

Effect of Cooperative Mastery Learning Approach on Secondary School Students Achievement In Kirinyaga County, Kenya

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Abstract

Through the study of Physics, technological advancement promoting standard of living, creation of wealth, health and industrialization has been realized. The Kenyan government has put much effort to improve Physics performance in secondary schools. However, and despite these efforts, the desired outputs have not been realized. Though a number of factors may be responsible for this prevailing situation in secondary schools in Kenya, it is envisaged that approaches used in teaching physics continue to negatively influence the performance of students. While cooperative mastery learning approach has been shown to improve performance in other science subjects' studies addressing the effect of cooperative mastery learning approach towards student's achievement in Physics are inadequate. Hence this study investigated the effects of Cooperative Mastery Learning Approach on secondary school students' achievement in Physics in Kirinyaga County. Solomon's four quasi experimental group design was used. The target population was 5850 form two Physics students in the secondary schools in Kirinyaga County, Kenya. A sample of 180 respondents was obtained from the population. Simple random sampling was used to draw the participating four schools from the purposively selected Sub-county schools. The assignment of selected schools to either experimental or control group was done by simple random sampling. The research instrument that was used was physics Achievement Test (PAT). The Reliability was tested by subjecting the instrument to a pilot study in a school in Embu County. Reliability coefficient for Physics Achievement Test was 0.798. Statistical Package for Social Sciences (SPSS) version 25.0 was used for data analysis. The raw data obtained was analyzed descriptively using Mean, Standard deviation, percentages and inferentially using parametric tests (one-way ANOVA, t-test and Posthoc Analysis). The level of significance for acceptance or rejection of null hypotheses was at $\alpha = 0.05$. The study established that cooperative mastery learning approach enhances students' academic achievement in Physics. Further the study findings show that there was statistical significance in student achievement. From the findings of the study cooperative mastery learning approach is effective in improving student achievement in Physics. Therefore, Physics teachers should incorporate the cooperative mastery learning approach in teaching in order to improve students' achievement in Physics.

Key Words: Achievement, Cooperative Mastery Learning Approach and Conventional Teaching Approach

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I. Introduction

Education in science, mathematics, engineering, and technology (STEM) is recognized as a pressing state and national priority (Honey, Pearson & Schweingruber, 2014). Excellence in STEM education can impact jobs, productivity, and competitiveness in multiple sectors and fields including health, technological innovation, manufacturing, distribution of information, political processes, and cultural change (Asunda, 2014). All the disciplines that make up STEM plays an important role in the development of twenty-first century skills such as critical thinking, problem solving, co-operation, leadership ability, scientific thinking, adaptability, entrepreneurship, curiosity and imagination, communication, access to information and use (Bybee, 2010).

Science education in a global and local perspective should foster understanding of concepts among students as a result of their intellectual commitments and practices. Such knowledge of science concepts is necessary in developing students' skills and abilities in preparation for their exposure to the outside world (Gonzales & Reyes, 2016). Science education is a key driver for development because technological and scientific revolutions underpin economic advances, improvements in health systems and infrastructure (Chioma, 2015). Scientifically produced products are transforming business practices in many economies as well as the lives of all who have access to the effects.

According to Kola (2013) science driven improvements in sectors such as health services have improved the lives of people through access to timely and quality medical services. The challenge in teaching science is to create experiences that involve the student in his or her own understanding and application of the scientific concepts required to make sense of the experiences in the environment. Secondary Schools attempt to achieve the educational goals through instruction within the school disciplines. Physics education is, therefore, about achieving educational goals through a context of physics (Meheux, 2017). Physics being one of the STEM subjects is taught in secondary education and serves as a preparation for further training and prepares students to be useful citizens within the society. Physics is taught through learning activities in schools by a set of activities that are designed to support student learning (Prima, Utari, Chandra, Hasanah, & Rusdiana, 2018). The principle of learning physics is to prioritize scientific processes to produce products and to be based on scientific attitudes.

Physics education therefore enables the learner to acquire problem-solving and decision-making skills that provides ways of thinking and inquiry which help them to respond to widespread and radical changes in industry, health, climatic changes, information technology and economic development. These changes demand knowledge of scientific principles in order to tackle them (Otieno, 2015). The teaching of Physics provides the learners with understanding, skills and scientific knowledge needed for scientific research, fostering technological and economic growth in the society, where they live thus improving the standards of living (Wambugu, 2006). Though physics is essential for industrialization, there has been a decline in academic achievement in secondary school students (Wachanga, Johnson & Francis 2013). Although the government has done its part the role of the teacher in the classroom is important. Muthomi (2013) pointed out that the teaching approach that a teacher adopts is one of the factors that may affect students' achievement. Therefore, use of appropriate teaching method is critical to the successful teaching and learning of Physics.

