The Effect of Integrating Concept Mapping Into Group Discussion as an Instructional Strategy on the Academic Achievement of Senior Secondary Pupils in Genetics

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Abstract
Integration of concept maps into group discussion is one of the instructional strategies. It helps pupils to have a practical application of the topic taught, help pupils understand clearly certain phenomenon, help learners become creative and innovative and also helps in knowledge retention. The objectives of the study were to investigate the effect of concept mapping into group discussion as an instructional strategy on the academic achievement of learners in genetics and If achievement in genetics varies with gender. The study made use of a pre-test post-test quasi-experimental design. Two (2) senior Secondary grade twelve classes were purposively selected. The two classes were assigned to the experimental and control groups by randomisation using odd and even number method where the odd number class became the control group while the even number class became the experimental group. A genetics achievement test was used for data collection. The two hypotheses were tested at 0.05 alpha level of significance using an independent samples t test analysis of SPSS. The results of the independent samples t test showed that; the average achievement of pupils' taught using the integration of concept mapping into group discussion was significantly higher than those taught using group discussion method with the t-test results (with equal variances assumed) show t value is 7.338 with 88 degrees of freedom. The corresponding two tailed P- value is 0.00, which is less than the alpha value = 0.05. Therefore the null hypothesis is rejected, which means that the pupils in the experimental and controlled groups significantly differ in their Achievement in the genetics test i.e. experimental group (Mean =63.04) are significantly better in achievement in the genetics test taught with concept mapping than the controlled group (Mean = 37.93) taught with group discussion only. Gender has no impacts on achievement.From the independent t test for both the control and the experimental groups on gender, $P › \alpha$ 0.05 the null hypothesis was not rejected and concluded that the mean achievement in genenetics between females and males was significantly not different.

1. INTRODUCTION

This study was aimed at finding out the effect of integrating concept maps into group discussion as a means of instructional strategy on the academic achievement of senior secondary students in genetics at Kansenshi Secondary School in Ndola. Biology is a science under which genetics is taught. The role of science in any national development cannot be over emphasized by anyone who has had an encounter of learning and understanding science. Offiah, Achuf & Usi, (2010) describe education as a vital and indispensible key to all forms of national development. (Olarinoye, 2001 & Otuka, 2006), have also defined education as an instrument for developing the economy of a country. They further point out that the political and scientific developments of all nations are hinged on education.

Zambia being a third world country too requires the need for this technology. This therefore, calls for concerted efforts by citizens in embracing science and technology.

Oak (2011) reports that technology is important and its importance can only be appreciated if the citizens are able to benefit from this technology. Technology is an important vehicle that humanity can be made to progress. With the progression of technology, an elimination of hunger, poverty and the lack of access to education for most of the citizens is observed. Human life is greatly simplified when science and technology play their role in society.

Biotechnology can be enhanced if the knowledge of genetics is well understoo**d**. Of the Science, Technology, engineering and Mathematics, (STEM) subjects, biology outplays other STEM subjects and it is the subject on which bulk of biotechnology breakthrough is dependent. Biotechnology breakthrough is built on the better ways by which biology as a subject is understood.

It has been observed that the major challenges teachers have is to determine better ways of creating experiences in which students get involved and create situations in learning which support their own thinking and find ways of explaining, evaluating, communicating and application of scientific models which make sense of their experiences. This was according to (Afolabi & Akinbobola 2009).

Morden science teaching and learning is about increasing the awareness in the use of learner centeredness. This has drawn a lot of attention in trying to understand how learners learn and how to help them learn about concepts in science (Jegede, Alaiymota & Okebukola 1990).

These efforts as observed by Cliburn (1990) and Danjuma (2005), when learners are assisted to learn more effectively, their meta-cognitive development is enhanced which leads to meaningful learning. Novak, (1983) says learners need to take charge of their own learning in meaningful ways. Novak & Godwin (1984) also explained further that meta- knowledge meant knowledge that dealt with the very nature of knowledge and ability to know, while they described meta-learning as one dealing with the nature of learning by the learners themselves and bringing about meaningful learning. Malone & Dekker (1984) stated that meaningful learning was a type of learning that learners would use to integrate their new knowledge into the already pre- existing concepts and their propositions present in their mental structures.

By integrating concept maps in group discussion, students have an opportunity to apply their joint knowledge in genetics on a new problem. From a socio-cultural point of view, the process of learning science involves acquainting oneself with both the scientific content and the scientific language. The content is the scientific point of view, which often involves new, scientific explanations to familiar phenomena. One of the many aims of science education is to introduce students to the social language of science. The teacher's role in science education is therefore to equip the student with a useful toolkit of ways of talking and knowing about science (Mortimer & Scott, 2003). This does not differ from any other school subject.

