Eurasia Journal of Mathematics, Science & Technology Education, 2016, **12**(9), 2543-2556
doi: 10.12973/eurasia.2016.1250a

The Effect of Cooperative Learning on Grade 12 Learners' Performance in Projectile Motions, South Africa

Israel Kibirige & Moyahabo Jeridah Lehong
University of Limpopo, SOUTH AFRICA

•*Received 28 May 2015*•*Revised 18 September 2015* •*Accepted 20 November 2015*

The study explored the effect of cooperative learning on Grade 12 learners' performance in projectile motions. A quasi-experimental research design with non-equivalent control group was used. Two schools were purposively selected from Maleboho Central circuit in South Africa based on their performance in Physical Sciences Grade 12 results of 2011. The sample consisted of 49 learners from two schools. School A was used as the Experimental Group (EG) and was taught using cooperative learning technique while school B was the Control Group (CG) taught using traditional teaching methods. Pre- and post-tests were used to collect data. Data were analysed using descriptive statistics: arithmetic means and standard deviations; and inferential statistics: independent student t-test, Analysis of Covariance (ANCOVA) and Cohen's d. Results show that EG outperformed the CG suggesting that cooperative learning technique enhanced learners' performance more than the traditional talk-and-chalk teaching approach.

Keywords: cooperative learning; performance; projectile motions; traditional teaching

INTRODUCTION

In a classroom, learners can interact as competitors or as co-operators of learning. In a competitive classroom, learners' goals and achievements are negatively correlated while in a cooperative classroom learners' goals are linked and positively correlated (Johnson & Johnson, 1994). Cooperative learning in educational research is reported to be a successful pedagogy because learners work towards a common purpose (Deutsch, 1949). These results in learners assisting one another and consequently both the high and low academic achievers benefit. In a science classroom cooperative learning may improve learners' future peer consultations as it is in the real world. Thus, the use of cooperative learning is often deemed useful in a science classroom to break down one individual prejudice. Despite cooperative learning overwhelming benefits, its use and effects in the South African schools has received little attention.

Correspondence: Israel Kibirige,
Department of Mathematics, Science and Technology Education (DMSTE), University of Limpopo, P/Bag X 1106, Sovenga, South Africa.
E-mail: israel.kibirige@ul.ac.za

ISSN: 1305-8223 http://iserjournals.com/journals/ejmste

Cooperative learning technique enables learners to learn from each other and gain important interpersonal skills (Topping, Thurston, Tolmie, Murray & Karagiannidou, 2011). The goals of cooperative learning are to enhance learners' learning and to develop their social skills like decision-making, conflict management and communication skills (Eslamian, Aref & Aref, 2012). This teaching strategy provides opportunities for higher order thinking as opposed to passive listening, reinforces listening to others and gives opportunity for immediate feedback and adjustment of thought (Eslamian et al., 2012). Learners assist each other in understanding material/content and this may even help them broaden their perspectives on issues. Often learners assess the ideas of peers, determine whether they "fit" their own, whether they disagree, or partially agree, resulting in an opportunity for better formulation of their own ideas. Some learners often say, "I didn't think of that" or "That's a different slant". Thus, learners talking together provide for input and listening which improves performance.

The central goal of cooperative learning in science and mathematics education is to improve performance especially in problem solving skills where learners in their groups will view each other as resources, but not as competitors, resulting in individuals learning (Iksan & Zakaria, 2007). Members often provide information prompts, cues, reminders and encouragement in response to other learners' request for help or their perceived need for help (Iksan & & Zakaria, 2007). In this way learners enhance their conceptual understanding. Therefore, cooperative learning is recognized as a method that promotes learning across the range of curricula from primary through high school to college (Gillies, 2003). This implies that the quality of education can be improved when learners are actively learning in the classroom (Iksan & Zakaria, 2007). There is no wonder that the National Curriculum Statement (NCS) and Curriculum Assessment Policy Statement (CAPS) for Grades R-12 encourage active and critical approach to learning, rather than rote learning.

Despite the importance of cooperative learning in CAPS, teachers rarely use it to teach Physical Sciences in Maleboho Central circuit. Teachers present many factors preventing them from using cooperative learning strategy. These include lack of background training in the use of active learning approaches; lack of prepared materials for use in the class; the fear that learners may resist collaborative learning strategies; fear to lose time for content coverage and lack of confidence in trying new methods. The purpose of this study was to explore the effect of cooperative learning on Grade 12 learners' performance in projectile motions. Also, to find out if cooperative learning approach is biased towards one gender. Therefore the following question guided the study: What is the effect of cooperative learning on learner's performance when compared to traditional learning of projectile motions in Physical Sciences? The hypothesis explored was that learners taught using

State of the literature

- Learners' interactions in science classrooms is competitive or cooperative. In a competitive classroom learners' goals do not match their performance which is not the case in a co-operative classroom. While both competitive and cooperative strategies have been studied, there is little information regarding cooperative learning on specific science topics in science.
- Cooperative learning enhances students learning through social norms like decision-making, conflict management and communication.
- Thus, the central goals of cooperative learning in science education is to improve performance.

