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Improving Science Teaching through the Use of Cooperative and Collaborative Instructional Strategies

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ABSTRACT

Instructional strategies are teaching methods used by instructors to improve students' learning, develop critical thinking skills and keep students on task. With an increasing awareness that many undergraduates are passive during teaching sessions calls for instructional strategies that would allow learning to be student centered,where students will be actively involved in the learning process.In other to achieve this aim,the use of cooperative and collaborative instructional strategies where students work in small groups and are active constructors of their knowledge was introduced.Thus,the purpose of this work is based on the role cooperative and collaborative instructional strategies play in improving science teaching. Areas where these cooperative and collaborative instructional strategies can be applied were discussed, benefits and challenges of using cooperative and collaborative instructional strategies were stated and suggestive recommendations were made.

Keywords: *Science,Teaching,Cooperative and Collaborative Learning,Instructional*

INTRODUCTION

The quality of education that teachers provide to students is highly dependent upon what teachers do in the classroom(Effandi,2003).Thus,in preparing the students of today to become successful individuals of tomorrow,science teachers need to ensure that teaching is effective.Teachers should have the knowledge of how students learn science and how best to teach it.Changing the way the teacher teaches and what he/she teaches in science is a continuing professional concern.Therefore efforts should be

taken to direct the presentation of science away from the traditional methods to a more student centered approach through experiment and practical work.

The Federal Ministry of Education in(2002)designed the science curriculum to equip the students in the acquisition of practical skills,attitudes and values for the development of the individual and the nation.The establishment of this science curriculum has enabled students to develop themselves through learning from one another.However,Uwameiye and Aduwa (2006)states that most students in tertiary institutions lack self-confidence and feel very inferior among their peers,which may lead to examination malpractice.According to Uwameiye and Aduwu(2006)the problem is not that the educators are not performing well or that the curriculum is inadequate but as a result of inadequate teaching method that is being used in the tertiary institutions.The need thus arise to modify the teaching and learning methods to the ones that should allow holistic participation of the students.Hence the instructional strategies should be considered.

Instructional strategies are techniques or methods teachers may adopt to meet the various learning objectives.These strategies helps students to walk on the path of independent learning and become strategic learners (Readence,Moore and Rickelman, 2000).These instructional strategies become learning strategies when students independently select the appropriate ones and use them effectively to accomplish a giving task to meet

educational goals.Instructional strategies can motivate students, help them focus attention and also help them to organize information for understanding and remembering.There are variety of learning strategies that instructors can use to improve science teaching and one of these learning strategy is the cooperative and collaborative learning

Cooperative and collaborative learning are instructional strategies used when students work together in small groups to accomplish a common learning goal.Johnson and Johnson (2012)define Cooperative learning as the instructional use of small groups so that students work together to maximize their own and one another's learning.The use of cooperative learning strategy also involves students working together on projects or problems in team or small group with both personal and team accountability for conceptual understanding(Teresa,2011).Cooperative learning have also enhanced students learning interest and motivation in teaching and learning science (Dickey, 2011).Dickey further stated that the use of cooperative learning strategy in teaching sciences have great potential in improving the learning achievement of students because the student is directly involved in the learning process.Thus,Jonassen (2012)states that for cooperative learning to be effective,the students must be engaged in critical thinking in order to solve any set of learning target to achieve a common goal.To accomplish this purpose,Albert (2010)opted that the group must be small enough to allow students capitalize on one another's resources and skills (asking one another for

information,evaluating one another's work).This leads to academic achievement because the student involved are active participants in the learning process.

The use of cooperative learning strategy in teaching sciences has resulted in a shift from a traditional teacher-centered learning environment to a student-centered environment in which the students are much more active and engaged in their learning and also acquire knowledge from one another (Harris,2010).Hence Walayat (2014)opted that for small groups to be active,the students have to be involved in a structured activity whereby objectives are accomplished through common learning goal under the guidance of a teacher.