Group discussion has a positive influence on learning, e.g. individuals' performance in the case of concept questions concerning genetics improves after peer discussions (Smith et al., 2009). Groups with and without participants who manage to solve the question before discussion must both be part of the learning process. If improved results are to be observed, it may not only be a copy of the answer from a student with more knowledge in the subject, but that they emerge from the discussion in itself. In a survey including six thousand students, their learning outcomes from traditional courses were compared to the learning outcomes of students participating in courses that used interactive engagement methods. Interactive engagement (IE) methods include methods that promote the interactive engagement of students by activities which give immediate feedback in discussions including peers and/or instructors (Hake, 1998). The results show significantly higher outcomes with IE methods both in a conceptual test and in a test on problem solving. IE does not necessarily include the opportunity to argue individual opinions; it could also be an opportunity to discuss interpretation on parts of the scientific content. Jonathan Osborne states in a review of recent science education research that the absence of opportunities to practice argumentation in contemporary science education is a significant weakness (Osborne, 2010).

The reason for choosing concept mapping in this study is because it is an activity that gives students an opportunity to think through the meaning of concepts and also give students an opportunity to relate a concept to other important concepts in a subject area (Wellington & Osborne, 2001).

The amount of information students are expected to master is too large and this leads to limited learning strategies available for students in mastering the huge volumes of information required to succeed. Due to the large volumes of information, most students resort to passive learning, a phenomenon that has been shown to increase the risk of academic difficulty (Dolan et al…2002).

A learning strategy that emphasizes memorization without an attempt to connect and understand information is termed "passive" learning. There is no cognitive stimulation among passive learners to attempt forming connections between units of information. In contrast, active learning encourages interconnectivity of units of information and encourages the learner in activities that promote meaningful leaning (Gage and Berliner, 1998).

According to a Baseline 2002 study report of the Ministry of Education Zambia, the low pass rate in biology was attributed to the type of teaching teachers engaged on learners. Genetics was cited as one of the topics that was difficulty by learners. According to this document titled; Strengthening of mathematics and science education in Zambian Secondary School; base line data (2002), pupils face challenges in understanding Biology topics. This is due to exclusive use of classroom based method of learning in which learners were not actively involved. Among the 14 biology topics listed to be difficult, genetics was one of them. Information from the same document also showed that most teachers used traditional methods of teaching that is, lecture methods and teacher demonstration. This shows that most teachers only restricted pupils to types of learning that did not involve them actively in the Classroom. Following the theories of learning by Edgar Dale (1964) which state that learners only get 20% of what they learn and read without images (minds on activity), while they get 75% to 90% on something they see and touch (hands on activity), because they use most of their senses in the activity.