There are learning models, approaches and learning methods that can support the process of learning physics. In order to achieve the objectives of physics education at this level of education, the subject should be well presented to students through proper teaching approaches (Puspitasari, Lesmono & Prihandono, 2015). The teachers' choice and use of suitable teaching approach for the acquisition of knowledge is paramount. To facilitate the process of knowledge transmission, teachers need to apply appropriate teaching approaches that best suit specific objectives that constitutes good teaching and learning (Thomas & Israel, 2013). Classification of teaching approaches are categorized into learner-centered and teacher-centered approaches (Gengle, Abel & Mohammed, 2017). Teacher-centered approach is an approach of teaching whereby the teacher dominates the teaching and learning activities (Gengle, Abel & Mohammed, 2017). The learners remain as passive listeners with little interaction between the students and the teacher. This makes the teacher to be a knowledge dispenser and the student a knowledge-memorizer (Abimbola & Abidoye, 2013; Hossain & Tarmizi, 2013). Teacher-centered approach does not motivate the students to actively participate in the learning process. To address such shortfalls, teaching should not merely focus on dispensing rules, definitions and process for students to memorize, but should also actively engage students as primary participants (Zakaria, Chin & Daud, 2010). In an attempt to achieve the objectives of secondary school education and improve on performance in physics cooperative mastery learning approach of teaching has been researched in Kenya though in other subjects.

According to Keter, Barchok and Ng'eno, 2014 cooperative mastery learning approach brings together cooperative learning and mastery learning approaches to teaching. It is therefore a hybrid of the two approaches. Cooperative mastery learning approach requires a small number of students to work together on a common task, supporting and encouraging one another to improve their learning through interdependence and cooperation with one another (Mehta & Kulshrestha, 2014). The cooperative mastery learning groups usually comprises two to five students in a group that allows everyone to participate in a clearly designed task (Sarah, 2006; Wendy, 2005). Students within small groups are encouraged to share ideas and materials and divide the work to complete the task. Small group competitive learning provides students with opportunity to explore and discuss concepts with peers in a Bonds-on, interactive environment (Keter, 2013). Few studies carried out globally on cooperative mastery learning approach indicate that cooperative mastery learning approach has significant positive influence on achievement in chemistry, Biology and mathematics.

Keter and Ronoh (2016) investigated the impact of cooperative mastery learning approach on students' academic achievement in chemistry by gender in Bomet County. The findings from the study indicated that the achievement level was high for students taught using cooperative mastery learning approach (CMLA) compared to those taught using Conventional Teaching approach (CTA). The results also indicated that there was no

gender difference in achievement when boys and girls were taught through cooperative mastery learning approach. Guzver and Emin (2005) investigated the effects of cooperative, mastery and combined cooperative mastery learning on achievement and attitudes in mathematics on 158 students in mathematics. The results indicated that combined cooperative mastery learning improves students' achievement and yields greater positive attitudes. Krank and Moon (2001) study, also combine mastery learning and cooperative learning teaching approaches to 104 undergraduate social science students enrolled in three sections of a required course. The results of the study confirmed the effectiveness of cooperative mastery group in producing significant achievement gains. Keter (2013), found out that cooperative mastery learning approach facilitated students' chemistry learning.

Kaur and Singh (2015) investigated the effect of teaching through co-operative mastery learning approach on student's achievement in social studies. Sample of the study consisted of 210 (105 experimental group and 105 controlled group) IX class students from two Government secondary schools of Ludhiana district of Punjab, India. Experimental group was exposed to co-operative mastery learning approach and the controlled group was exposed to conventional approach. Achievement test in social studies was used as tool for data collection. The results of the study showed that achievement in social studies of the group exposed to co-operative mastery learning approach was significantly more as compared to the group taught by conventional teaching approach.