Collaborative learning is a learning process that involves students working in pairs,as a team or in small groups to discuss concepts or find solutions to problems. Collaborative learning is also a learning process in which group of students work together to search for understanding,meaning or solution of their learning(Collins, 2011).Collaborative learning can occur peer-to-peer or in smaller groups to discuss a concept or find solutions to problems.This often occurs in a class session after students are introduced to the learning materials.Collaborative learning is also an active way of engaging students in the learning activities(Alexander,2014).This strategy helps the learner in development of high-level thinking,oral communication,self-management and leadership skills which will enable the learner achieve a positive outcome.Hence, collaborative learning strategy has been found to improve science teaching because when students work in groups,they tend to be more effective and efficient in any given scientific concept (Debora,2013).Cooperative and collaborative learning can be used interchangeably.This is reasonable,as both favor small-group,active student participation over passive lecture based teaching,each help students develop social and team building skills and each requires a specific task to be completed (Cooper and Robinson 2001).Cooperative and collaborative learning is founded on constructivist theory because knowledge is discovered by students and transformed into concepts that students can relate to,it is then reconstructed and expanded through new learning experiences (Myers,2004).

Cooperative and collaborative learning is a student centered learning method,which can be linked with the constructivist learning theory in which learners are in control of constructing their own meaning in an active way(Almala,2005).Constructivist learning is based on the belief that learning occurs when learners are actively involved in the process of acquiring knowledge.Constructivist theory suggests that human construct knowledge and meaning from experiences.This theory incorporates notions from the works of Vygotsky (1978).He stated that we learn through our interactions and communication with others and that our social environment influences the learning process.Vygotsky suggested that learning takes place through the interactions students

have with peers,teachers and other experts.On the other hand,social learning theories helps us on how teachers construct active learning communities.

Constructivist learning theory believes that all knowledge is constructed from the base of prior knowledge.Hence Cox-Peterson and Olsen(2000)define Constructivist theory as a process whereby individuals build new meaning upon previous meaning that they have acquired through life experiences.But for Vygotsky,education is a social process whereby the child is provided a means by which the aptitude and abilities of the child could be used towards social means.According to Brooks and Brooks (2000)learning is a social process in which knowledge is constructed by the learners in a social context. Therefore,in cooperative and collaborative learning,students should be made to engage in constructivist learning to encourage them play the role of active constructors of knowledge in other to learn more when they are in control of constructing their own meaningful knowledge through reciprocal interaction among students on any given task (Snowman and Biehler 2000).Thus in the constructivist classroom students work primarily in groups where knowledge and learning are interactive and dynamic. Therefore there is great focus and emphasis on social and communication skill,as well as collaboration and exchange of ideas.

ELEMENTS OF COOPERATIVE AND COLLABORATIVE LEARNING

Conducting cooperative and collaborative learning does not mean that you simply let students sit next to each other at the same desk and ask them to do their own task (Gillies,2003).According to Johnson and Johnson (2008)in order to engage students in learning,the following five elements must be considered.

1.Positive Interdependence: Team members are obliged to work together as a group to achieve their goal (Yager,2000).Students must ensure that other members of the group complete their task and are actively involved in order to achieve the academic outcomes.When team members fails to work together by not sharing individual ideas,the success of the group would not be achieved.

2.Individual Accountability: All students in a group are held accountable for doing their share of the work.Individual accountability exists when the performance of each individual member is assessed and the member is held responsible by the group mates for contributing his or her own quota to the

group success.

3.Face-to Face Promotive Interaction: Group assignment should be constructed so that the work cannot be simply parceled out and done individually. Assignments must include work that has to be done interactively.

4.Appropriate Collaborative Skills:Group members must be able to work together,but the ability to do so doesn't always come naturally,sometimes these skills needs to be taught.Examples of these collaborative skills include trust

building,leadership,decision making, communication and conflict

management.

5.Group Processing: Group members needs to monitor themselves,set up group goals,periodically assess what they are doing well as a team,and identify

changes they will make to function more effectively in the future.

