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Cooperative Concept Mapping Strategy in the Teaching of Biology in Secondary Schools for the Enhancement of Students' Creative Skills in Fako Division of the South West Region of Cameroon

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Abstract

Creativity is one of the 21st century skills that every educational system must enhance. Instructional strategies play an important role in learning outcomes. Thus, the study aimed at investigating the effect of cooperative concept mapping strategy on the acquisition of creativity skills in secondary schools Biology students. The study made used of an explanatory sequential research design with a sample of 123 form four students and a teacher. This was purposively selected from Government High School Bonadikombo Limbe I sub division, Fako Division in Cameroon. The instruments used for data collection was Biology Creative Skills Achievement Test (BCSAT) and an interview. The instruments were validated by experts. The reliability coefficient of the test was 0.894 calculated using Alpha Cronbach. Data was analysed using descriptive and inferential statistics. The results revealed that the students of the experimental group had a mean creativity skills achievement score of 8.46 and those of the control group had a mean creativity skills achievement score of 3.50. It was concluded that cooperative concept mapping strategy can enhance biology students' acquisition of creative skills in secondary schools. We recommended that secondary school biology teachers should implement cooperative concept mapping strategy in the teaching of biology in secondary schools.

Keywords: Cooperative Concept Mapping Strategy, Teaching of Biology, Direct Teaching Strategy, Creative Skills

1. Introduction

Nationally and internationally, there is growing recognition that if education is to produce skilled thinkers and innovators in a fast-changing global economy, then creative skills are more important in education than ever. The ability to be creative in a learning context is essential for the development of knowledge, understanding and innovations (Priyanka & Gopalkrishnan, 2017) [25]. Giving biology students the opportunity to engage in the process of constructing their own knowledge through using of complex authentic teaching strategies, assessment strategies and problem solving encourages the students to use content knowledge to develop creative thinking. This promotes deep understanding of the subject matter and its application in real life (Chinedu & Kamin, 2017) [11]. For biology students to develop these skills effectively, they need to be engaged in problem solving activities. However, the aim of biology is to provide the students with biology-related learning experiences for the students to develop scientific literacy skills or generic skills, so that they can be creative and participate actively in the rapid changing knowledge-based society as new problems pop up on daily base. In order to meet these challenges, biology like any other science subjects needs to provide a platform for developing creative thinking skills in the students to meet up these challenges (Endeley & Ibi, 2020; Lawyer, 2020; Mazano, 2007) [12, 20, 22]. In this context, creative skills are the ability for a student to be able to identify a problem, understand the problem through brainstorming, develop strategies to solve the problem, solve the problem by coming up with a novel decision or solution to the problem.

2. Literature review

The concept of cooperative concept mapping strategy

According to Olatoye, Aderogba and Aanu (2011) [26], cooperative learning strategy is a teaching strategy in which small teams, each with different abilities of students use a variety of learning activities to improve on their understanding of a subject. According to Şimek, Byilar and Kucuk (2013) [33], cooperative learning is a process meant to facilitate the

accomplishment of a specific end product or goal through people working together in groups. Brandy and Tsay (2010) as cited in Sor, Jamabo and Igwe (2018) [36] defined cooperative learning as a method of organizing classroom activities into academic and social learning experiences. Johnson and Johnson (2014) [17] reiterated that in a cooperative learning class students should work together in order to maximise each other's knowledge and achieve a shared goal and acquire skills. The principles of cooperative learning (Johnson & Johnson, 2014; Lawyer, 2020; Slavin, 2011) [17, 20, 35] include positive interdependence, individual accountability, face-to-face interactive promotion, group processing, social skills and group heterogeneity.

A Concept is defined according to Novak (2004) [25] as regularities or patterns of events or objects, or records of events designated by a label. In the teaching learning process, concepts are arranged hierarchically with the most general, most inclusive concept at the top, and the most specific, least general concepts toward the bottom (Nekang, 2014) [23]. Concepts are linked to one another using propositions. Tchombe (2019) [39] reiterated that the process of constructing a concept map requires metacognition and brainstorming thus enhancing skills acquisition in the learners. Thus, concept mapping is a teaching learning strategy whereby knowledge is represented in the form of diagram or map to enhance retention and skills acquisition. The hybridization of these two broad concepts refers to cooperative concept mapping strategy (CCMS).