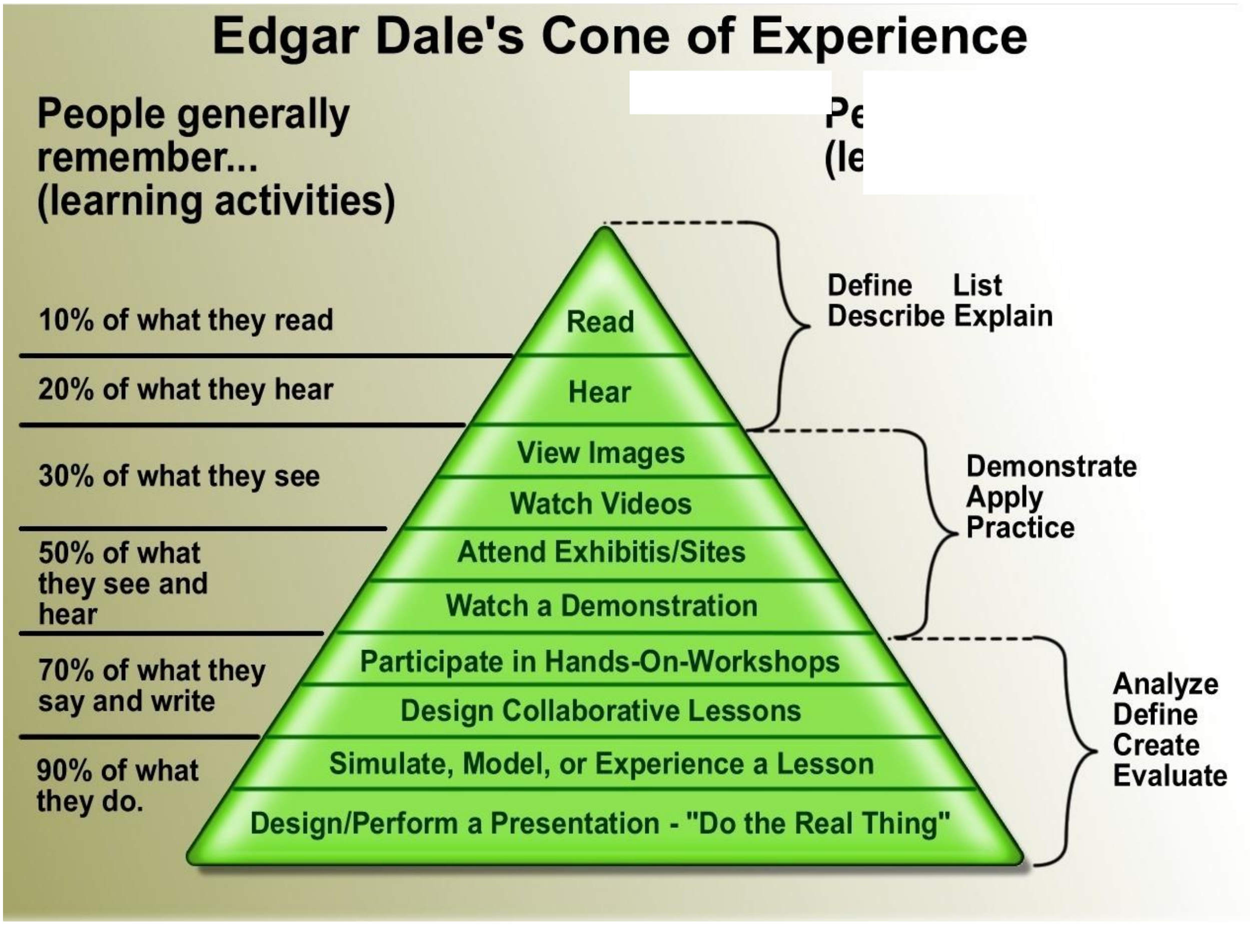


FIGURE 1

This means that the students learn better on something they visualize, which is called learning by observation. According to the Ministry of educations' report quoted earlier, it has been observed that teachers in Secondary Schools teach 'genetics' in abstract, that is, they do not expose the learners to the construction of their own knowledge by linking up several concepts which they will easily understand. Since the topic involves construction of knowledge, it requires that the learners are exposed to learning environments that involve there active participation. Therefore, engaging in concept mapping activities may enable the learners understand the topic better and see its applications in life.

Genetics receives less attention as it is taught towards the end of the year just before the summative examinations, followed by the inappropriate teaching methods, makes it difficult for the learners to fully comprehend the concepts. Genetics connects secondary to tertiary education especially for all those that go to the field of biological sciences. Terminological aspects of genetics have made it somewhat difficult for the learners to engage into meaningful understanding of the subject matter (Baseline study report 2002).

Strong empirical evidence is that some fundamental concepts on which scientific understanding is built, are commonly not well understood by learners and that there are patterns in the difficulties learners experience (Shipstone1984).

This chapter covers the following: background to the problem, problem statement, research objectives, scope of the study, significant of the study, hypotheses, operational definitions, assumptions, delimitations, conceptual and theoretical frameworks.

1.1 BACKGROUND OF THE STUDY

Educational reforms in science education are cardinal in which both the subject matter and the instructional contexts of science learning are being restructured, and new standards intended to shape meaningful, authentic, relevant, and contextualized science education are unfolding. Practically the standards are meant to enable students to transfer what they learn in class to both related and unrelated real world situations (Haskell, 2001). Literature suggests that biology should not only be taught to prepare students for an academic career in biology, but also to help them become relevant and informed individuals in today's fast changing society (Ware, 2001).

Ideally, biology education should aim at making students appreciate how science and technology contribute to their daily lives as well as to the society in which they live. Modern society is highly influenced by scientific advances and its accompanying technological implications. Consequently, in order to educate the future citizens, biology should be taught with appropriate strategies and emphasis on relevance to everyday life and its role in technology, and society in which its recipients live.

The ECZ examiner's report (2017) reviewed that many candidates performed badly when attempting questions on genetics. Some literature also reveals that majority of secondary school students learn chemistry as a foreign subject, detached from real life situations hence do not see its relevance in their own lives (Chibuye & Singh, 2014). The situation is as described by (Chibuye & Singh, 2014) is not different in biology.

When the academic achievement of learners in a subject is negatively affected, they struggle to see the relevance of such a subject in their lives. This finally can lead to the inability by the learners to connect theoretical knowledge to its application to real life contexts.