Contribution of this paper to the literature

- This study contributes to the knowledge of social constructivist learning where learning is not in isolation of others but in an inclusion of them as a stepping stone in order to develop higher order thinking skills.
- Cooperative learning in projectile motions improved learners' performance and is thus, more profitable than the traditional learning approach. The hypothesis that learners taught using cooperative strategy perform better than those taught using traditional learning cannot be rejected.
- Also, cooperative learning strategy is not biased towards any gender because in this study boys and girls performed equally well.

cooperative learning technique perform better than those taught using traditional learning.

THEORETICAL FRAMEWORK

The research was informed by the theory of constructivism (Vygotsky 1978). Matthews (2000:161) contends that "constructivism is undoubtedly a major influence in contemporary science and mathematics education". In essence, constructivism is described as a learning theory that claims that: "knowledge is not passively received, but is actively built up by the cognising subject"; and "that the function of cognition is adaptive and serves the organisation of the experimental world" (Matthews, 2000:175). Carr, Jonassen, Litzinger and Marra (1998:5) also mention that constructivism emphasises learner activity and how learners construct knowledge as a process of making sense and giving meaning. Furthermore, Vygotsky (1978) emphasises the importance of "social interaction" in learning that often forms social cohesion (Johnson & Johnson, 1994), while Atherton's (2003:1) contends that interaction entails the social issues and how they are communicated during the learning process. Similarly, Carr et al. (1998:5) argue that constructivism enables learners to "talk to one another about their learning". What is important during cooperative learning is that learners are compelled to "crystallise what may be internally fuzzy into concrete words, and encourages knowledge synthesis and meaning making" (Carr et al., 1998:8) and this is why social constructivism theory is deemed fit for this study. O'Donnell (1999) suggested that when learners interact with their peers, learning is mediated and more often than not complete tasks they would not on their own. In this way, a complex and dynamic relationship between learning and development can be determined by Zone of Proximal Development (ZPD), which refers to the area between a learned level of independent performance and of assisted performance (Vygotsky, 1978). Also, the potential of learners can emerge when they interact with peers and in this way there is gain of knowledge from others.

METHODOLOGY

Design

A quasi-experimental design with non-equivalent control-group was used. Quasi-experimental designs are normally used when causal inference is desired and the participants cannot be manipulated (Schoenfeld, 2006).

Sample

Two schools in Maleboho Central Circuit were purposively selected based on their low Physical Sciences matric results of 2011. The sample for the study comprised of 49 Grade 12 learners from two schools. Class A (EG) consisted 23 learners (11 boys: 12 girls) from one school and class B (CG) had 26 learners (11 boys: 15 girls) from another school.

Instruments

A pre-test and a post-test were used to collect data. Three Physical Sciences teachers checked pre- post-tests for face validity. For reliability a pilot study was conducted with 10 learners who were not part of the study. The calculated Cronbach Alpha was 0. 88, which show that the instruments were suitable to be used in the study. Also, any question that was not clear was adjusted for clarity before instruments were administered.

Procedure

Pre-test with 17 open-ended questions was administered to EG and CG to determine their level of understanding before intervention. Both EG and CG were taught by one of the researchers. EG was taught using cooperative learning which included teacher designed activities (sample Appendix A) such as group discussions, problem-solving and hands-on activities. CG was taught using traditional approach or chalk-and-talk.

In the post-test, the 17 open-ended questions of the pre-test were administered but this time the numbers were rearranged to minimise recognition effect (Kibirige & Teffo, 2013).

Data analysis

Data from the pre- and post-tests were analysed using descriptive statistics: means and standard deviations (SD) of question items; and inferential statistics: independent student t-test, ANCOVA and Cohen's d. All data were analysed using SPSS as a tool. An independent t-test was also used to analyse the difference between the groups' arithmetic means before and after the intervention. Cohen's d was used to measure gain between the two groups after intervention. Finally, ANCOVA was used to determine if indeed the treatment had an effect on the performance.

Ethical issues

Permission was granted by the Education Department. During the process of data collection and processing anonymity and confidentiality were assured.

