Abstract

Cooperative learning is an effective method of improving students’ academic performance. There is, therefore, a need to maximize the use of this method in promoting learning outcomes. The study investigated how cooperative learning conditions, ability levels and interpersonal attraction affect performance and how the effects of cooperative learning conditions on performance can be mediated by peer interaction and attitude towards Physics. The study utilized the causal research design using 90 students with different ability levels. Path analysis procedure was used to estimate the coefficients of the structural equations of the proposed causal model. Results revealed that cooperative learning condition significantly influences peer verbal interaction. It has no significant direct effect but has a significant indirect effect (through peer verbal interaction) on Physics Learning. Students’ ability level and interpersonal attraction do not significantly influence peer verbal interaction. Peer verbal interaction significantly influences attitude towards Physics. Peer verbal interaction in combination with the attitude towards Physics significantly influences Physics learning. Since the hypothesized model is not entirely acceptable, a re-conceptualized model was constructed. This new model indicates that the use of cooperative learning with positive reward interdependence results in the high peer verbal interaction that resulted in a more positive attitude and consequently enhances Physics learning.

Keywords: physics, cooperative learning, causal model, path analysis, Philippines

1.0 Introduction

Quality and excellence in science, mathematics, and technology education is very necessary for effective living. This situation is particularly true in the world that is increasingly more science and technologically oriented. Science education is beset by the problem of low achievement and productivity among students. This problem is true in many countries in the world. Many studies have pointed out the students’ low achievement in science at all levels of education. Varied education reforms have been made to improve
the quality of science learning at all levels. Despite the continuing efforts made, problems still exist in current practices of science teaching. Results of recent studies revealed that many students pass their science courses without acquiring a full understanding of the concepts and theories that are intended to teach. This problem is true in all major fields of science where Physics is not an exception. In Physics, in addition to low achievement, students have negative attitudes toward the subject. The very mention of the word Physics is already enough to make them think of long, cruel examinations and abstract terms so that the subject is often met with hostility. Hence, there is an urgent need to develop instructional strategies that can improve students’ cognitive, affective as well as behavioral learning outcomes.

A review of related literature and studies revealed that cooperative learning is one of the instructional methods which has been proven effective in improving students’ achievement and attitude in all subject areas at all levels. However, there is a little understanding of the factors that could explain the effectiveness of this method. Some behaviorists mentioned the need for a more precise understanding of cooperative learning before its potential as an instructional method can be maximized. These behaviorists emphasized the need to study is why cooperative learning increases students’ achievement. Hence, the critical elements contributing to this effect need to be determined.

In Vietnam, Lewis (2012) found out that the use of jigsaw learning among tertiary students is effective in improving their attitude towards working with others. Jigsaw learning was also found to have contributed to the Vietnamese students’ higher academic achievement and knowledge retention.

In Malaysia, Iksan and Effandi (2007) reported that the use of cooperative learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete academic tasks. Their study focused on selected studies were done in Malaysia and their expected educational outcomes.

In Nigeria, the use of cooperative goal learning structure groups is better than individualistic goal learning structure. The cooperative strategy was reported to have enhanced students’ mastery of mathematics content at both the comprehension and application
levels.

Cooperative learning then needs further study. A study of the different variables that mediate cooperative learning and performance should be done to maximize the use of this method in improving students’ attitude and performance.

Among cooperative learning methods, findings were mixed as to whether those that use group work but do not use group rewards can raise students’ achievement as much as those that use group rewards.

In the book of social psychologists Deutsch (1962) and Johnson (2007), it was stated that positive goal interdependence results in a promotive interaction pattern among students, which increases their achievement. There is a need to understand how cooperative rewards function as motivators, to understand how they interact with variously constructed tasks to enhance students’ achievement, and to understand how these cooperative goal and rewards affect actual student behavior within cooperative learning methods, both to solve practical problems of instruction and to expand the range of operationalization of cooperative learning.