The teaching of biology without integrating the aspects of the concept maps ignores one of the most important features of modern teaching and its technological achievements. In addition, biology studies also have an important role in educating future citizens to cope objectively with societal and ethical issues in general, and environmental implications in particular. This therefore, calls for a paradigm shift in the biology curriculum from the approach of focusing on the structure of the subject (focusing only on theories, key concepts, and processes) to a multidimensional approach, in which students are provided with the knowledge, values and skills of being able to make connections between concepts to fully comprehend the subject matter. Improvement in academic achievement of learners towards biology will depend upon the relevance of education provided (Milner, Ben-Zvi, & Hofstein, 1987). This relevance is itself dependent upon the type of teaching strategies used by instructors. Education is supposed to help learners acquire skills, knowledge, values and attitudes necessary to convert them into responsible and productive citizens. In many states around the globe, the irrelevance of education to the life experience of learners seems to be coming crystal clear (Barker & Millar, 1999; Blumenfeld et al., 1991; Byrne & Johnstone, 1988; Holbrook, 2005; Kesner, 1999; Yager & Hofstein, 1986).

.In this regard therefore the researcher was interested in the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of senior secondary students in genetics.

1.2 STATEMENT OF THE PROBLEM

The information an education system intends to offer should be dictated by the particular needs of the people receiving it. If the education that learners receive is not aligned to their particular needs then it becomes irrelevant to them (Whitehead, 2005). In 1995 the world conference on education for All made a declaration to reaffirm the connection between education and personal needs (UNESCO, 1996):

‘Every person-child, youth and adult-shall be able to benefit from educational opportunities designed to meet their basic needs’

This means that the education system should endeavour to provide specific knowledge, skills and values that its beneficiaries can apply for their own sustainability in their communities.

Learning is a continuous process and any person engaged in learning should be able to benefit from the learning process by applying what they learn to real life situations capable of solving societal problems. Learning therefore becomes meaningless if its knowledge cannot be used to solve problems in the society.

The amount of information students are expected to master is too large and this leads to limited learning strategies available for students in mastering the huge volumes of information required to succeed. Due to the large volumes of information, most students resort to passive learning, a phenomenon that has been shown to increase the risk of academic difficulty (Dolan et al…2002).

Pupils have problems in understanding of the biology topic “genetics”. This is as a result of traditional methods of teaching outlined in the Ministry of Education Report(2002) which include; teacher-centered (lecture method) and teacher demonstration. In these methods, the teacher is the authoritative figure and the learners are empty tins. This means that learners are not given a chance to participate in the lesson instead they just listen to the teacher’s instructions. As a result, pupils fail to understand the genetics concepts. The theories of learning by Edgar Dale (1964) also indicated that pupils understand more from the teaching which involves seeing and touching what they learn in the classroom. It also promotes high retention of knowledge and active learning.

The main problem being investigated in this study is the failure by the majority of biology students at Kansenshi secondary school to clearly connect genetics concepts in the understanding of the topic of genetics.

1.3 SIGNIFICANCE OF THE STUDY

The findings of this study will benefit the following: Policy makers, curriculum developers, teachers and learners. The policy makers will be able to make relevant educational policies which will create a favourable platform for use of concept maps for teaching and learning to thrive. The curriculum developers will be able to include relevant instructional contexts in the curriculum; teachers will be encouraged to link concepts by use of concept maps in their teaching in order to make the learning meaningful and students achievement maybe enhanced as they will come to the realisation of the relevance of genetics. This study also seeks to make a significant contribution to better and effective learning and teaching strategies in the education circles. By advocating for the integration of concept maps into group discussion lessons, the researcher hopes that the teaching and learning of biology will become more interesting and meaningful to the learners.

1.4 RESEARCH QUESTIONS

- What is the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of senior secondary students in genetics?
- Does mean achievement in genetics vary with gender?

1.5 OBJECTIVES

- To investigate the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of senior secondary students in genetics.
- To find out whether mean achievement in genetics varies with gender.

1.6 RESEARCH HYPOTHESES

H_A1

There is a significant difference in the mean academic achievement of students taught genetics using the integration of concept mapping into group discussion as an instructional strategy and those taught using discussion method.

H_A2

Academic achievement in genetics varies with gender

H_O1

There is no significant difference in the mean academic achievement of students taught genetics using the integration of concept mapping into group discussion as an instructional strategy and those taught genetics using discussion method.

H_O2

Academic achievement in genetics does not vary with gender.

1.7 DELIMITATIONS

The following points explain how the study is narrowed down in scope:

- 1. The researcher has decided not to study other grades because from his hunches the topics involved in this study are grade 12 curriculum topics:
- Types of variation
- Cell division (mitosis and meiosis)
- Genetic crosses
- Sex inheritance

The researcher also assumed that all grade twelve pupils of kansenshi secondary were aware of topic on genetics.

Assumption Of The Study

- The treatment and the control groups were conceptually equal in the understanding of genetics after purposively sampling the groups and this was confirmed through a pre-test.

- The conceptual activities that were used in this research were familiar to all the learners and this helped them make informed connections to the concepts presented to them.
- The learning styles in both the control and experimental groups were the same.