RESULTS

Results of arithmetic means and standard deviations of items of pre- and post-tests are presented in Tables 1 and 2 respectively. Independent student t-test are presented in Tables 3, 4, 5 and 6, Cohen's d as well as ANCOVA are presented in Tables 7 and 8, respectively.

Results of arithmetic means and standard deviations of question items

In Table 1, pre-test shows results for CG versus EG with p values ranging from 0.6 to 0.95 ($p > 0.05$). Thus, there are no significant differences between the EG and CG scores (Figure 1) suggesting that learners had similar conceptual understanding of projectile motions before the study.

Post-test results in Table 2 and Figure 2 CG versus EG show that 92.86% of the test items were significantly different ($p < 0.05$) while 7.14% were not.

Results for the student t-test and Mann-Whitney U-test

Results for the pre/post-test EG were analysed (Table 3) ($t= -12.20$, $p = 0.00$). The results indicate a significant level $p< 0.05$, implying that there was a difference between the EG's arithmetic means before and after the intervention.

Results for the pre/post-test CG were analysed (Table 4) ($t =-7.71$; $p > 0.00$). The significant level ($p> 0.05$) implies that there was no significant difference between the CG's arithmetic means before and after the teaching.

There is an improvement with EG and CG after intervention. Post-tests results for EG and CG were analysed (Table 5) ($U =155.50$; $Z =-2.88$; $p < 0.05$). These results indicate a significance difference between the EG and CG means of the post-tests.

The mean of the EG is greater than that of CG. Therefore the results of post-test revealed that EG performed better than CG. Furthermore, the number of learners in EG is less than in CG. Hence, it is evident in the post-test results that smaller classes

Table 1. Pre –test: CG against EG

Question Item	Cont/exp	Mean	SD	U value	Z-value	*p*-value
1.1	CG	1.10	0.90			
	EG	1.40	0.50	283.00	-3.44	0.73
1.2	CG	0.40	0.60			
	EG	0.90	1.00	210.00	-2.01	0.06
2.1	CG	0.40	0.60			
	EG	0.80	0.90	245.00	-1.21	0.23
2.2.1	CG	0.50	0.70			
	EG	0.70	0.70	242.00	-1.28	0.20
2.2.2	CG	0.20	0.40			
	EG	0.80	0.90	279.00	-0.71	0.48
2.2.3	CG	0.50	0.80			
	EG	0.90	2.40	248.00	-1.32	0.186
3.1	CG	0.20	0.50			
	EG	0.60	0.90	248.00	-1.32	0.19
3.2.1	CG	0.30	0.70			
	EG	0.60	0.70	242.00	-1.52	0.13
3.2.2	CG	0.40	0.60			
	EG	0.70	0.60	260.00	-0.88	0.38
3.3	CG	0.50	0.80			
	EG	0.70	0.80	289.00	-0.23	0.82
4.1	CG	0.20	0.70			
	EG	0.40	1.00	247.00	-1.47	0.14
4.2	CG	0.80	0.60			
	EG	1.10	0.60	224.00	-1.71	0.09
4.3	CG	0.40	0.90			
	EG	0.30	0.70	281.50	-0.55	0.59
4.4	CG	0.10	0.50			
	EG	0.10	2.10	298.00	-0.06	0.95

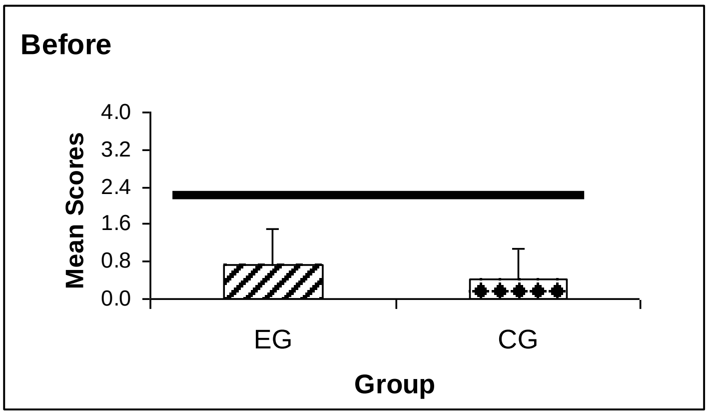

Figure 1. Mean pooled scores (mean ± SD) of EG and CG before intervention. Bar line indicates significant differences between the scores of EG and CG (T-test, $p < 0.05$)