Onwuegbuzie & Da Ros-Voseles (2001) cited Davidson and Kroll (1991) who also recommended “Further research is needed to determine the conditions under which various combinations of group rewards and group goals are optimal for raising student achievement.” To understand why most cooperative learning studies have found positive effects on achievement, one must also have a knowledge of the group processes, more importantly, the nature and level of student-student verbal interaction that occur. According to Webb (1995), there was a need to do a systematic of the group processes to have an understanding of the type of interaction that are beneficial for learning and the types of interaction that must be encouraged or discouraged to maximize learning.

Hence, to maximize the use of cooperative learning in promoting learning outcomes in science, Physics, in particular, a path model that explains the effect of cooperative learning on students’ performance was determined.
2.0 Framework of the Study

This section provides theoretical underpinnings of students’ verbal interaction and learning as well as research studies on cooperative learning, students’ interaction, achievement, ability level and interpersonal attraction. The concept of cooperative learning methods is anchored on well-established social psychological theories.

As cited in Classroom Assessment Theory into Practice, Social learning theory focuses on “the learning that occurs within a social context. It considers that people learn from one another, including such concepts as observational learning, imitation, and modeling”. Albert Bandura and Lev Vygotsky are the main contributors to this theory (https://goo.gl/TZ4c3Y). This theory is based on the common principle that the students work hard on those tasks for which they secure a reward of some sort and fail to work on tasks that yield no reward or yield punishment (Johnson, Johnson & Smith, 1999). When group members work together for a common goal, their mutual dependency often motivates them to work hard to help the group, and thereby themselves, to succeed. Moreover, they often help the members of the group to do well, and they often come to like and value the other members of the group.

The social interdependence theory, according to Johnson, Johnson & Monson (2012), was formulated by Morton Deutsch in 1949, extending Kurt Lewin’s notions of interdependence among members. It was mentioned that the essence of a group is the interdependence among members created by common goals. According to the theory of the social construction of knowledge, Andrews (2012) cited Berger and Luckman (1991) who viewed knowledge as created by the interactions of individuals within society. Berger and Luckman (1991) believed in the division of labor that the emergence of a more complex form of knowledge gives rise to expert knowledge.

In cognitive developmental theory, Piagetian perspectives suggest that when individuals work together, socio-cognitive conflict occurs and creates cognitive disequilibrium that stimulates perspective-taking ability and cognitive development (Johnson, Johnson & Holubec, 1999). Johnson & Johnson also mentioned that children and adolescents, in their interaction with peers, directly learn
attitudes, values, skills and information unobtainable from adults, such as how to deal with conflict or temptation. In their interaction with each other, children and adolescents imitate each other’s behavior and identify with friends possessing admired competencies. The statement of Kamii supported the idea that sanctions by reciprocity provide students the opportunity to consider other people’s points of view and motivate them to construct rules of conduct by coordinating viewpoints with others. Kamii also cited the idea of Piaget that when children acquire moral values in the same way they acquire knowledge—by constructing beliefs internally through interaction with the environment (Arikan, 2004).

Johnson, Johnson & Monson (2012) mentioned Piaget, who believed that improvement of cognitive and moral reasoning abilities only result when intellectual conflicts occur. When individuals disagree and argue over the solutions to problems, they gain creative insights necessary for the attainment of higher-level reasoning. Hence, positive interdependence is established and disagreements are constructively managed.

Learning according to behaviorist theory, is an observable change in behavior. It is grounded on the concept that actions followed by extrinsic rewards (Skinner’s group contingencies) are repeated. The general assumption of this theory is that cooperative efforts are powered by the extrinsic motivation to achieve group rewards (Johnson, Johnson & Holubec, 1999).

According to McGoldrick (2012), cooperative learning involves classes divided into small groups and group members work collaboratively in a manner that the success of each member of the group depends on the success of the whole group. There are five basic elements of cooperative learning: positive interdependence, promotive interaction, individual and group accountability, interpersonal skills and group processing.

In positive interdependence, all members of the team are indispensable for the group to succeed. The group succeeds only if each member of the group contributes their share to the accomplishment of tasks. The most common way of restructuring positive interdependence is through the use of positive goal interdependence and positive reward interdependence. In positive goal interdependence, students can achieve their goal only if each member of the group achieves their goal. In positive reward
interdependence, a mutual reward is given to the group for the successful group effort in accomplishing a task.