The study was informed by two theories: (a) Ausubel's (1963) theory of meaningful learning and (b) Paigets (1963) Constructivist theory of learning.

According to Ausubel's (1963) theory of meaning learning, a learner is considered learning only if they are able to relate what they are currently learning to what they already know. The construction of knowledge begins with our observation and recognition of objects and events through concepts we already have. These observations are encoded orderly and hierarchically in the learners' minds as knowledge structures or schemas. Meaningful learning occurs only if new concepts interact and integrate with old concepts. Because meaningful learning involves recognition of the links between concepts, it has the privilege of being transferred to long-term memory.

Piaget (1952) stated that any learner is responsible for creating his or her own understanding of the world view based on the life experiences they have gone through. Construction of new meaning is dependent on experiences. According to the constructivist theory which seeks to explain how learning occurs, it states, 'People construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences'.

When a learner is exposed to any piece of new information, they need to reconcile it with the previous ideas and their own experiences which can change what they believe or may discard the new information as being not useful. In any case, a learner is an active creator of their own knowledge. In order to achieve all this, one needs to ask questions, explore and assess what is already known. Learning is not so much of acquiring new knowledge, but of reconstructing our existing schemas. New concepts related to the more inclusive concepts are assimilated while concepts not related are accommodated. Accommodation is the process of reconstructing the mental structure so that new information can fit in it. Therefore, it is important that the schemas that learners come with to the class from their communities act as prerequisite knowledge on which new learning could be assimilated or accommodated depending on the information being received.

Learners actively construct or create their own subjective representations of objective reality. New information is linked to prior knowledge, thus mental representations are subjective in nature.

The variables in this research will interact in the following way: if the genetics instruction is taught with the integration of concept maps the academic achievement of the learners will improve.

2. Literature review

This chapter will look at the literature on the concept maps and their effect in improving learners' understanding of the topic "genetics" by way of assessing the pupil achievement in genetics after the intervention.

Learners' performance

Considering poor performance, this section defines poor performance and looks at performance indicators in Zambia.

In the Zambian case, the performance of learners in biology has been consistently poor for many years. Poor performance is learners' inability to meet a set standard in their competencies. Asikiha (2010) defines poor performance as any performance that falls below a desired standard, while Okoye (1982) describes it as a candidates' inability to attain a set performance standard in a given evaluation exercise such as an examination. In accordance with the Zambian case a learners' work may be lacking in aspects stipulated by the senior secondary school Biology syllabus (2013). The syllabus states that performance of pupils in Biology should be based on the outcomes that supposedly meet the learners' educational needs and the expectations and assignations of the society (Curriculum Development Centre 2013). The performance is gauged by performance indicators like marks scored, grades and divisions obtained by the candidate in respect to standards of Examinations Council of Zambia (E.C.Z).

Any candidate scoring below the set standards is regarded as showing poor performance. In this study it is not clear whether teachers of Biology are trained markers of the subject and whether the assessment within schools can measure up to the examination standard, in particular, whether the grading system at school level can equate to ECZ's. It is a national concern when competencies in Sciences are poor as this raises a question of how best delivery methods can be integrated for effective performance of the learners in the science subjects.

According to the Examinations Council of Zambia's (2013) performance analysis for biology, the general performance of candidates in 2013 examination at Grade 12 level was generally poor, with majority of candidates obtaining lower grade division. Reports of a slight improvement in the performance from 2012 to 2013 were noted but no major improvement has been reported to take place since 2013.

The Examinations Council of Zambia is aware that the performance of pupils in Biology is poor. E.C.Z hoped that the 2013 report's reflections could be used to address the challenges it faces in teaching Biology. Five years down the line the story is still the same with performance levels in Biology remaining stagnantly poor.

2.1 Integrating concept mapping into group discussion

This research is concerned with concept map integration into group discussion. Concept mapping according to Novak & Godwin (1984) is a schematic device for representing a set of concept meaning embedded in a hierarchical diagram that illustrates the interconnections between and among concepts. It can be deduced that concept maps provide a visual road map showing the pathways a learner can take to construct meaning of concepts and propositions.

Concept mapping according to Kinchin, (2005) is a strategy that helps learners organise their cognitive frameworks into more powerful integrated patterns.

2.2 Advantages of integrating concept maps into group discussion

Past works have found group work and concept maps to have advantages. The major reason is that students' learning is supposed to involve active participation in the classroom (Astin 1985, Johnson and Johnson 1991, Kember and Gow 1994, McKeachie 1990), group discussion also encourages critical thinking this is according to (Garside 1996, Smith 1977, Weast 1996), and degree completion (Tinto 1975, Tinto 1997). In addition to facilitating these general education goals, Brookfield and Preskill (1999) present an argument that as a useful tool, classroom discussion helps students develop sociological imagination. They went on suggesting that four key purposes are present in group discussion which were outlined as follows;

- Helping learners reach a more critical level of understanding about what they learn
- Enhancing the learners' self awareness and develop the capacity for self critique
- Acting as catalysts in helping the learners to take up informed decisions in the world (Brookfield & Preskill 1999, p,3)
- Fostering and appreciation among the learners for the wider range of opinions which emerge during the group discussions.