Table 2. Post –test: CG against EG

Question	Group	Mean	SD	U value	Z-value	*p*-value
1.1	EG	1.10	1.40			
	CG	1.90	1.80	180.00	-2.93	0.00
1.2	EG	0.40	0.90			
	CG	2.10	1.90	152.50	-3.10	0.00
2.1	EG	0.40	0.80			
	CG	2.20	2.20	55.00	-1.20	0.23
2.2.1	EG	0.50	0.70			
	CG	1.80	1.70	161.00	-2.98	0.00
2.2.2	EG	0.20	0.80			
	CG	0.70	0.80	208.50	-2.16	0.03
2.2.3	EG	0.50	0.90			
	CG	3.90	3.60	134.00	-3.47	0.00
3.1	EG	0.20	0.60			
	CG	1.20	2.00	167.00	-2.75	0.01
3.2.1	EG	0.30	0.60			
	CG	1.10	1.70	180.00	-2.62	0.01
3.2.2	EG	0.40	0.70			
	CG	0.90	1.70	160.00	-2.14	0.01
3.3	EG	0.50	0.70			
	CG	1.20	2.70	94.50	-4.84	0.00
4.1	EG	0.20	0.40			
	CG	1.20	1.00	214.00	-1.92	0.06
4.2	EG	0.80	1.10			
	CG	1.00	1.70	158.00	-3.11	0.00
4.3	EG	0.40	0.30			
	CG	1.20	2.00	144.50	-3.40	0.00
4.4	EG	0.10	0.10			
	CG	1.50	2.80	161.50	-3.11	0.00

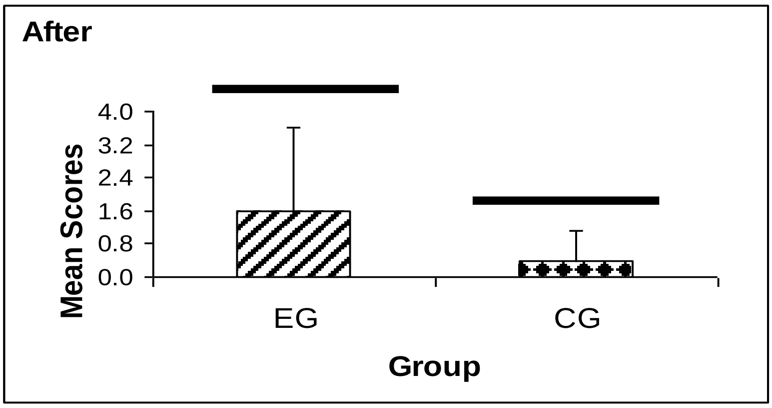

Figure 2. Mean pooled scores (mean ± SD) of EG and CG after intervention. Bar lines indicate significant differences between the scores of EG and CG (T-test, $p < 0.05$)

Table 3. Pre-test versus Post-test EG scores

	Levene' Test		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval o the Difference	
								Lower	Upper
EG	15.96	0.00	-12.2(	44	0.00	-54.87	4.50	-63.94	-45.80
			-12.2(	30.40	0.00	54.87	4.50	-64.05	-45.69

Table 4. Pre-test versus Post-test CG scores

	Levene's Test		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean)ifference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
CG	17.32	0.00	-7.71	50	0.06	-36.69	4.76	-46.25	-27.14
			-7.71	35.10	0.06	-36.69	4.76	-46.35	-27.03

Table 5. Difference between the means: CG vs EG

	Mann-Whitney –U Test		
	U	*Z*	*P*
Pre-test	265.00	-0.68	0.49 ns
Post-test	155.50	-2.88	0.00*

**Significant (p <0.05), ns represents not significant*

Table 6. Post – Test: EG (Boys against girls)

Question	Gender	Mean	SD	U	*Z*	*P*
1.1	Boys	1.80	0.40			
	Girls	1.80	0.60	62.00	-0.42	0 .67
1.2	Boys	1.60	1.10			
	Girls	2.20	0.80	56.00	-0.67	0.51
2.1	Boys	2.20	1.00			
	Girls	2.30	0.90	63.00	-0.20	0.84
2.2.1	Boys	1.80	0.70			
	Girls	0.30	0.60	65.50	-0.04	0.97
2.2.2	Boys	1.10	1.00			
	Girls	0.60	0.90	41.00	-1.68	0.09
2.2.3	Boys	4.40	2.20			
	Girls	2.80	2.30	40.00	-1.59	0.11
3.1	Boys	2.00	0.90			
	Girls	2.00	0.90	65.00	-0.33	0 .97
3.2.1	Boys	1.70	0.80			
	Girls	1.60	0.60	61.00	-0.43	0.67
3.2.2	Boys	1.80	0.60			
	Girls	1.60	0.70	54.00	-0.96	0.34
3.3	Boys	2.70	0.80			
	Girls	2.60	0.90	65.00	-0.09	0.93
4.1	Boys	1.30	0.90			
	Girls	0.70	1.00	46.00	-1.42	0.15