According to Siltala (2010), in face-to-face promotive interaction, group members promote each other’s success, they help each other in accomplishing a task like completing an assignment. Brown & Ciuffetelli (2009) also mentioned that group members should be accountable for each other’s success. To observe individual and group accountability, each member of the group must demonstrate mastery of the content being studied, and should also be accountable for their learning and work. In this case, social loafing is eliminated. Cooperative learning also requires group members to use appropriately interpersonal and social skills. The students must, therefore, be taught the social skills needed for collaboration and be motivated to use them. In group processing, it is required for the group members to assess often their effectiveness as a group and make decisions how they can improve their effectiveness.

From Wittrock’s model of generative learning, the learner generates an association between new information and concepts already learned. This model also leads to the predictions of a positive relationship between receiving explanations and achievement. Receiving explanations may help the learner to generate associations between new and previously learned information and concepts.

From group dynamics theory, the students in a group can be regarded as a collection of individuals who relate to one another formally and informally simultaneously. They perform in the physical essence of one another to develop themselves intellectually and emotionally. The more supportive or threatening the interpersonal relationships in the group becomes, the more likely the individual students’ academic learning and classroom behavior can be affected. When individuals feel anxious or fearful in the presence of another, they have difficulty in accurately perceiving the world. The greater the threat individuals feel from another, the more pronounced the restricting and distorting effect is on their thoughts and perceptions of their surroundings. Their perceptions are distorted that they are not able to behave efficiently.

The relation between small-group learning experiences and various academic and social outcomes was conducted by Battistich & Delucchi (1993). They found out that the effect of
cooperative learning on students is dependent on the quality of group interaction. There is also a association between frequent "high-quality" group experiences in which group members were friendly, helped one another, showed concern for one another's welfare, and worked collaboratively and a more positive classroom environment, increased liking for school, and greater intrinsic motivation, concern for others, and self-esteem. (Battistich, et al., 1993). The quality of group interaction was positively associated with students’ achievement in the subject.

Two behaviors were hypothesized to predict mathematics achievement: receiving explanations instead of only the right answer and subsequently carrying out the constructive activity (Webb, et al., 1995). Findings showed that the level of constructive activity was the strongest predictor of achievement. The level of help that students received predicted the level of constructive activity but did not predict achievement directly.

In the study conducted by Ladd, et al. (2013), four categories of work-related and interpersonal skills of children’s were identified, and these skill types were differentially associated with children’s work partner preferences, peer acceptance, and achievement. Overall, the findings helped to specify the types of skills grade-schoolers need to relate effectively with classmates in the context of collaborative academic tasks. (http://goo.gl/zgSPHN).

Based on the preceding discussions, a conceptual model showing the relationship of key ideas was presented in Figure 1.

![Figure 1](http://example.com/figure1.png)

**Figure 1. Conceptual Model Relationship of Key Ideas.**

Figure 1 was based on the social learning theory that students worked hard on those tasks for which they secured a reward. Hence, there is a reason to believe that when students are given group rewards for meeting a set criterion of excellence, there is an increased collaboration among the group members. Increased collaboration suggests an increased verbal interaction among group members,
which may develop a more positive attitude toward the subject and, in turn, may enhance learning. The group dynamics theory also suggests that students’ behavior can be affected by their interpersonal relationships. Based on this suggestion, the high interpersonal attraction could cause an increased verbal interaction among students. Moreover, students’ ability level or ability composition of the group could also cause varying verbal interactions.

3.0 Objectives of the Study

This study aimed to test a causal model of the performance in Physics of students working in different cooperative learning conditions. This study aimed to test a causal model of the performance in Physics of students working in cooperative learning condition. It was designed to investigate the effect of cooperative learning conditions on student’ performance, determine the contribution of peer verbal interaction and attitude towards Physics to the enhancement of Physics learning, and the effect of ability level and interpersonal attraction on peer verbal interaction.

Specifically, it investigated the following: a) whether cooperative learning conditions (cooperative learning with goal and reward interdependence, cooperative learning with goal interdependence and traditional group learning) influence students’ peer verbal interaction and performance in Physics; b) whether students’ ability level and interpersonal attraction influence peer verbal interaction; c) whether peer verbal interaction influences attitude towards Physics; and d) whether peer verbal interaction and attitude towards Physics, singly and in combination, influenced students’ performance in Physics.