Concept maps do not only widen the scope of the learners but also allows the quick coverage of the larger volumes of content and serve as rich information sources that can help learners understand what they learn and it can also be used as an assessment in its usage as pre-test or post-test (Rice et al, 1998)

The use of concept mapping acts as source for various information; the presence and absence of the connections in concept maps, the quality of the connections and the different link labels used determine the worthiness of the map. Learners have a role to play guided by the teachers on the usage and the interpretation of such concept maps for their particular topics.

Many researchers such as Okebukolo & Jegede, (1988); Novak, (1983); & Bello and Abimbola (1997) have observed that concept mapping can improve meaningful learning and help learners learn independently. This strategy as observed by Novak & Godwin (1984), serves as both learning tool as well as evaluation tool, which encourages the students to use meaningful mode-learning pattern**s**. Concept maps are graphical tools for organizing and representing knowledge. It is a way of representing relations between ideas, images or words, in the same way that a sentence diagram represents the grammar of a sentence. Concept maps provide an excellent tool for students to generate meaningful connections between biological concepts and they provide information about students' conceptual understanding.

Francisco et al (2002) & Cardellini (2004), represent concept maps as graphical tools that can be used for the representation of knowledge. They also describe concept maps as ways by which relations between ideas, images and words can simply be represented. Concept maps act as an excellent tool for the learners to generate logical and meaningful connections between the various biological concepts they come across. Concept maps also provide guidance to the teacher about the learners' conceptual understanding.

The use of concept maps may be beneficial in the following ways;

- If well presented and understood by the learners, it will enable a learner convey meaning in a visual manner as it has also been seen to foster an understanding between individuals viewing the same map (Novak, 1977; Malone & Dekkers, 1984; Hoover & Rabideau, 1995; Novak, 1998).
- Concept mapping enhances recall and memory as well as aiding and balancing any form of conflicting ideas, hence creating a mutual understanding.
- Concept maps are used to demonstrate a conceptual understanding of an issue to others (Fraser, 1993; Glynn, 1997) or as a means of helping others understand the concepts of topics so easily (Suen et al., 1997; Thatcher & Greyling, 1998).

- Enables a form of collaboration amongst learners emanating from different forms of discipline in problem solving (Howard, 1989).
- Concept maps effectively increase the performance of learners in groups (Cannon-Bowers et al., 1993; Hinsz, 1995; Blickensderfer et al., 1997) and also increases expectations and understanding in groups (Rewey et al., 1989; Kraiger & Wenzel, 1997).

. Trochim (1989, p. 1) argues “concept mapping encourages the group to stay on task, results in an interpretable conceptual framework, expresses this framework in the language of the participants, yields a graphic or pictorial product, and improves group or organizational cohesiveness and morale.” Describing an individual’s cognitive structure through other techniques such as “a spoken narrative, an outline, a written summary, formal and informal conversation, a flowchart, etc.” is limited in that these techniques are linear and unable to depict the complexity of the relationships between concepts and ideas (Fraser, 1993, pp. 40-41). The process of creating and using the map is as important as the content of the map. For example, “through the actual process of constructing a concept map the individual can also make new connections and recognize concepts which should be added” (Fraser, 1993, p. 33). Concept mapping will allow for a very inclusive diagram of the scenario with few structural limitations.

Disadvantages of group discussion

- Time consuming as learners take time to agree on certain matters of their discussion.
- If coverage of content is achieved, it may not be helpful if learners do not engage in meaningful ways of learning.
- Poses a challenge to teachers in determining the most effective ways by which learners will engage to felicitate an effective means of viewing concepts in a meaningful manner.
- Learning is dominated by few individuals and if not checked, learning becomes passive by majority of the learners (Karp and Yoels 1976).

Past performance in genetics

The poor performance in genetics can be considered to arise from the inappropriate methods used in delivering knowledge to the learners by the teachers, wrong spellings of the scientific terminologies, shallow subject matter knowledge and lack of skill in differentiating most of the technical terminologies used in understanding genetics.

Okebokola (1997) was of the view that concept mapping was applicable to any type of subject under study. Genetics is a challenging topic with most of the students and for this reason; it requires better techniques applied to enhance meaningful learning and a systematic learning in a problem solving approach.