According to Adaobiagu, Obiagu, Mezieobi, Aroh and Akubue (2020) [5], cooperative concept mapping strategy refers to the hybridization of cooperative learning strategy and concept mapping strategies. This concept embodies the elements of cooperative learning and concept mapping. This concept at the class room level application simply means that after the students work in teams, the group member brainstorm together to come up with a concept map for their task which enhances their skills acquisition. Working together helps the students to develop skills such as analytical, evaluative, communicative, conflict resolution skills and creative skills (Ajaja, Raphael, & Nwanekezi, 2018; Webb & Mastergeorge, 2003) [3, 40]. This kind of approach promotes active students' participation as the students construct knowledge for themselves. The importance of CCMS cannot be overemphasized in the teaching of a life science subject like biology that requires a lot of experiments field trips and other hands-on activities in its teaching and learning process to imbibe the students with scientific literacy skills.

These two instructional strategies that form the indicators of CCMS have been used by teachers of biology independently and it has been observed from literature and experience that these have not been able to equip biology students with sufficient creative skills. Francisco, Nicoll and Trautmann (1998) stated that the prevailing teaching methods and strategies do not actively involve students in the learning process and that seems to deprive them from taking charge of their learning and acquire the expected skills. Therefore, biology teachers need to adopt teaching learning strategies and methods that would enable the students to be able to understand, apply, analyse, and evaluate phenomena and become creative in an ever-changing environment that is characterized with evolving technologies, competition, and new challenges on daily basis. This in a nutshell equips the students to become future problem solvers with high creative skills. Okoli (2006) [27] underscored that a learning environment in which students discuss the material, share ideas, listen and consider ideas of others and clarify their thinking through verbal interaction with each other cannot be overemphasized in this era as it enhances students' different types of skills acquisition.

Keraroj, Wachanga, and Orora (2007) [18] posit that cooperative concept mapping strategy motivate students to learn as it brings together the benefits of the two approaches. This is because this teaching strategy is learner-centred and gives the learners the opportunity to study together and help each other to understand content and acquire the expected skills. It is believed that when students are given the opportunity to study together in teams, they develop their skills acquisition (Tchombe, 2019) [39].

Yore (2012) [41] argued that direct instruction which is frequently used in the teaching of biology in secondary schools and it makes the students to be passive listeners, and hinders their exposures to creative thinking skills, thereby discouraging students from becoming creative and innovative. Thus, the importance of the implementation of CCMS in secondary schools cannot be overemphasized. Tambo (2012) [38] opines that, the use of direct teaching strategy has failed to bring about the desired outcomes in the learners thus hampering academic performance and skills acquisition of the learners. Mezieobi (2014) [21] emphasized that, the use learner-centred strategies in the teaching learning process is important as it motivates the learners, enhance students' academic performance, achievement and skills acquisition.

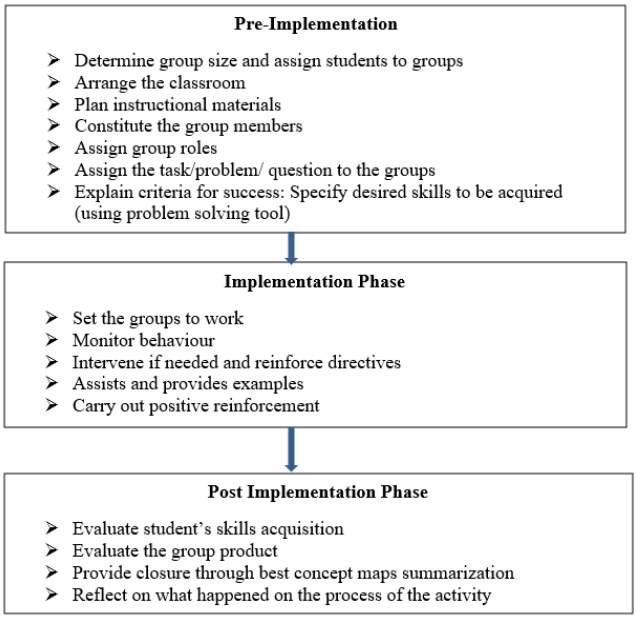

Fig 1: Conceptualized Implementation of Cooperative Concept Mapping Strategy

The inappropriate use of teaching strategies by secondary school biology teachers in Cameroon has created a knowledge gap between teaching strategies used in teaching biology and students' acquisition of creative skills as revealed by literature. However, there is a possibility that cooperative concept mapping strategy might bridge this gap. This is because CCMS activities exonerate students understanding of the concept taught in a constructivism perspective which awakens their critical consciousness and