Goreyshiet *al.* (2013) investigated the effect of cooperative mastery learning approach on working memory capacity, self-efficacy and academic achievement in grade skipping. Sample of the study consisted of 25 students middle school in Tehran, Iran who were eligible to take grade skipping test were randomly selected and were then examined with working memory capacity test and self-efficacy questionnaire. The repeated measures ANOVA showed a significant increase in working memory capacity and its components, storage and processing, and self-efficacy which had a positive effect on students' academic success.

Khana and Masooda (2015) investigated the effectiveness of an interactive multimedia courseware with cooperative mastery learning approach in enhancing higher order thinking skills in learning cellular respiration in the University of Sains in Malaysia. A multimedia interactive courseware was developed and applied in three different strategies, namely the Multimedia-assisted Mastery Learning, Multimedia-assisted Cooperative Learning and Multimedia-assisted Cooperative Mastery Learning. The multimedia mastery learning used a self-learning approach while multimedia cooperative learning and multimedia cooperative mastery learning involved learning in groups. The result of the study revealed that the MML and MCML students performed significantly better in the creating domain score compared to MCL. Overall, the findings of this study revealed that the multimedia interactive courseware with the combination of cooperative mastery learning approach had a positive effect in the learning of Cellular Respiration.

Hoonet *al.* (2010) investigated the effect of an Interactive Courseware in the Learning of Matrices. The main aim of this study was to integrate cooperative learning approaches, mastery learning, cooperative mastery learning and interactive multimedia to improve students' performance in Mathematics, specifically in the topic of matrices. The study results of the study showed that computer assisted cooperative mastery learning and computer assisted mastery learning approaches were superior compared to the computer assisted cooperative approach. Computer assisted cooperative mastery learning approach produced the highest gain score. For students with low academic ability, the computer assisted mastery learning approach was found to be the most effective approach. The findings of this study also suggested that high academic ability students would obtain high gain scores regardless of any of the approaches involved. In terms of time-on-task, students in computer assisted cooperative learning and computer assisted mastery learning approaches demonstrated significant lower time-on-task than computer assisted cooperative mastery learning approach.

A study by Tukuret *al.* (2018) carried out an evaluation of Jigsaw and mastery learning module versus convectional instruction in teaching mathematics. The results of the study showed that the students in the cooperative mastery learning group achieved significantly better in posttest than the students in the conventionally instructed students. After the treatment the cooperative mastery learning group stated that the Jigsaw mastery learning module alone provided them with effective instruction that led to a conclusion that cooperative mastery learning is an acceptable and effective approach of teaching students to learn mathematics. This study therefore sought to determine the effect of cooperative mastery learning approach on students' achievement in physics.

II. Statement of the Problem

Physics is poorly performed at KCSE level. An analysis of the pattern and trends in achievement in physics in KCSE examination clearly indicates that the achievement is below an average score of 50%. The poor performance of candidates in physics results has continued to trigger a lot of concern among educationists and other stakeholders nationally and also in Kirinyaga County over the years. This poor performance is

attributed to inappropriate teaching approaches. Even though student centered approaches such as cooperative mastery learning approach have been shown to improve performance in Chemistry, Biology and Mathematics, such information is little in relation to the teaching of physics. Specifically, there was need to know how cooperative mastery learning approach would influence student's achievement in physics. Therefore, it was on this basis that the study assessed the effect of cooperative mastery learning approach on student academic achievement in physics in Kirinyaga County, Kenya.

III. Objective of the Study

The objective of the study was to investigate whether there is a difference in academic achievement in physics between students taught using co-operative mastery learning approach and those taught using conventional teaching approach.

IV. Hypotheses

There is no statistically significant difference in academic achievement in physics between students taught using co-operative mastery learning approach and those taught using conventional teaching approach.

V. Methodology

The study used Quasi-experimental design, specifically Solomon four-group design. The design enables the researcher to control and measure the main effects of testing. It also allowed the researcher to carry out studies in natural and real-life setting as the students are already constituted by the school administration and the researcher worked with existing streams (Nachmias&Nachmias, 2004). The design enabled the researcher to make a more complex assessment of the cause of the change in the dependent variable and even tell whether changes in the dependent variable was due to interactions effect between the pretest and treatment. In addition, it allowed the researcher to exert complete control over the variables and to ensure that the pretest did not influence the results, (Shuttleworth, 2009). Solomon four-group design involves four groups. The Experimental group E1, was pretested (O1), receive treatment (X) and post tested (O2). Control group C1, was pretested (O3), no treatment and received posttest (O4). Experimental group E2, received treatment (X) and posttest (O5). Control group C2, only received posttest (O6). C1 and C2 was taught using conventional teaching approach while E1 and E2 was taught using cooperative mastery learning approach. Posttest O5 and O6 eliminated the interaction between testing and treatment.

