1073.69	5.47	.005*
Model		33794.74	6	5632.46	28.69	.000
Residual		32977.16	168	196.29		
Total		66771.91	174	383.75		

*significant at p<0.05

Table 5: Multiple Classification Analysis of Attitude by Treatment and Personality Type Grand mean = 35.26

Variable + Category		Predicted Mean		Deviation		Eta	Beta
		Unadjusted	Adjusted for Factors and Covariates	Unadjusted	Adjusted for Factors and Covariates		
TREATEMNT	TPS	32.58	36.13	-2.68	.86	.14	.04
	Control	37.98	34.39	2.71	-.87		
PERS TYPE	Introverts	32.22	33.15	-3..5	-2.11	.16	.09
	Ambiverts	35.63	37.35	.36	2.09		
	Extroverts	39.92	36.65	4.65	1.39		
R = .69							
R Squared = .47							

Table 6: Scheffe Posthoc Analysis of Achievement by Personality Type

Personality Type	Personality Type				
	N	Mean	1. Introverts	2. Ambiverts	3. Extroverts
1. Introverts	106	7.79			*
2. Ambiverts	83	8.08			*
3. Extroverts	95	9.77	*	*	

**pairs significantly different at p<.05*

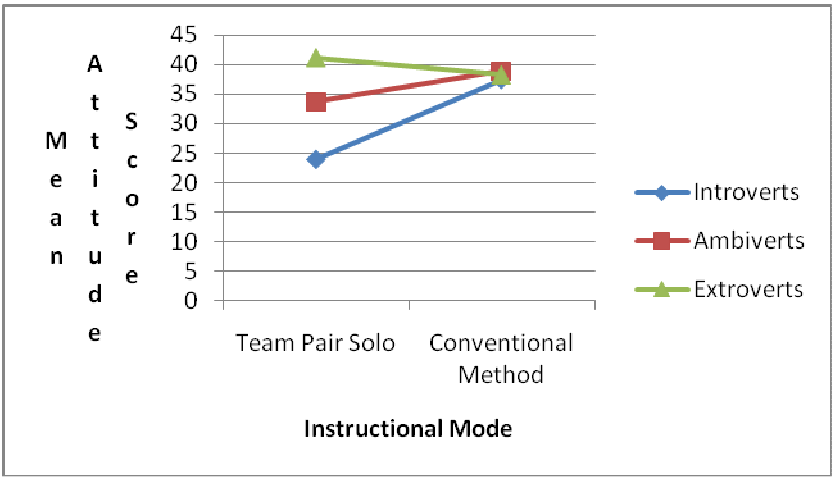

Figure I: Interaction of Treatment and Personality Type on Students' Attitude