enhance skills acquisition in the learners (Adaobiago *et al*., 2020) [5]. To buttress this point, Kyado, Abah, and Samba (2019) [19] and Ajaja and Eravwoke (2010) [2] in their studies concluded that students exposed to CCMS and cooperative learning performed higher in biology mean achievement test than those exposed to conventional teaching strategy. Fig 1 demonstrates the implementation of CCMS in a classroom setting.

Creative skills

Sternberg (2009) [34] defines creativity as an imaginative action fashioned so as to produce outcomes which are both original and of value. Also, novelty is necessary rather than originality meaning that someone's idea does not have to remark thinking that has never been thought before by anyone. This thinking should be new for that individual, not necessarily for the society as a whole. According to Coughlan (2007) [10], creativity refers to creating or rearranging something in a new or original way. Creativity involves divergent and convergent thinking to produce new ideas (Crowl, 1997) [9]. Creativity's place in the using appropriate strategy was well articulated in Pasteur's observation that "chance favours only the prepared mind" because "only a trained mind can make connections between unrelated events, recognize meaning in a serendipitous event," and produce a solution that is both novel and suitable (Crowl, 1997, p. 188) [9]. This requires that for the learners to develop creative thinking skills and be creative they need to engage in teaching learning strategies such as CCMS that is motivating to prepare the learners mind to learn more and acquire more skills.

Robson (2013) reiterated that creative thinking is not merely based on art-based activities such as dance, music, drama and so on as it was previously assumed. In recent years, creativity has been valued as universal capability that it can be applied in everyday situations and generate in subjects based on the strategy the teacher chooses to use in a particular lesson. According to Sternberg (2009) [34], creative thinking is distinct from analytical and practical thinking. Choices and critical evaluations, observations are made by participants and it constitutes part of creativity process in a cooperative setting. Wright (2010) as cited in Robson (2013) also pointed out that creativity integrates both problem setting and problem-solving skills with meaningful solutions. Newbill and Baum (2012) [24] argued that today's world is technology-driven, problem-riddled, competitive, chararaterized with billions of information as such acquiring creative and critical thinking skills are very vital for all students to live and contribute to the development to the society of today. Brett and Parlin (2012) [6] opined that in a direct teaching setting, there is little or no opportunities for reflection and debate on learners' misconceptions or errors thus hindering the acquisition of skills. Using cooperative concept mapping strategy, students' debate, discuss and clarify themselves with the assistance of the teacher. In this light they are able to construct knowledge for themselves as postulated by social constructivism theorists (Tchombe, 2019) [39]. Gillies (2008) [15] contended that team's problem solving could be used to stimulate learners' high level of debate between team members thus enhancing critical and creative thinking of the learner. According to Havard, Du and Xu (2008) [16] and Riley and Anderson (2006) [31], when learners discuss concepts with their team mates, suggest possible solutions and find mistakes, they potentially improve on their creative thinking abilities.

Enhancing creative skills acquisition through cooperative concept mapping strategy Biology class

Promoting the acquisition of creative skills in a cooperative learning classroom, the biology teacher needs to adopt one of the problem-solving models that will facilitate the acquisition of the desired skills. There are many models that can facilitate creative skills acquisition of students; however, this paper focuses on Bransford's IDEAL model (Foshay & Kirkley, 1998) [13] which starts with identify the problem, define the problem through by searching for relevant information, explore the solutions through looking at alternatives and different points of view, act on the strategies derived at from exploration and look back and evaluate the effects of your activity which is the solution to your problem.