4.2	Boys	1.80	0.40			
	Girls	1.50	0.80	51.00	-1.20	0.23
4.3	Boys	1.90	0.60			
	Girls	2.10	0.80	55.00	-0.88	0.38
4.4	Boys	2.50	2.20			
	Girls	3.10	1.90	55.00	-0.70	0.48

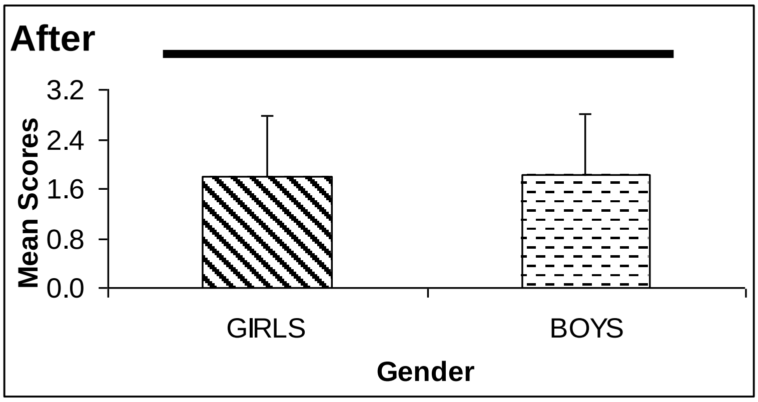

Figure 3. Mean pooled scores (mean ± SD) of boys and girls after intervention. Bar line indicates no significant differences between the scores of boys and girls (Man Whitney U-test, $p < 0.05$)

can benefit all pupils in terms of individuals and active attention from the teacher (Blatchford, Brown & Bassets, 2011).

Results of a Mann-Whitney U-test in Table 6 and Figure 3 show that there were no significant differences between performance of boys and girls in EG after intervention ($p > 0.05$).

Gain between EG and CG after intervention

Cohen's d was used to measure gain between two groups after intervention. Results for Cohen's d are presented in Table 7. The calculated Cohen's d for the CG was 2.33 while for the EG was 3.94.

Effect of treatment on the performance of the two groups

ANCOVA was conducted to determine if the treatment had an effect on the performance of the two groups. The dependent variable included learners' post-test scores and the covariate was the learners' scores on the pre-test. The ANCOVA results are presented in Table 8. From Table 8, we see that the ANCOVA p-value was significant ($p <0.05$).

DISCUSSION

This study explored the effect of cooperative learning in Grade 12 learners' performance on projectile motions. A pre-test was given to both groups (EG and CG) and the results show that there was no significant difference in performance of learners from both groups (T-test, $p > 0.05$; Table 1), suggesting that learners in the two groups had similar understanding of concepts before intervention. However, in the post-test, the mean of the EG is greater than that of the CG ($U =155.50$; $Z =-2.88$; $p < 0.05$). This indicates that learners in the EG performed better than learners in

Table 7. Cohen's *d* for CG and EG

Group	PRE-TEST (Mean ±SD)	POST-TEST (Mean ±SD)	Cohen *d*
CG	17.9 ±9.9	54.6±21.6	2.33
EG	18.9±8.6	73.8±19.3	3.94

Table 8. ANCOVA summary results of EG and CG before and after

Source	SS	Df	MS	F	*P*
Pre-test	968.87	1.00	968.87	2.33	0.14 ns
Post-test	2587.64	1.00	2587.64	6.22	0.02*
Error	16634.22	40.00	415.86		
Total	202620.00	43.00			