4.0 Methodology

The respondents of the study were ninety (90) college students enrolled in General Physics at the University of Northern Philippines in Vigan City, Ilocos Sur. The students were exposed to three cooperative learning conditions (cooperative learning with group rewards, cooperative learning with no group rewards, and traditional group learning). The cooperative learning environment was structured to follow the basic elements such as positive interdependence, promotive interaction, individual and group accountability, interpersonal skills,
The study used several methods to gather the data needed in the study. A questionnaire was used to gather data on attitude toward Physics through the Physics attitude scale developed by the researcher. The Physics attitude scale underwent validity testing and reliability testing. It has a Cronbach alpha reliability of .93. The questionnaire was likewise used to test the interpersonal attraction of the students using the Interpersonal Scale also developed by the researcher. It has a Cronbach alpha reliability of .90. Also, the performance in Physics of the students was measured through the use of an achievement test that was likewise constructed by the researcher. The test also underwent validity and reliability testing. It has a reliability coefficient (KR20) of .80. The audio recording was done to gather data on peer verbal interaction. Transcripts of the audio recording were analyzed by the researcher. A verbal interaction scheme was developed and used to determine the frequency of involvement of the students in their verbal interaction with other members of the group. Prior to data gathering, the objectives of the study were presented to the respondents. The respondents were not forced to be part of the study and an informed consent was therefore sought from them.

Processing of the data gathered in the study was done using the path analysis. Path analysis is a method of testing the validity of theory about causal relationships between three or more variables that have been studied using correlational research design (Borg & Gall, 1989). It is a multiple regression with a picture or known as the path diagram. In addition to the path diagram, published studies have a tabulation of direct, indirect, and total effects of independent variables on the dependent variable. The path coefficient measures the direct effect of the independent variable on the dependent variable. The method of path analysis involves three steps. First was to formulate a theory linking the variables of interest. Second was to select or develop measures of the variables. Third was to compute the statistics that show the strengths of the relationship between each of the pairs of variables that are causally linked to the theory. Statistical values are then interpreted to determine whether they support or disconfirm the theory.

The model in the study incorporated three types of constructs: a) antecedents variables,
b) mediator variables and c) criterion variable. The antecedent variables were the cooperative learning conditions, ability levels, and interpersonal attraction. These variables were not influenced by other variables. Hence, they acted as exogenous variables in the model. Meanwhile, the mediator variables were the peer verbal interaction and attitude towards Physics. Finally, the criterion variable was the students’ performance in Physics, which was being predicted by other variables in the model. The hypothesized path model was illustrated in Figure 2.

A parsimonious attempt to build a concise and coherent model was the main consideration that guided the development of the model. Based on the relationship of key ideas presented in Figure 1, the proposed model is presented in Figure 2. The model was intended to reflect a causal theory.

This causal theory as hypothesized in the study is: The use of positive reward interdependence in cooperative learning in Physics will lead to high peer verbal interaction that, in turn, will enhance Physics learning as manifested by their performance score in the subject. It was also hypothesized that under cooperative learning condition, the students’ verbal interaction was dependent on their ability levels and interpersonal attraction or their willingness to work with the group.

5.0 Results and Discussions

A series of multiple regression analysis were computed to determine the path coefficients needed in the proposed causal model. Table 1 showed the results of regression showing following: 1) the influence of cooperative learning conditions, students’ ability level, and interpersonal attraction on peer verbal interaction; 2) the influence of peer verbal interaction on attitude towards Physics; and 3) the influence of cooperative learning condition, peer verbal interaction and attitude towards Physics on performance in the subject.

The causal model with the path coefficients was reflected in Figure 3. Throughout the discussion on the direct and indirect effects of the independent variable/s on the dependent variable, please refer to this figure.