The units for sampling was secondary schools rather than individual students because secondary schools operate as intact groups (Borg & Gall, 1996). The republic of Kenya consists of 47 counties. Kirinyaga county was purposively selected from the list of counties that are performing poorly in physics. Kirinyaga county consists of 160 single gender and mixed schools. Purposive sampling technique was used to select the schools with the desired characteristics from the list of mixed schools in Kirinyaga County. The desired features for the schools that qualified for the study was class size of more than forty-five form two physics students and mixed Sub-county secondary school. The sub county schools were selected because nearly all schools in the county fall into the sub county schools' category (over 68% of schools in the county) thus, by picking the sub county schools, the findings were more generalizable to the whole county. A total of four schools were drawn using simple random sampling from a list of mixed sub county schools. The assignment of selected schools to either experimental or control group was done by simple random sampling. The stream that was considered for analysis where the sampled school had multiple streams was selected using simple random sampling. The ministry of education science and technology recommends 45 students per class. The schools that were sampled were assumed to have an enrolment of 45 students per class. Frankel and Wallen (2000) recommend at least 30 cases per group for experimental research. The researcher picked four schools randomly.

The physics achievement test was used to measure student's achievement in physics. The test (PAT 1) contained items to assess the students' general students' achievement in physics before the treatment. The test (PAT 2) contained items to assess the students' and also the conceptual understanding of the topic; Magnetic Effect of an Electric Current after the treatment. The PAT 1 consisted of 12 test items and was marked out of a total score of 30 marks. The PAT 2 consisted of 12 test items and was marked out of a total score of 30 marks. The items tested knowledge, comprehension and application levels of blooms taxonomy.

VI. Results And Discussion

5.1 Results of the Pre-test

The experimental group (E1) and control group (C1) were exposed to pre-test before the start of the treatment to ascertain whether the students selected to participate in the study had comparable characteristics before the study. The independent samples t-test was used to analyze whether there were significant differences in the mean scores of experimental group (E1) and the control group (C1). Table 1 shows the t-test results of the pre-test mean scores in PAT for E1 and C1.

Table 1: PAT Mean Scores and t-test of Pre-test for E1 and C1

Group	N	Mean (%)	Std. Deviation	T	df	p-value
E 1	45	44.47	13.999	0.775	88	0.441
C 1	45	46.51	12.11365			

The findings in Table 1 shows that E1 had a mean score (44.47%) and C1 (46.51%). This shows that the groups had comparably close means. The standard deviation of E1 was 13.999 while that of C1 was 12.11365. Further there was no significant difference in the pretest mean scores of control group one (C1) and experimental group one (E1), $t(88) = 0.775$, $p=0.441 > 0.05$. The $p(0.441)$ is greater than 0.05 hence the difference in pretest mean score is not significant. Thus, experimental group (E1) and control group (C1) were similar on PAT measure, implying that the level of achievement prior to administration of the intervention of the two groups were similar; that is the groups had comparable characteristics before administration of treatment. Thus, the two groups contained learners with similar characteristics hence suitable for the study.

5.2 Effects of Cooperative Mastery Learning Approach on Students’ Academic Achievement in Physics

All the four groups took post-test PAT. Achievement was measured by use of PAT post-test. While experimental groups (E1) and (E2) were exposed to cooperative mastery learning approach, the control groups (C1) and (C2) were exposed to convectional teaching approach. The results of the student’s PAT post-test scores were as shown in Table 2.

Table 2: PAT Posttest Mean Scores Obtained by Students in the Four Groups

Group	N	Mean (%)	Std. Deviation
E 1	45	58.67	13.30755
E 2	45	56.58	12.61681
C 1	45	51.62	12.11365
C 2	45	49.31	12.07707
Total	180	54.04	12.15717

The findings in Table 2 shows that the mean scores of the E1 (58.67%) and E2 (56.58%) were higher as compared with those of the C1 (51.62%) and C2 (49.31%). This indicates that experimental groups had higher scores than the control groups in PAT. The standard deviation of E1 and E2 were 13.30755 and 12.61681 respectively. The standard deviations of the control groups C1 and C2 were 12.11365 and 12.07707 respectively. The group with the highest mean score was E1 with a mean score of 58.67%. The findings indicate that students taught using CMLA achieved higher in PAT as compared to those students taught using CTA. The data in Table 3 further illustrates the mean gain obtained by the students in pretest and posttest in PAT.