**Significant (p <0.05), ns represents not significant*

the CG. This is in agreement with the findings of Kutnic, Ota and Berdondini (2008) which show that performance and motivation of learners improve when cooperative learning is used in science classroom. In cooperative teaching, learners are treated differently when compared to the traditional chalk-and-talk classrooms: learners are encouraged to take responsibility for their own learning which occurs through experiences; learners have to consider self-evaluation and focus on factors that contribute to achieving meaningful solutions (Mitchell, 2010:4). In fact, cooperative teaching method engages learners twice as effective as traditional method does (Hake, 1998). The engagement may ultimately result in high performance when compared to passive learners (MacManaway, 1970). However, for this to happen, teachers need to be aware of learners' capacities, needs and past experiences and must be able to use this information to create a learning situation in which learners solve a problem in an autonomous and independent way (Watkins, 2005:135). Furthermore, the social cohesion perspective (social interdependence theory) results in effective communication, mutual influence, trust, and constructive management of conflict (Johnson & Johnson, 1994). This suggests that the effects of cooperative learning are largely dependent on the cohesiveness of the group and also on their ZPD on others in the group. These findings are not surprising because cooperative learning involved tasks that raised contextual issues unlike in the traditional teaching method. Furthermore, Even and Kvatinsky (2009) reiterate that, in the cooperative learning, the teacher is vital for initialising learners' processes of knowledge construction. The instructional practices are supposed to be characterised by limited teacher intervention and by interaction and communication between learners. Hence this study shows that teaching learners using cooperative learning technique result in higher learning gains than those taught using chalk-and-talk method (Table 7). Our results underscore the importance of collaboration between learners and the teacher as they engage in a cooperative enterprise that implies a continual and cohesive process of activity, reflection, analysis and the enhancement of critical reflection.

In this cohesive perspective, learners help each other to learn because they care about the group and its members and come to derive the benefits of self-identity from group membership (Nichol & Boyle, 2003). Most important is that cooperative learning exploits the diversified abilities of learners to increase their cognitive, psychological and social performance, and as such, it is an effective way to address the problem of individual differences (Nichol & Boyle, 2003). Our findings resonate with the work of Mercer and Hodgkinson (2008) who emphasise the central importance of classroom talk in promoting learning. Classroom talk entails teachers' talk with learners and learners' talk amongst themselves in paired or group activities. This is seen as dialogic teaching which is: collective, supportive and reciprocal, through the sharing of ideas and alternative viewpoints; and cumulative, in group-based and whole-class situations (Mercer & Hodgkinson, 2008, Kibirige & Maoko, 2014). This may be so because teachers ask learners a lot of questions, creating the initiation-response-follow up/feedback dialogue (Mercer & Hodgkinson, 2008). Teachers offer class summaries of what they consider to be salient features of the activity, which can help learners to relate activity to past experience (Smith & Higgins, 2006). Thus, "Good teaching is generally seen as the ability to set a certain emotional climate, to use learners' experiences as educational resources, to provide plenty of evaluative information to learners, and to encourage collaboration and participation" (Smith & Higgins, 2006:491). Furthermore, the ANCOVA results clearly show that EG and CG were different in performance and the differences were due to the treatment and not by other variables (Table 8). Therefore, the hypothesis that learners in the EG taught using cooperative learning technique perform better than those learners in the CG taught using traditional learning cannot be rejected.

Results of Mann-Whitney U-test (Table 5) show that there were no significant differences between performance of boys and girls in EG after intervention ($p > 0.05$). This is supported by Ridley and Novak's (1983) hypothesis that gender differences in science achievement is due to differences in the type of learning activities used in class. As girls progress through secondary grades, they become less confident of their academic skills; thus, their career aspirations are narrowed (Morse, 1998; Else-Quest, Hyde & Linn., 2010). Commenting on this scenario, Smyth (2010) suggests that girls need to have positive attitudes to be motivated to achieve in science. Therefore, methods of teaching like cooperative learning ensure equality of treatment and equality of opportunity for boys and girls (Nichol & Boyle, 2003). It is most likely that cooperative learning instilled positive attitudes in girls resulting in them performing equally as well as boys in the EG. The results further show that cooperative learning can improve girls' performance in co-educational science classes. In the United States, for example, girls in non-coeducation schools had more self-confidence in their science (Morse, 1998). The question of whether learners learn better in non-coeducation classes and schools has been a debate for decades (Morse, 1998) and the debate remains inconclusive (Sikora, 2013). The apparent benefits of non-coeducation schooling may be attributable to selectivity on socio-economic background or academic achievement. For example, Smyth (2010:53) argues: "It is difficult to systematically compare non-coeducation and co-educational classes. In many countries, non-coeducation schools are highly selective in their social and ability profile; even in countries with a large number of non-coeducation schools, the two school sectors differ in their intake. Therefore, "it should be accepted that there is no well-designed research showing that non-coeducation improves learners' academic performance" (Sikora & Pokropek, 2012:236). Research in Australia concluded that non-coeducation schooling made no real difference because learner intake policies and other learner characteristics were not taken into account (Ainley & Daly, 2002). At times non-coeducation schools in Australia routinely mix with the opposite sex from other schools for various activities, including specialised science classes (Sikora, 2013). This suggests that mixing boys and girls from non-coeducation schools have no negative effect in performance. Nevertheless, co-education or non-coeducation may not be significant in this study because these models represent artefacts and not educational design that are vital to performance (Sikora, 2013) and this needs further study.