**Influence of cooperative learning condition on performance in Physics**

The direct influence of
cooperative learning conditions on performance in Physics was seen from the path analysis of the model presented in Figure 3. The direct influence of cooperative learning condition on performance in Physics was not statistically significant (p=.1409). However, the influence was considered meaningful. This finding suggests that the condition under which cooperative learning is used in the classroom has a meaningful direct effect on the performance of the students. This further means that the group reward given to the group members when all meet a preset criterion of excellence has a meaningful contribution to the improvement of the students’ performance in Physics.

According to Slavin (1984) from Watson (1991), the reason for the success of cooperative learning as an instructional strategy in increasing achievement was the giving of group rewards.

The results portrayed in Table 2 provided evidence concerning the indirect effects of cooperative learning conditions on performance in Physics. The indirect effect of cooperative learning conditions on performance through peer verbal interaction

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**Table 1. Summary of multiple regressions for the proposed model.**

<table>
<thead>
<tr>
<th>Equation Number 1</th>
<th>Dependent Variable: Peer Verbal Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step</strong></td>
<td><strong>Mult R</strong></td>
</tr>
<tr>
<td>1</td>
<td>.5117</td>
</tr>
<tr>
<td>2</td>
<td>.5389</td>
</tr>
<tr>
<td>3</td>
<td>.5365</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equation Number 2</th>
<th>Dependent Variable: Attitude towards Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step</strong></td>
<td><strong>Mult R</strong></td>
</tr>
<tr>
<td>1</td>
<td>.2104</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equation Number 3</th>
<th>Dependent Variable: Performance in Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step</strong></td>
<td><strong>Mult R</strong></td>
</tr>
<tr>
<td>1</td>
<td>.1384</td>
</tr>
<tr>
<td>2</td>
<td>.5781</td>
</tr>
<tr>
<td>3</td>
<td>.6441</td>
</tr>
</tbody>
</table>
(indirect effect = .5117 x .4827 = .2470) is significant. This finding suggests that peer verbal interaction is a significant mediator of cooperative learning conditions and performance in Physics. This result could also imply that students’ interaction is the essence of cooperative learning. On the other hand, the path from cooperative learning condition to performance in Physics through peer verbal interaction and attitude towards Physics (indirect effect = .5117 x .2104 x .4178 = .0450), while approaching a meaningful level, suggests a negligible indirect effect. The total indirect effect of cooperative learning on performance (total indirect effect = .2470 + .0450 = .2920) is significant. The total effect of cooperative learning condition on performance in Physics is .4304, clearly suggesting that the conditions under which cooperative learning is used have an important contribution on Physics learning as reflected in the students’ scores.

Moreover, the above findings also indicated that students in cooperative learning with positive goal and reward interdependence also achieve significantly higher in Physics. This is due to their high level of verbal interaction with their peers in learning Physics concepts, performing experiments, and in accomplishing group laboratory activities.

Since peer verbal interaction was found to be a significant mediator of cooperative learning condition and performance, it is believed that peer verbal interaction can enhance learning.

**Influence of ability level on peer verbal interaction**

![Path model of students’ performance in physics.](image)

Figure 3. Path model of students’ performance in physics.
From the path model in Figure 3, the path from ability level to peer verbal interaction (Beta=.1231) is not statistically significant (p-value=.1702). However, it was considered meaningful. This result indicates that students’ ability level has a meaningful influence on peer verbal interaction. The meaningful influence of cooperative learning condition on peer verbal interaction could indicate that the high ability students do not necessarily have the highest verbal interaction score. The above finding is justified by the lower mean verbal interaction scores of the high ability students compared to the medium ability students.

**Influence of interpersonal attraction on peer verbal interaction**

The results portrayed in the path model reveal that the path coefficient (.0238) from interpersonal attraction to peer verbal interaction is not statistically significant (p-value=.9162). The insignificant result denoted that students’ degree of acceptance and willingness to work with the group members has no significant influence on students’ involvement in the verbal interaction among the group members. The students’ relationship with the members of the group is not a significant indicator of a promotive verbal interaction. This result confirmed the findings of Miller (1988) that pairs of friends interacted in a manner similar to that of non-friends when they work with academic tasks. The theory developed by Snygg and Combs (1949) stated that when individuals feel anxious or fearful in the presence of another, they have difficulty in behaving efficiently, thus resulting in a low level of interaction does not support this finding. Increased acceptance or willingness to work with group mates did not contribute to an increased verbal interaction with the group.