Fig.1:Cooperative and collaborative learning environment

Source:Harriett (2014)

THE ROLE OF COOPERATIVE AND COLLABORATIVE INSTRUCTIONAL STRATEGIES IN IMPROVING SCIENCE TEACHING

Science teaching can be improved through a shift in education paradigm from teacher centered approach to a more student centered approach which occurs in a small group whereby the teacher would be able to have one on one interaction with each student in other to meet their individual needs(Pratt,2003).An example of cooperative and collaborative learning strategy is the application of Jigsaw technique.

Jigsaw is a cooperative and collaborative learning strategy that enables each student of a group to specialize in one aspect of a topic or one part of a given task.Jigsaw was introduced by Aronson(1973).Jigsaw is an efficient way for students to become engaged in their learning,learn a lot of materials quickly,share information with other groups,and be individually accountable for their learning (Karacop and Doymus, 2013).According to karacop and Doymus(2013)Jigsaw is a highly structured cooperative and collaborative learning approach which is implemented in four stages, they are:

1.Introductory Stage

2.Focused Exploration Stage

3.Reporting and Reshaping Stage

4.Evaluation Stage

1.The Introductory Stage: In this stage,the class is divided into heterogeneous “home”group consisting of between three to five students.Upon establishing the“home”group,the academic material is broken down into subtopics and presented to each student.

2.Focused Exploration State: Each student of the"home"group is responsible for learning the material he or she has being assigned to.Students from each “home”group that have selected the same subtopic will form an“expert”group. It is in the“expert”groups that students will explore the material pertaining to the subtopic that is,they work together to learn the material or solve the problem and will prepare for teaching it to "home"group.

3.Reporting and Reshaping Stage: Each student of the“expert”groups returns to their“home”groups.By so doing,the work of the"expert"groups are quickly disseminated throughout the home group,with each person taking responsibility for sharing a piece of what has been learnt.

4.Evaluation Stage:Students are then tested on what they have learnt.

Jigsaw can be used for sharing different solution to the same problem.This scenario can be practically applied in a biology class where the teachers objective is to explain the various parts that makes up the digestive system and how they function,they include:The part that enables food to enter the stomach which is the "Mouth and esophagus"the part that absorbs and distribute food which is the "Intestine"and lastly the part that removes waste products from the body which is the"Anus".

Demonstration of Cooperative and Collaborative Learning in a Biology Class. Activities:

Jigsaw technique can be explained through the teacher by placing students into group ABC and giving each of the student a piece of yam to chew.Some students were given large piece and other were giving small piece.As the students chew the yam,the teacher explains what is happening to the piece of yam that they are eating.For example,let the students know that the teeth is responsible for grinding the food in their mouth and that after the piece of yam is broken down,it will go through the esophagus.At this stage,the teacher points to the esophagus and ask the student if they feel any food there and ask of their observations.It was observed that students who ate small piece of yam didn't experience difficulty swallowing their piece of yam but students who ate large piece of yam experienced difficulty swallowing theirs.The teacher explains to the students that chewing something large can make one cough because it gets stuck in the esophagus which can lead to chest pain,heartburn and difficulty in swallowing.The teacher further explains that the food item that they ate will go to the stomach after it leaves the esophagus and will break down in the stomach through the small intestine. Explain to the students that the leftover food goes to the large intestine and the large intestine enables it to exit from tile body through the anus.

At the reporting and reshaping stage,each student goes back to their previous groups and explains the various experience to their fellow students lastly at the assessment or evaluation stage,the teacher ask the students to complete“What happens when you eat? Worksheet