Table 3: Mean Gain of Students in Pretest and Posttest Scores in PAT

Group	E 1	C 1
Posttest Mean Score	58.67	51.62
Pretest Mean Score	44.47	46.51
Mean Gain	14.20	5.11

The results on Table 3 shows that the mean gain for students in experiment group one (E 1) was 14.2 and that of control group one (C 1) was 5.11. The mean gain for students in experiment group that were taught using cooperative mastery learning approach was higher than the students in control group that were taught using conventional teaching approach. The results in Table 3 illustrates the improvement of the experiment group students’ achievement scores over those in control group. This implies that cooperative mastery learning approach improves students’ achievement in physics. Further illustration of the PAT mean scores for the four groups are shown in Figure 1.

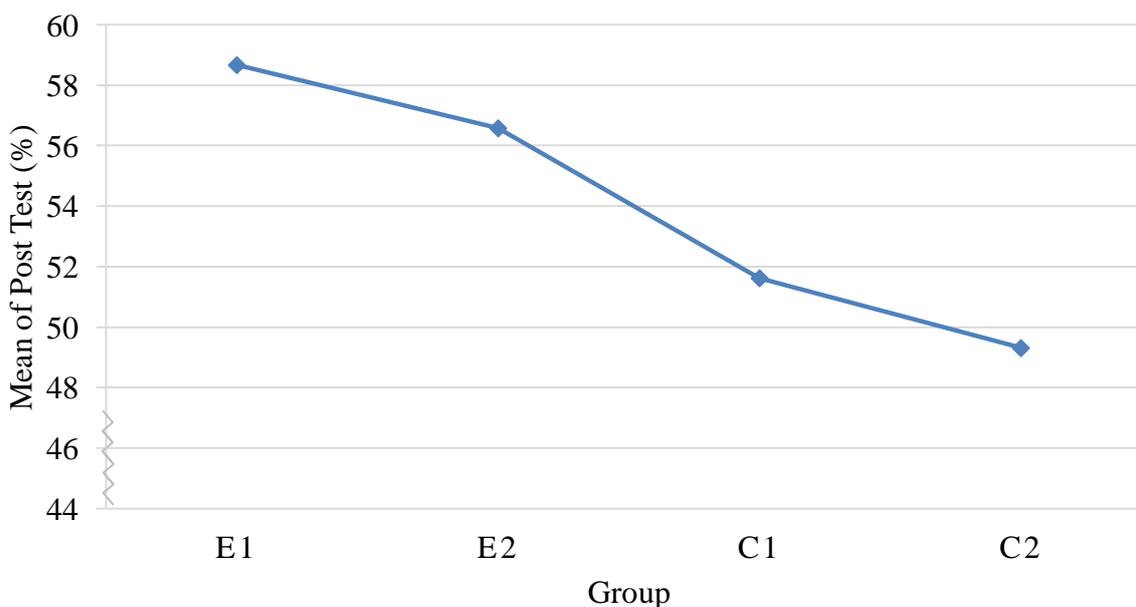


Figure 1: Relationship between Post-test Mean score in PAT in the four Groups.

The highest mean score was attained by Experimental group (E1) followed by Experimental group (E2) then Control group (C1) and finally Control group (C2). Table 4 shows the ANOVA of posttest mean scores on PAT.

Table 4: Analysis of Variance (ANOVA) for the Posttest PAT mean scores of the four groups

	Sum of Squares	df	Mean Square	f	p-value
Between Groups	2522.444	3	840.815	6.183	0.001
Within Groups	23933.200	176	135.984		
Total	26455.644	179			

The findings in Table 4 show that the differences between the post-test mean scores on PAT were statistically significant ($F(3,179) = 6.183, P < 0.05$). Therefore, the hypothesis was rejected, which stated that there is no statistically significant difference in the level of achievement to learn physics between students who are taught using cooperative mastery learning and those who are taught using conventional teaching approach. The results suggest that cooperative mastery learning approach as an intervention had positive effect on student achievement. To determine where the difference existed, a post-hoc analysis test using a post-hoc analysis using Least Significant Difference (LSD) was used to compare all pairs of the groups as shown in Table 5.