**Influence of peer verbal interaction on attitude towards Physics**

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Direct Effect</th>
<th>Indirect Effect</th>
<th>Total Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative Learning Condition</td>
<td>.1384</td>
<td>.2920</td>
<td>.4304</td>
</tr>
<tr>
<td>Peer verbal Interaction</td>
<td>.4827</td>
<td>.0879</td>
<td>.5706</td>
</tr>
<tr>
<td>Attitude towards Physics</td>
<td>.4178</td>
<td>none</td>
<td>.4199</td>
</tr>
</tbody>
</table>

Table 2. Direct, Indirect and Total Effects of Independent Variables on Performance in Physics

*University of Northern Philippines, Vigan City, Ilocos Sur*
The path coefficient from verbal interaction to attitude towards Physics (.2104), as shown in the model, is statistically significant (p-value=.0451) indicating that verbal interaction has a significant influence on attitude towards the subject. The students’ active involvement in the verbal interaction with other students in the group while accomplishing a task in Physics contributed significantly to a more positive attitude towards Physics. This finding was consistent with the belief that students’ interaction with one another during instruction has a considerable impact on how students feel toward the subject.

Since the influence of verbal interaction on attitude towards Physics is significant, the study also looked into the specific verbal interaction that has a significant contribution to the development of a more positive attitude towards the subject. As reflected in Table 3, the frequency of giving unsolicited explanations has a positive influence, while receiving orders or directives in imperative forms has a negative influence on attitude towards the subject. This finding implies that students who most of the time provides explanations about a concept or task procedure to group members tended to have a more positive attitude towards the subject. On the hand, students who most of the time received orders/directives in imperative forms tended to have a less positive attitude towards the subject.

As further reflected in the table, 33.52 percent of the variation in students’ attitude could be due to their frequency of doing verbal interactions with other students as

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Regression Coeff</th>
<th>Beta</th>
<th>t</th>
<th>prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiving simple disagreement</td>
<td>-2.7152</td>
<td>-2.135</td>
<td>-1.995</td>
<td>.0512</td>
</tr>
<tr>
<td>Doing hostile behavior</td>
<td>1.620</td>
<td>.2158</td>
<td>1.214</td>
<td>.0915</td>
</tr>
<tr>
<td>Receiving solicited clarification</td>
<td>1.5963</td>
<td>.2134</td>
<td>1.782</td>
<td>.0672</td>
</tr>
<tr>
<td>Receiving unsolicited numerical comments</td>
<td>-5.152</td>
<td>-1.718</td>
<td>-1.619</td>
<td>.1127</td>
</tr>
<tr>
<td>Giving unsolicited explanation</td>
<td>4.1892</td>
<td>.4275</td>
<td>3.581</td>
<td>.0002</td>
</tr>
<tr>
<td>Receiving orders</td>
<td>-7.0841</td>
<td>-2.956</td>
<td>-2.844</td>
<td>.0021</td>
</tr>
<tr>
<td>Receiving corrections</td>
<td>1.5857</td>
<td>.1338</td>
<td>1.048</td>
<td>.2913</td>
</tr>
<tr>
<td>(constant)</td>
<td>114.8059</td>
<td>30.541</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Regression of verbal interaction on attitude towards physics.
presented in the table. Further, among the variables entered in the regression equation, the frequency of giving unsolicited assistance and receiving correction when a member made errors, are the best and least predictors of attitude towards the subject, respectively.

**Influence of peer verbal interaction and attitude towards Physics on students’ performance in Physics**

The effect of peer verbal interaction on performance in Physics was also illustrated in the path model presented in Figure 3. The path coefficient (.4827) from verbal interaction to performance in Physics is significant (p-value=.0000). Verbal interaction alone has a significant contribution to improving students’ performance in the subject. This finding also implies that verbal interaction among students in accomplishing learning tasks contributes significantly to Physics performance. Likewise, the path coefficient from attitude to performance (Beta=.4178) is also significant (p-value=.0007) indicating that students’ attitude toward the subject has a significant role in their performance in that subject. The more happy and satisfied they are with what they are doing in the class, the more likely for them to attain better learning outcomes.