Table 1:Formation of Jigsaw Technique

Home Groups

Group A	Group A	Group A	Group B	Group C
Mouth and Esophagus	Mouth and Esophagus	Mouth and Esophagus	Mouth and Esophagus	Mouth and Esophagus
(Fejo)	(Fejo)	(Fejo)	(Law)	(Fred)
Intestine(Harriet)	Intestine(Harriet)	Intestine(Harriet)	Intestine(kennedy)	Intestine(Sarah)
Anus(Tessy)	Anus(Tessy)	Anus(Tessy)	Anus(Desmond)	Anus (Precious)
Expert Groups	Expert Groups	Expert Groups	Expert Groups	Expert Groups
Group	A	A	Group B	Group C
Mouth	and	Esophagus	Intestine(Harriet)	Anus(Tessy)
(Fejo)				
Mouth	and	Esophagus	Intestine (kennedy)	Anus (Desmond)
(Law)				
Mouth	and	Esophagus	Intestine(Sarah)	Anus (Precious)
(Fred)				
Home Groups	Home Groups	Home Groups	Home Groups	Home Groups
Group A	Group A	Group A	Group B	Group C
Mouth and Esophagus	Mouth and Esophagus	Mouth and Esophagus	Mouth and Esophagus	Mouth and Esophagus
(Fejo)	(Fejo)	(Fejo)	(Law)	(Fred)
Intestine(Harriet)	Intestine(Harriet)	Intestine(Harriet)	Intestine (kennedy)	Intestine(Sarah)
Anus(Tessy)	Anus(Tessy)	Anus(Tessy)	Anus(Desmond)	Anus (Precious)

Source:(Aronson and Patnoe 1997)

Demonstration of Cooperative and Collaborative Learning in a Physics Class.

In a physics class,Rainbow Science was explored using triangular prism.The main objective of this activity is to make students understand that when sunlight reflects through a triangular prism it produces twelve colours of the rainbow.

Materials needed includes:Three triangular prism,three blank white paper and three packs of coloured pencils in the colours of the rainbow.

Activities:

In a class of 15 students,three groups X Y Z were formed and each of the groups were given one triangular prism,one blank white paper and one pack of coloured pencils

respectively.At the introductory stage,group X which is made up of five students placed their prism on the white paper and kept it by the window seal,group Y also made up of five students placed their prism on the white paper and kept it on the balcony rails and lastly group Z which is also made up of five students placed their prism on the white paper and kept it on the school loan.The teacher then instructs every student of each group to take turns and observe what happens to the prism placed on various locations when sunlight reflects on it.At the focused exploratory stage,students in groups X Y Z saw little rainbows inside the prism and the teacher asked each of the students to use the coloured pencil to colour over their rainbows created by the prism on the white paper.It was observed that students in group X saw and coloured red, yellow,blue,green,purple,indigo,and violet while students in group Y saw and coloured purple,red,yellow,indigo,green,blue,and violet.Finally the last group Z saw and coloured purple,red,green,blue,violet,yellow and indigo.At the reporting stage,each of the groups assembled in the classroom and collectively discussed their results then they came to a conclusion that the rainbow has seven colours.Lastly the teacher evaluates the students by asking them to write down the seven colours of the rainbow.

Demonstration of Cooperative and Collaborative Learning in a chemistry class on the topic"Titration"

The main objective of this activity is to introduce students to acid and base reactions.

Materials needed includes,Burette,pipette,indicator,acid and base solution,conical flask,retort stand,beaker and funnel.

Activities

At the introductory stage,the teacher sets up the apparatus and provides all the necessary materials needed for titration as mentioned above then the teacher groups the students into three groups R S T and give them instructions on how to go about the process in order to ensure safety in each group.At the exploratory stage,each group carries out the following:

1.Fill up the burette with dilute solution of acid.

2.Using a pipette the required measurement of base were taken and transferred into a conical flask.

3.Two drops of the necessary indicator for that reaction were turned into the conical flask contain the base.

4.The student places the conical flask under the burette and run the acid into the conical flask until there's a change in the colour of the solution in the conical flask.

5.Once a colour change is observed the student closes the tap of the burette from flowing and takes readings.At this stage,each students would participant by

taking reading of the burette based on their own observations then come to a conclusion of the volume of acid gotten and record their reading.This process is repeated up to three times for accuracy and the average volume of the acid is taken and recorded.

At the reporting stage each group member comes together with their various values for the volume of acid obtained.At this stage,if there's are any differences in their values, they discuss the possible causes and arrive at a conclusion.Finally the teacher evaluates the students by asking each of them to bring a report of the titration process based on their observations in a practical workbook.