Table 5: Post Hoc Comparisons of Posttest of PAT Mean Scores for the Four Groups

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p-value
E 1	E 2	2.08889	2.45840	0.397
	C 1	7.04444*	2.45840	0.005
	C 2	9.35556*	2.45840	0.000
E 2	E 1	-2.08889	2.45840	0.397
	C 1	4.95556*	2.45840	0.045
	C 2	7.26667*	2.45840	0.004
C 1	E 1	-7.04444*	2.45840	0.005
	E 2	-4.95556*	2.45840	0.045
	C 2	2.31111	2.45840	0.348
C 2	E 1	-9.35556*	2.45840	0.000
	E 2	-7.26667*	2.45840	0.004
	C 1	-2.31111	2.45840	0.348

The results indicate that the differences in mean scores of groups E1 and C1, E1 and C2, C2 and E1, C2 and E2, E2 and C1 were statistically significant at 0.05 levels with $p < 0.05$. The mean scores of groups E1 and E2, C1 and C2 were not statistically significant at 0.05 with $p > 0.05$. This suggests that cooperative mastery learning approach had a significant and positive effect on students understanding among the students. The results further suggested that the use of cooperative mastery learning approach promotes student's achievement

in that the students that were taught using it performed higher than those that were taught using conventional teaching approach.

The results of the study agree with the findings of Kaur and Singh (2015) who investigated the effect of teaching through co-operative mastery learning approach on student's achievement in social studies. The results of the study showed that achievement in social studies of the group exposed to cooperative mastery learning approach was significantly more as compared to the group taught by conventional teaching approach. The research findings, provided evidence for positive effects on students' achievement when taught using cooperative mastery learning approach. The findings of the study are also consistent with the findings of Goreyshiet *al.* (2013) that investigated the effect of cooperative mastery learning approach on working memory capacity, self-efficacy and academic achievement in grade skipping which showed a significant increase in working memory capacity, its components, storage, processing, and self-efficacy which had a positive effect on students' academic success implying that cooperative mastery learning has a positive effect on achievement when fully implemented.

The findings of the study also concur with the findings of Guzver and Emin (2005) who investigated the effects of cooperative, mastery and combined cooperative mastery learning on achievement and attitudes in mathematics. The results indicated that combined cooperative mastery learning improves students' achievement and yields greater positive attitudes. The results of the study are in agreement with Khana and Masooda (2015) who investigated the effectiveness of an interactive multimedia courseware with cooperative mastery learning approach in enhancing higher order thinking skills in learning cellular respiration in the University of Sains in Malaysia whose results revealed that the multimedia interactive courseware with the combination of cooperative mastery learning approach produced a significant achievement gains in the learning of Cellular Respiration.

The findings of the study also concur with the findings of a study by Hoonet *al.* (2010) that investigated the effect of an Interactive Courseware in the Learning of Matrices which integrated cooperative learning approaches, mastery learning, cooperative mastery learning and interactive multimedia in the learning of mathematics. In the study, the collected data was used to investigate the effects of the three learning approaches on the gain scores and time-on-task. Based on the gain scores the study showed that the computer assisted cooperative mastery learning and computer assisted mastery learning approaches were superior compared to the computer assisted cooperative learning approach, where computer assisted cooperative mastery learning approach produced the highest gain score. The results of the study are also in line with the findings of a study by Tukuret *al.* (2018) that carried out an evaluation of Jigsaw and mastery learning module versus convectional instruction in teaching mathematics. The results of the study showed that the students in the cooperative mastery learning group achieved significantly better in posttest than the students in the conventionally instructed students. After the treatment the cooperative mastery learning group stated that the Jigsaw mastery learning module alone provided them with effective instruction that led to a conclusion that cooperative mastery learning approach is an acceptable and effective approach of teaching students to learn mathematics

VII. Conclusions

The study findings showed a statistically significant difference in academic achievement in physics between the students taught using cooperative mastery learning and those taught using the conventional teaching approach. Student taught physics using cooperative mastery learning approach had a higher score in physics achievement test as compared to those taught using convectional teaching approach Therefore, this indicates that cooperative mastery learning approach is more effective than the convectional teaching approach in improving the student academic achievement in physics. This shows that students who are taught physics through cooperative mastery learning approach learn better than those taught using conventional teaching approach. Therefore, it can be concluded that cooperative mastery learning approach facilitates students' academic achievements towards learning physics more than conventional teaching approach.

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