The data presented earlier in Table 2 also gave information about the indirect effect of verbal interaction on performance in Physics. The indirect effect of verbal interaction on performance through attitude towards the subject (indirect effect = .2104 x .4178 = .0879) is meaningful. This path coefficient suggests that a promotive interaction among and between the students while working on a task results in an improved attitude towards the subject that, in turn, enhances performance in the subject. Moreover, cooperative learning condition indirectly affected students’ achievement through peer verbal interaction. Therefore, students’ verbal interaction is a significant mediator of cooperative learning condition and performance in the subject.

The results of the regression analysis for the path model (please refer to Table 1) show that the combination of verbal interaction and attitude towards Physics is significant. The two variables, when taken together, has a significant contribution to students’ learning. These variables were able to explain 39.57 percent of the variance in students’ performance scores in Physics ($R^2=.4149-.0192=.3957$).
Looking further at the path model presented in Figure 4, the indirect effect of cooperative learning condition on post-achievement, through verbal interaction (indirect effect = .5117 x .4827 = .2470), is considerably larger than its direct effect. It appeared that peer verbal interaction is more important in enhancing student performance in Physics than cooperative learning condition. It could be the verbal interaction between and among students that make cooperative learning more effective in enhancing learning.

The use of reward interdependence in cooperative learning improved the students’ level of verbal interaction in accomplishing group tasks, which in turn, enhanced learning in Physics. This is based on the significant effect of cooperative learning condition on students’ verbal interaction and the very significant effect of verbal interaction on performance.

The indirect effect of cooperative learning condition on Physics performance through verbal interaction and attitude (indirect effect = .5117 x .2104 x .4178 = .0450), while approaching a meaningful level, indicates a negligible indirect effect. Verbal interaction between students explains the effect of cooperative learning on positive goal and reward interdependence on students’ learning in Physics.

Miller (1988) pointed out that during interaction with peers, students acquire facts, ideas, and skills that contribute to their education. From the social construction of knowledge, as an exchange of ideas occur, active participants engage in making sense of and resolving contradicting issues. Thus, communication and cooperation promotes cognition and reorganization. Verbal exchanges make new concepts more meaningful to the learner and, therefore, easier to understand and remember.

The value of $R^2$ (.3342) in Table 1, Equation number 3, indicates that cooperative learning condition and peer verbal interaction jointly account for 33.42 percent of the variation in students’ performance in Physics. Moreover, $R^2$ increases from .0192 to .3342 with the addition of peer verbal interaction in the regression equation. This value suggests that verbal interaction shares 31.50 percent of the variation in students’ performance already explained by cooperative learning condition.

Since peer verbal interaction was found to be a significant mediator of cooperative learning condition and performance, it is...
important to know the specific verbal interaction which enhances Physics learning. Results of multiple regression analysis reveal that the frequency of giving and receiving solicited explanations about concepts in Physics significantly affect performance in the subject. When students interact with peers, explanation of one’s view is promoted. This also confirmed the idea of Siltala (2010). These findings indicate that students who actively engage in explaining produce a highly organized cognitive structure than students who just study to learn for themselves. The process of explaining to others allows the explainer to clarify materials. Between giving and receiving explanation solicited explanations, giving is more beneficial to the one who gives the explanation than to the one who receives it.

For the unsolicited explanation, receiving is more beneficial than giving. Giving explanations to others even if these are not asked could add to the knowledge on the part of the receiver and help them understand the concept better. According to Johnson, Johnson and Smith (2007) as cited by Laal, et al. (2013), oral explaining, summarizing and elaborating the material being learned and listening to others’ summaries carefully to check accuracy and to ask questions to test understanding and encourage elaboration, promote mastery, understanding, and retention of the material being learned.