After teaching the CG using traditional method, the group did not perform well when compared to EG. Unlike the post-test performance of the EG who seem to have developed clear conceptual understanding of scientific procedures, the CG did not. The reasons are that learners lacked support from their peers and therefore did not learn from the social learning environment provided in the classroom. According to Vygotsky (1978) ZPD support is important because most learners experience challenges during the transition from assisted to independent learning. Therefore reducing the dependence to increase independence learning may take a while in order to yield positive results. The strength of peer support is in the interaction it fosters between learners, who by virtue of their similar ages, language, and common experience, are often "better at clearing up each other's confusions and misconceptions" than their teacher (Wood, 1997:269). Learners need to talk to one another about their learning (Carr et al., 1998; O'Donnell, 1999) which they miss in talk-and chalk teaching approach. In fact, learners feel that discussion among themselves is helpful as attested in surveys about peer learning by Ainley, Kos, Nicholas (2008). In their study they found that 92% of learners agreed that discussing questions with others aided conceptual understanding, 82% agreed that hearing others' explanations helped them to learn, and more than 90% reported that the moment they felt most engaged during class was when they were working with their peers in small groups. At times teachers who use talk-and chalk try to compensate for learners' passiveness in order to have learners' sustained concentration, by prompting one or two learners to participate either as volunteers or by calling learner names (Kibirige & Maoko, 2014). These options may maintain participation but only for a short time and this is not sustainable in education. On the other hand, those learners that are vocal can give the teacher an impression that the silent majority of the class either understands or misunderstands concepts (Simpson & Oliver, 2007). Knowledge is not always passively received; it is actually better received through active learning which assists in developing investigative skills that are vital in the modern world (Matthews, 2000). Therefore, in talk and chalk teaching learners miss the complex and dynamic relationship between learning and development that can be determined by the area between a learned level of independent performance and of assisted performance, the Zone of Proximal Development (ZPD) (Vygotsky, 1978; O'Donnell, 1999). This study involved a small sample and it is not clear what the results would be if a large sample was used and this may need further study.

CONCLUSION

Cooperative learning has the potential to improve performance of learners if used effectively as it was shown in this study. Also, cooperative learning may be used for both boys and girls since the results show that the method did not discriminate against gender. These findings have implications for the understanding of issues associated with low pass rate in Physical Sciences in secondary schools in Maleboho Central circuit.

REFERENCES

Ainley, J. & Daly, P. (2002). Participation in science courses in the final year of high school in Australia: The influences of single-sex and coeducational schools. In A. Datnow & L. Hubbard (Eds.), *Gender in policy and practice: Perspectives on single-sex and coeducational schooling* (pp. 243–262). New York, NY: Routledge.

Ainley, J., Kos, J. & Nicholas, M. (2008). Participation in science, mathematics and technology in Australian education, ACER research monograph no.63, Australian Council for Educational Research, Melbourne.

Atherton, J.S. (2003). *Learning and teaching: Constructivism*. Retrieved from http://www.dmu.ac.uk/~jamesa/learning/constructivism.html

Blatchford, P., Basset P. & Brown P. (2011). *Learning and Instruction*, 20: 1-1.

Carr, A.A., Jonassen, D.H., Litzinger, M.E. & Marra, R.M. (1998). Good ideas to foment educational revolution: the role of systemic change in advancing situated learning, constructivism, and feminist pedagogy. *Educational Technology,* 5-15.

Deutsch, M. (1949). A theory of cooperative and completion. *Human Relation*, 2, 129-152.