Pólya as cited in Barczi, 2013; Nekang, 2014 [23]) also came up with four phases of problem solving steps that students can be used in a CMMS classroom to enhance student's acquisition creative skills using problem solving process: Understand the problem, make a plan, carry out the plan, Look back: This phase is more than just checking whether the answer is correct, They need to review how they solved the problem and discuss the difficulties they had to face, the ideas that helped them carry on and so on (Ambrus, 2004), and Draw a concept map: This occurs when the solution to the task/problem/ question has been discovered or the answer to the question has been found.

Ponnambaleswari (2012) [30] came up with some steps known as tools that can be used to enhance creative skills acquisition through problem solving process. This can be used to set the base for the learners at the secondary school because of its simplicity. The tool involves the following steps: define the problem, Clues identified to arrive at the solution, arrive at the solution and state the solution arrived at. This paper adopted these steps to enhance student's creative skills. This example demonstrates how students can be groomed to acquire creative skills through problem solving using CCMS.

Statement of the problem

Biology is the bed rock of many science professions. As such many innovative teaching strategies have been included in the biology curriculum for secondary schools in Cameroon to enhance the acquisition creative skills. Creative skills help biology students to answer examination questions related to creative thinking and apply biological content knowledge to solve individual or societal real life biological problems. However, it has been observed that biology students and graduates from secondary schools in Cameroon do not have sufficient creative skills despite the efforts put in place by the government through the Ministry of Secondary Education and biology stakeholders of education. Many factors may account for this, one of which is the instructional strategy used. Teachers make use of direct teaching more and direct teaching does not enhance creative skills.

It is against this backdrop that, this study sought to investigate if cooperative concept mapping strategy has an effect on biology student's acquisition of creative skills in secondary schools in Fako Division of the South West Region of Cameroon.

Objective of the study

To compare the mean creative skills achievement scores of forms four students in biology when taught using cooperative concept mapping strategy and direct teaching strategy.

Hypothesis of the study

Ho: There is no significant difference in the mean creative skills achievement scores of forms four biology students that are taught using cooperative concept mapping strategy and direct teaching strategy.

Ha: There is a significant difference in the mean creative skills achievement scores of forms four biology students that are taught using cooperative concept mapping strategy and direct teaching strategy.

3. Methodology

This study adopted a mixed methods research approach with an explanatory sequential research design. A quasi-experiment (pre-test, post-test non-equivalent control group) was used to collect the quantitative data and an interview guide was used to collect qualitative data. This design was suitable for this study because the weakness of one approach neutralises the weakness of another. The sample size was 123 (122 form four students and one form four biology teacher) was drawn from Government High School Bonadikumbo. Purposive sampling technique was used to select the school and the form four biology students and form four teacher. The instruments used for this study was Biology Creativity Achievement Test (BCAT) and an interview guide. The instruments were validated by expects. The reliability coefficient was 0.894 and was calculated using Alpha Cronbarch. The methods of data analysis were descriptive and inferential statistics. Independent sample t-test was used to test the hypothesis.

Procedure: Form four was selected for the study. This form four was made up of three streams (A, B and C). Two of the streams (A and C) were selected for the study. These two classes were taught by a single teacher. These classes where automatically selected for the study. Form 4A was assigned the control group and form 4B the experimental group. Some topics on Nutrition focusing on photosynthesis were taught for four weeks. Before the commencement of the study the students were given a pre-test to measure their levels knowledge before the treatment. A treatment was administered to the experimental group using CCMS while the control group was taught using direct teaching strategy/conventional teaching strategy. Four weeks later a post-test was administered to all the groups. Fig 2 presents the quasi-experimental schema for the study.

Group 1	O1	X	O2
		.....	
Group 2	O3	C	O4

Key: Pre-tests 01 and 03, Post-tests 02, 04, Treatment X, Control C, --------- Dashed lines show that the experimental and control groups were not equated by randomization hence non-equivalent. 1and 2=Various form four

Fig 2: Quasi-Experimental Schema for the Study

The following intervening variables were controlled; the researcher taught both the groups to control some intervening variables. To control material variation the researcher prepared the same content materials notes for the both groups. Subject interaction and test infiltration was controlled as the researcher made sure that all the groups were not aware of the different treatments that were given to them with the help of the class teacher. The test was written on the same day at the same time simultaneously.