BENEFITS OF USING COOPERATIVE AND COLLABORATIVE INSTRUCTIONAL STRATEGIES

The benefits from small groups learning in a cooperative and collaborative environment includes:

1. Interpersonal Development: Students learn to relate with their peers and other learners as they work together in group.According to James (2002)Students work with each other by sharing their personal knowledge and skills.

2. Promotes a Positive Attitude towards the Subject Matter: Cooperative and collaborative learning fosters a higher level of performance by students,their critical thinking increase and their retention of information and interest in the subject matter improves (Ibrahim,2003).When students are successful,they view the subject matter with a very positive attitude because their self-esteem is enhanced which in turn leads to more interest in the subject matter and higher performance in it.

3. Development of Social Interaction Skill: Social skills must be taught in order to achieve successful cooperative and collaborative learning.According to Baker & Clark (2010)such skills include effective communication,confict management skills and decision making skills.

4. Anxiety is Reduced Tremendously: Competition increases anxiety and makes people feel less able to perform.Cooperative and collaborative learning creates the opposite response from students.

5.Cooperative and Collaborative Learning fits in well in the Constructivist Approach: According to Almala (2015)it is only when students formulate their own constructs and provide solutions that they are truly thinking critically. Cooperative and collaborative instructional strategies creates a constructivist approach when students become actively involved in defining questions in their own language and working out answers together instead of reproducing materials presented by the teacher or the textbook.

CHALLENGES OF USING COOPERATIVE AND COLLABORATIVE INSTRUCTIONAL STRATEGIES

Incorporating cooperative and collaborative learning is not without challenges. Teachers and students have to face various challenges.The main problems which arises includes the following:

1.It is difficult for the teacher to be sure that groups are discussing the academic content rather than something else.

2.Space and furniture constraints.To maximize the full potential of cooperative learning,the learning environment must be spacious with intact desk and chairs. But in a situation whereby furniture's are lacking,it becomes a huge challenge on cooperative and collaborative learning.

3.Uneven learning experience,work load and evaluation.Cooperative and collaborative learning encourage students to support and assists one another, with all involved,in experiencing an equitable growth in knowledge in other to achieve success in their studies(Jacob,George,and Christopher 2000). Unfortunately,in some instances,more advanced students simply take over the majority of the work for the sake of ease and speed rather than helping struggling students learn.Conversely,indolent students might deliberately rely on more diligent group members to complete the work and avoid exerting any effort themselves.Both cases can result to an uneven learning and uneven work load that can lead to some student falling behind.The same holds true for students evaluation as it is often impossible to evaluate group members individually.This can result in all group members receiving the same grade or credit regardless of how much the contributed.

4.Group Dilemmas:-Conflict between individuals can diminish or stall a group's ability to work together,which raises a significant problem when group members are too young to have fully formed conflict resolution skills.Students relationships are often fraught with playground drama that immature students can't leave outside of the classroom.Mismatched personalities can cause unsatisfactory cooperative and collaborative learning even when no conflict or drama is present as students with dominant personalities might move into leadership roles whether or not they are best suited to steer the project at hand.

CONCLUSION

The use of cooperative and collaborative instructional strategies are very essential in teaching and learning processes as changes are needed in sciences.Teachers should give less emphasis on students acquisition of information and scientific knowledge through lecture method which is teacher centered but place more emphasis

on students understanding of a particular concept,guiding students in active learning,providing opportunities for discussions and also encouraging them to work in peers.

Using cooperative and collaborative instructional strategies offer students freedom to contribute to their own learning thereby enhancing students'knowledge and understanding of scientific concepts.

RECOMMENDATIONS

The following recommendations were made;

1.Science teachers should encourage learning together and incorporate Jigsaw teaching strategies in order to enhance students academic achievements and retention of scientific concepts.

2.Schools science laboratory should be fully equipped by the government in order

to encourage cooperative and collaborative learning.

3.Seminars and workshops should be organized by ministry officials,and local educational authority in order to educate practicing teachers on how to implement cooperative and collaborative teaching strategies in schools.

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