A report according to Okebokola (1998), reviewed that between the years 1991 and 1995, up to 25% only of all candidates that sat the Nigerian senor secondary examination passed with credit level. Researchers have however, blamed the poor performance in biology teaching and performance on the following factors;

- Most teachers handling senior students were not qualified and did not do adequate practical works (Ali 1998).
- Traditional teaching methods were rampant (Ollarewayju, 1986).
- Biology has a highly conceptual nature which requires expertise (Schmid and Telaro, 1990; and Umeh, 2002).

The aims of each topic need to be considered by teachers of biology if results have to improve. All biology topics which require use of concept maps should be taught as such unlike muddling them up with theory during the teaching sessions.

RELATED ARTICLES

According to a Nigerian study conducted by Namdi, Okoye&Okechukwu, (2006)revealed that students exposed to the concept mapping strategy while studying genetics achieved significantly higher than those students exposed to the traditional lecture method. This implies that concept mapping when incorporated into teaching, improves the students' performance in genetics.

A study conducted by Danladi, Shehu & Zayum, University of Malaysia indicated a significant difference in the performance between the learners taught genetics with the integration of concept maps and those taught genetics using the expository method alone. The finding of Danladi were also in line with those of Chiou (2008) who showed that the learners that were taught accounting with the integration of concept maps performed significantly better than those that were taght accounting with the expository methods. Danladi (2012) further clarified those possibilities of the findings as also being attributed to the students being actively involved in the whole learning process. Abdullahi (1982) and Danjuma (2005) suggested that with learners being exposed to work that involved active participation and learners discovering information for themselves using concept maps, learning was indeed better facilitated and yielded positive results.

According to a study in the Swedish biology education research, the teaching and learning of genetics has been investigated thoroughly. Difficulties in understanding genetics have been ascribed to several reasons. Knippels (2002) lists five main causes for these problems, of which three were addressed in his study.

Firstly, he says there is the domain-specific vocabulary and terminology. When students come in touch with genetics as a school subject they practically are drown in new concepts that are central to the subject. Being familiar with the definitions of the words improves the possibility to succeed in learning genetics and students in his study declared that the large amount of new words was one obstacle (Bahar, Johnstone & Hansell, 1999).

The second problem is how the gametes arise. There is a difference between ordinary cell division (mitosis) and the cell division that creates gametes (meiosis). This causes confusion among students. An important source for this confusion is a lack of understanding of how concepts relate to each other, e.g. the relationship between chromosomes in a gamete and in a fertilized egg (Wood-Robinson et al., 2000). Another study shows differences between the understanding of mitosis and that of meiosis, and verifies that it is easier for students to understand the mechanism behind the first one (Marbach & Stavy, 2000). The fact that the concepts also represent different levels of biological organization constitutes the third problem. The biological organization levels are only partially visible. Learners can see the multicellular organism and experience events on the multicellular level. With a microscope, the cells and chromosomes can be visible, but the processes in the cell can still not be seen. The learners' inability to relate the processes on the molecular and cellular levels to relevant scientific problems causes difficulties to learn new scientific facts (Dreyfus & Jungwirth, 1989). Three levels of organization that are central in the teaching and learning of genetics are the visible macroscopic level, the microscopic level and the sub-microscopic level. This multi-level conceptualization has been reported to cause difficulties in different parts of science education, for example in the case of chemistry (Johnstone, 1991). In the case of genetics, one needs knowledge about chromosomes and cell division to be able to give a scientifically accepted explanation to why characteristics move from parents to offspring. During an investigation of students' cognitive structures in elementary genetics by the use of word association tests, the results showed the strongest interconnectedness between chromosome and gene, two words which belong to the microscopic and sub-microscopic levels. Much weaker interconnectedness was shown between gene and phenotype, which demand an association between the sub-microscopic and macroscopic levels (Bahar, Johnstone & Suttcliffe, 1999). In the same test, the interconnectedness between cell division and gamete was estimated as weak, which confirms the problem to understand how gametes arise.

According to the examinations of Zambia results analysis report for the year 2017, the question on genetics expected the students to draw a genetics diagram. Candidates were expected to answer the question using the genetic diagram to show the percentage of children whose blood group was O while that for the father was AB and the mother O.

The report further stated that genetics has been problematic for most learners. Genetics questions were poorly answered and in some cases the questions were not answered and spaces left blank, the report stated. The report also stated that it was almost a fact that question 5 of each examination paper was always on genetics and that the candidates could be trained to answer the questions on genetics. The report also stated that candidates needed to know phenotype and genotype, when to use F1 and F2 generations. The report also indicated that learners did not know where to place a cross in the genetic diagram.

GAPS IN THE RELATED ARTICLES

In the analysis of all the related articles above, the researchers' findings were based on use of concept maps compared with the conventional lecture method. Lecture method may be used to quickly cover contents of a topic but may not be an effective method of teaching strategy to elicit meaningful learning. Other methods like group discussion could have been used to compare it with the experimental groups that used concept maps.