Else-Quest, N. M., Hyde, J. S. & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin*, 136: 103–127.
Eslamian, D., Aref K. & Aref, K. (2012). The influence of cooperative learning on learners' performance. *Journal of American Science*, 8(2): 200-203.
Even, R. & Kvatinsky, T. (2009). Approaches to teaching maths in lower-achieving classes. *International Journal of Science and Maths Education,* 7: 957-985.
Hake, R. R. (1998). Interactive-engagement versus traditional methods: a six-thousand learner survey of mechanics test data for introductory physics courses. *American Journal of Physics*, 66(1):64-74.
Iksan, Z. & Zakaria, E (2007). Promoting Cooperative Learning in Science and Maths Education. *Journal of Maths, Science and Technology Education*. 3(1): 35-39.
Johnson, D.W. & Johnson, R.T. (1994). *Learning together and alone*. London: Allyn and Bacon.
Judith, L.M. & Jones, M.G. (1996). Gender Differences in Motivation and Strategy Use in Science: Are girls Rote Learners? *Journal of Research in Science Teaching.* 33(4): 393-406.
Kibirige, I. & Teffo, L.W. (2014). Actual and Ideal Assessment Practices in South African Natural Sciences Classrooms. *International Journal of Educational Sciences*, 6(3): 509-519.
Kibirige, I. & Maoko N. (2014). Getting it from the horse's mouth : a case of dialogic teaching in high school. *Journal of Educational Studies*, 13(2): 193-215.
MacManaway, L. A. (1970). Teaching methods in higher education—innovation and research. *Universities Quart*. 24(3):321-329.
Matthews, M.R. (2000). Constructivism in science and mathematics education. In D.C. Phillips (ed.), *National Society for the Study of Education, 99th Yearbook,* 161-192. Chicago: Chicago University Press.
Mercer, N. & Hodgkinson, S. (2008). *Exploring talk in school*. London: Sage.
Mitchell, I. (2010). The relationship between teacher behaviours and learner talk in promoting quality learning in science classrooms. *Research in Science Education*, 40(2): 1-16.
Morse, S. (1998). *Separated by sex: A critical look at single-sex education for girls*. Washington, DC: American Association of University Women Educational Foundation.
Nichol, D. J. & Boyle, J. T. (2003). Peer instruction versus class-wide discussion in large classes: a comparison of two interaction methods in the wired classroom. *Studies in Higher Education*, 28(4):457-473.
O'Donnell, A. M., & King, A. (Eds) (1999). *Cognitive Perspectives on Peer Learning*. New Jersey: Mahwah.
Schoenfeld, A. H. (2006). Design Experiments. In Judith L. Green, Gregory Camilli, & Patricia B. Elmer (Eds.), *Handbook of complementary methods in educational research,* 193–205. Mahwah, New Jersey: Erlbaum.
Sikora, J. (2013). Single-sex schools and science engagement, NCVER, Adelaide. ISBN 978 1 922056 68 9 TD/TNC 113.18 Retrieved from https://www.ncver.edu.au/wps/wcm/conn ect/c5417e42-4ab8-4343-bb8d-b6e0c68e9b78/Single-sex-schools-2668.docx?MOD =AJPERES&CACHEID=c5417e42-4ab8-4343-bb8d-b6e0c68e9b78...
Sikora, J. & Pokropek, A. (2012). 'Gender segregation of adolescent science career plans in 50 countries', *Science Education*, 96(2): 234-264.
Simpson, V. & Oliver, M. (2007). Using electronic voting systems in lectures. Date Electronic Retrieved from http://www.ascilite.org.au/ajet/ajet23/simpson.html
Smith, H. & Higgins, S. (2006). Opening classroom interaction: the importance of feedback. *Cambridge Journal of Education*, 36(4): 45-502.
Smyth, E. (2010). Single-sex education: what does research tell us? *Revue Française de Pédagogie*, 171:47-55.
Topping, K., Thurston, A., Tolmie, D., Murray, P. & Karagiannidou, E. (2011). Cooperative learning in science: Intervention in the secondary schools. *Research in Science and Technological Educatio,* 29(1):91-106.
Vygotsky, L. S. (1978). *Mind in society*. (Trans. M. Cole). Cambridge, MA: Harvard University Press.
Watkins, C. (2005). *Classrooms as learning communities*. Abingdon: Routledge.

Wood, W. B. (2004). Clickers: a teaching gimmick that works. *Developmental Cell*, 7(6):796-798.

Wood, B. S. & Brown, L. A. (1997). Participation in an all-female Algebra I class: Effects on high school mathematics and science course selection. *Journal of Women and Minorities in Science and Engineering*, 3: 265-277.

◈◇◈

APPENDIX A: Sample of type of questions used in the class activities

<u>Practical Confirmation of the Value of acceleration for a falling object</u>

Apparatus:

1. Stop watch
2. Tennis ball
3. Measuring tape
4. Writing materials

Instructions to learners

-In pairs, one pupil does the experiment while the other records the results
- **Problem:** Drop a tennis ball 5 times from the top of the table. Record the results (height from which the ball was dropped and the time it took to hit the ground) in the table below and complete the table:

Trial	Height in metres (h)	Time in seconds (t)	Time deviation (mean time-t)	Average velocity **(v= h/t)**	Average acceleration **(a= v/t)**
1					
2					
3					
4					
5					
	Total (T)				
	Mean Time				
	Mean Time deviation				
	Real Time				

- Explain your answer.