4. Presentation of results and discussion

At the pre-test level the result showed that the mean biology creative skills achievement scores were 0.90 for control group and 0.80 for the experimental group. The difference in their achievement level was 0.1 which was low. This implies that the students were almost at the same knowledge level on creative skills abilities before the treatment was administered. This shows that any change at the end of the exercise could only be as a result of the implementation of the CCMS, if the extraneous/intervening variables are well controlled.

Table 1 presents comparisons of students mean creative skills scores at the pre-test level.

Table 1: Comparisons of Student Mean Scores in Creative Skill at the Pre-test Level

Schools	Test level	Group	N	Mean	Median	Std. Error of Mean	Std. Deviation
Bonadikombo	Pre-test	Control	61	.90	1.0	.0926	.7235
		Experimental	61	.80	1.0	.0830	.6373

P-value =0.072, t-value=0.1832, df=106, Mean difference=0. 1

At the post-test level, the results after four weeks of treatment show that the students of the control group had a mean biology creative skills achievement score of 4.58 and the experimental group had mean biology creative skills achievement scores of 7.95. The mean difference was 3.37. This was very significant. Thus, the students of the experimental group achieved more creative skills than their counterpart of the control group. Table 2 presents the comparisons of students mean achievement creative skills scores at the post-test level.

Table 2: Comparisons of Student Mean Scores in Creative Skill at the Post-test Level

Schools	Test level	Group	N	Mean	Median	Std. Error of Mean	Std. Deviation
Bonadikombo	Posttest	Control	61	4.58	4.5	.2283	1.7975
		Experimental	61	7.95	8.0	.3052	2.3835

P-value =0.00, t-value= 13.746, df=106, Mean difference=3.37

Testing of the hypothesis of the study, table 3 presents the testing of hypothesis of the study.

Table 3: T-Test Mean Score in Creative Skills Acquisition Taught Using Cooperative Concept Mapping Strategy and Direct Teaching Strategy

Group	N	Mean	Std. Deviation	Std. Error Mean	P-value	$T_{calculated\ value}$
Experimental (Taught using cooperative concept mapping strategy	61	8.23	1.7853	.1357	0.00	22.093
Control (Taught using direct teaching strategy)	61	3.76	2.0128	.1503		

At confidence interval (CL) 95%, df=106, $t_{critical\ value}$=1.960, Mean difference=4.47, P-value 0.00≤ 0.05

Statistically, the results showed that students in the experimental group taught using cooperative concept mapping strategy (Mean 8.23±1.7853) significantly (P-value 0.00< 0.05) perform more than two times better in creativity skills than those in the control group taught using the direct teaching strategy (Mean 3.76±2.0128) with $t_{calculated\ value}$ of 22.093 > than the $t_{critical\ value}$ of 1.960. Therefore, the null hypothesis was rejected and it was concluded that there is a significant difference in the mean creative skills achievement scores of forms four biology students that are taught using cooperative concept mapping strategy and direct teaching strategy.

To confirm this statistical result, the researchers went further to carry out and interview the teacher who was involved in this study corroborate the result from the biology creativity achievement test which resulted to acceptance of the alternative hypothesis. Table 4 presents teacher's opinion on students' acquisition of creative thinking skills.

Table 4: Teacher's Opinion on Students Acquisition of Creative Skills

Question	Theme	Quotation
Based on your observation, can CCMS enhance creative skills acquisition among biology students?	Yes (Enhance creative skills acquisition)	"Yes, creative skills enable the students not to easily forget as they learn". "Yes, it motivates the students to explore the insight of their task based on different ideas from team members". "Yes, biology is our body, entire environment and students do not have good knowledge of it to apply it to solve individual or global problems".
From your observation, were students able to describe their idea to group members and to the class?	Yes	"Yes, most of the students called up to speak and answer their questions well while others were able to come up with concrete concept maps in relation to their task". "Yes, the manner in which they respond to questions". "Yes, students were able to brainstorm, compare what they were saying to similar context and each other's idea"
Were the students in their respective groups able to justify their points or ideas during their group activities when an argument breaks out?	Yes (Participation)	"Yes, students were very participative to back up their ideas". "Yes, all students were active to answer the teacher's questions or when they were called upon in front of the class to explain their task". "Yes, students could illustrate their points for clarity to all the team members".
Were the students in their respective groups during activities able to substantiate their points to make contribution clearer to their group members?	Yes (Respondent properly to questions)	"Yes, this is because they were able to give the correct answer of the task". "Yes, there were able to answer questions asked by the teacher".
	No	"No, other members just followed those who are active in the group".
Were group members able to draw appropriate conclusion with respect to their task?	Yes (Due to critical thinking and interaction)	"Yes, it is interactive learning". "Yes, student could explain think critically, differently, come out with ideas, and answer technical questions that require knowledge transfer and application". "Yes, students can easily master a topic using the CCMS".