Table 4. Regression of peer verbal interaction on students’ performance in physics.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Regression Coeff</th>
<th>t</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giving unsolicited explanation</td>
<td>.1785</td>
<td>1.251</td>
<td>2108</td>
</tr>
<tr>
<td>Giving unsolicited comments</td>
<td>.5108</td>
<td>3.208</td>
<td>0029</td>
</tr>
<tr>
<td>Giving solicited explanation</td>
<td>2.9117</td>
<td>5.114</td>
<td>0000</td>
</tr>
<tr>
<td>Receiving unsolicited explanation</td>
<td>.3804</td>
<td>2.381</td>
<td>0217</td>
</tr>
<tr>
<td>Receiving solicited explanation</td>
<td>1.5495</td>
<td>1.905</td>
<td>0452</td>
</tr>
<tr>
<td>Receiving orders</td>
<td>-1.1191</td>
<td>-1.851</td>
<td>0583</td>
</tr>
<tr>
<td>Giving no correction when student makes error</td>
<td>-2.7681</td>
<td>-1.489</td>
<td>0825</td>
</tr>
<tr>
<td>Receiving correction when makes error</td>
<td>1.0384</td>
<td>3.361</td>
<td>0189</td>
</tr>
<tr>
<td>Receiving no help when asked for it</td>
<td>-.3455</td>
<td>-1.734</td>
<td>1084</td>
</tr>
<tr>
<td>Giving correction when student makes error</td>
<td>1.9320</td>
<td>3.481</td>
<td>0008</td>
</tr>
<tr>
<td>(constant)</td>
<td>16.0847</td>
<td>17.308</td>
<td>0000</td>
</tr>
</tbody>
</table>

\[ R^2 = .55891 \]
\[ Adjusted R^2 = .61080 \]
\[ F \text{ value} = 13.69792 \ (p = .0000) \]
Other verbal interactions found to have a significant influence on Physics learning are giving direction when a group member makes an error and receiving corrections when one makes an error. Frequent giving of correction on the part of the giver could help him review and master the concepts. On the part of the receiver, corrections could help him identify whatever misconceptions he had and correct such misconceptions, thus making him understand the concept better. However, frequent receiving of orders, giving no correction when a group member makes an error, and receiving no help when it is needed were found to be detrimental to learning.

In summary, the influence of cooperative learning condition on performance in Physics through peer verbal interaction and attitude towards Physics were statistically significant. However, the influence of ability levels and interpersonal attraction on peer verbal interaction was not statistically significant. Also, the influence of cooperative learning condition on performance in Physics was likewise not statistically significant. There is, therefore, a need to refine the proposed causal model.

Refining the Causal Model. The modification of the model included trimming of all paths that did not contribute significantly to the variance explanation in a latent variable to obtain a parsimonious model. The re-conceptualized models are therefore constructed and are presented in Figure 4 and 5.

Figure 4. Re-conceptualized Model-Relationship of Key Ideas

Figure 5. Re-conceptualized Model-Relationship of Key Variables

model, the path connecting ability levels and interpersonal attraction on peer verbal were removed from the initial causal model. The direct path from cooperative learning condition
to performance in Physics was also removed. The final path model consisted of two paths. The first path included cooperative learning condition as the exogenous variable, peer verbal interaction as the mediator, and performance in Physics as the criterion. The second path included cooperative learning condition to peer verbal interaction then to attitude towards Physics and finally to performance in Physics.

5.0 Conclusions

The use of group reward in cooperative learning resulted to high verbal interaction among students in the group that, in turn, affected the enhanced learning. When students were given group rewards for meeting a criterion of excellence, there was an increased collaboration among the members of the group. Increased collaboration effects increased verbal interaction among group members, and this develops a more positive attitude towards the subject and, in turn results in an enhanced learning.

Meanwhile, the use of positive reward interdependence in cooperative learning in Physics resulted to high peer verbal interaction which, in turn, enhances Physics learning as manifested in the students’ performance score in the Physics Test. Apparently, it was the students’ interaction that explained the relationship between cooperative learning and performance in Physics. Students who were given group rewards for excellent performance in the class have high performance on a test when they interact actively with other students during group learning activities. Their high level of interaction with the group result to a more positive attitude towards the subject and, in turn enhances their learning. Hence, group rewards reinforce the group to have a high degree of collaboration among them in the accomplishment of work.

6.0 Literature Cited


Johnson, D. W., & Johnson, R. T.