Based on the teacher's opinion about cooperative concept mapping strategy in relation to student acquisition of creative skills, the biology teacher interviewed said that cooperative concept mapping strategy enhances creative skills as they said "Yes, it allows the students explore the insight of their task based on different ideas from group members". Also, they said students were able to describe their ideas/contributions to other group members and to the whole class. Furthermore, the teacher said the students in their respective groups were able to justify their points or ideas during their group activities when an argument breaks out during active participation of all the group members. In addition to that, the biology teacher said students in their respective groups were able to substantiate their points to make contribution clearer to their group members resulting to correct answering of questions. Finally, the teacher said the students were able to draw appropriate conclusions with respect to their task because they could think critically, differently, come out with ideas and answer technical questions that require knowledge application with respect to their task. Based on this interview with the form four biology teacher, it was concluded that CCMS enhance the acquisition of creative skills in form four students. Thus, this finding corroborates with the result of the BCSAT

This result is in line with the findings of the study carried out by (Benedek, Mühlmann, Jauk and Neubauer, 2013) [7] who found out in their study that creativity evaluation skills are positively correlated with divergent thinking and creative achievement, which suggests that evaluation skills are relevant for creative ideas as well as creative accomplishment.

This result is supported by the findings of the study carried out by Auta (2015) [1] entitled, effects of concept mapping and inquiry strategies on achievement and creativity among colleges of education physics students in North-East Nigeria. He found out that innovative teaching strategies enhance students' academic achievement and creativity.

Similarly, the study of Pandey and Kishore (2016) on the effect of cooperative learning on cognitive achievement in science also confirms the result of this study. They found out in their study that cooperative learning strategy was more effective than traditional method teaching method or direct teaching strategy as it enhances the acquisition of comprehension, analyses, evaluation and creativity levels of

the revised Bloom's taxonomy. Thus, cooperative learning enhances students' acquisition of creative skills.

In addition to that, this result is also in conformity with the findings of the study of (Taie, 2014) [37] who found that concept mapping improved students' meaningful learning levels and enhance cognitive learning in the aspects of analysis, evaluation and creativity. This therefore implies that students' acquisition of creative skills was improved upon when the students were taught using concept mapping strategy.

The result of this study can be explained by fact that when the students are given the opportunity to study together in teams, they become confident to study extra hard to meet with the levels of the other team mates as they assign tasks to work on. This helps them through brainstorming and research to come up with creative ideas than when they would have been studying alone through direct teaching strategy. By engaging through this process of learning they develop creative ideas. This creative thinking skills is also much enhanced as the students brainstorm to come up with diagrams, maps to summarize their knowledge acquired. Furthermore, putting into writing or explaining have they have found based on their assigned task within the groups also enhance their creative skills. In this light the teacher is only a guide and not a reservoir of knowledge as the students generate knowledge for themselves to overcome the zone of proximal development.

5. Conclusion

Based on the result it was concluded that cooperative concept mapping strategy can enhance biology students' acquisition of creative skills in secondary schools. As a way forward biology teachers should implement cooperative concept mapping strategy in the teaching of biology in secondary schools. In addition to that workshop, refresher courses, seminars be organized for biology teachers on how to implement cooperative concept mapping strategy for the teaching of biology in secondary schools in order to enhance student's creative skills acquisition. Finally, Heads of Department for biology should supervise the implementation of CCMS by biology teachers as the students will benefit from creative skills acquisition.

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