According to ECZ report of 2017, it only stated that there was poor performance on genetics questions without stating the causes of the poor performance.

Most teachers still use conventional teaching techniques such as lecture method (Shinn, 1997) and (Cashi, 1990).Teachers play a dominant role in the teaching and learning process than learners. The students just listen to the explanation and do the class exercises from their teachers. As a result, the students are not fully engaged in the learning process. Ketter & Arnold (2003) contend that if teachers do not win the students' attention, they will find it hard to teach them. For this reason, teachers should always use instructional techniques or approaches that can create interest in students so that learners enjoy the learning process. In other words, teachers should use the appropriate instructional strategies that can explore the interest of the students so that they get actively involved in the learning process. One of the approaches is the use of integrating concept maps into group discussion that helps learners learn meaningfully.

The present study is designed to look at the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of senior secondary school students in genetics.

Gender

Gender is a reference to several characteristics relating to and differentiating between masculinity and femininity (Male and Female). One of the sustainable development goals (SDGs) is gender equality which succeeded the millennium development goals (MDGs). It is however noted with dismay that, in most societies this goal is far from being achieved because even in this century (21st century), the role of women is still reduced to the floor preventing women from participating in and benefiting from the efforts of development (Fatokun and Odagboyi, 2011).Fatokun and Odagboyi further added that some subjects such as science and mathematics were viewed as masculine, while others like home economics, secretarial studies are perceived to be friendly and for women.

Gin (2011), also observed that there is a world view that women are inferior to men and so, the power relations attached to their ideas and beliefs, give men more power and more opportunities over and above women in society. It is with this notion that these viewpoints penetrate the education system and consequently translate into academic achievement of the learners by gender. Coined differently, pupils' achievement in biology is influenced by gender among other factors. There could be more girls than boys who perceived more biological concepts as difficult to learn or vice versa. This means that, the perception of things even when it comes to learning varies across gender. Socialization factors and classroom experiences are among the causes of more girls perceiving biological concepts to be difficult than boys. For example, boys are perceived to be more competitive, confident and willing to have a goal at something as opposed to the low esteem and passive dependent behaviour among girls (Shamai, 1996 and Tinklinet al., 2001).

Other scholars however, such as Turner et al (1995) have suggested in their study that gender does not seem to affect pupils' overall views about difficult topics in biology. This means that we are far from making a conclusion as to whether or not gender determines understanding in biology and if it does, which sex has positive views about topics perceived to be difficult in biology. To this effect, this study will incorporate gender as a way of establishing whether gender really has an effect on the performance in genetics when taught with the integration of concept maps into group discussion and or gender has an effect when taught with group discussion only.

3. METHODOLOGY

This chapter covers the following subtopics: research design, variables, research methodology, and location of study, target population, sampling techniques, sample size, research instruments, content preparation and pilot testing the study, validity and reliability of instruments, data collection techniques and ethical considerations.

3.1 Research Design

The design for this research was Quasi- experimental that employed pre-test post-test non-equivalent control group design (Ali, 2006). Pre-test was administered before the treatment by the researcher. This was to determine the equivalents of the learners in their academic ability. Post-test was administered after the treatment to investigate the role of the treatment (effect of integrating concept mapping into group discussion as an instructional strategy) on the teaching and learning of genetics. This was done using the same instrument (Genetics Achievement Test). The experimental group received treatment using the integration of concept mapping into group discussion while the Control group was taught using the group discussion method.

3.2 Method of Data Collection

Since there were two groups in the study which included the experimental and control groups, respectively, a lesson plan was developed by the researcher for the experimental group using the integration of concept mapping into group discussion as a teaching strategy and the control group using ordinary discussion method. A pre-test was administered to the groups to determine the equivalence of the ability level of the sample subjects. The researcher then administered the post-test Genetics Achievement Test (GAT) to the students in the experimental and control groups after he had taught both groups using their respective instructional strategies with the same instrument and marking scheme. The questions of the genetics achievement test were reshuffled after the pre-test to avoid test wiseness. The scripts were then marked and subjected to statistical analysis.

3.3 INTERVENTION

In this study, the researcher used concept maps integrated into group discussion to content-rich the learning environment. During each lesson, learners were provided with specific contents to be explored in the construction of concept maps. At the end of it all learners in the experimental group were required to make some concept maps to summarise some topics while those in the control only made summaries without concept maps.

3.4 LOCATION OF THE STUDY

The study was carried out at Kansenshi Secondary School in Ndola District on the copper belt Province of Zambia. Ndola is one of the most highly industrialised urban cities in Zambia. The main socio- economic activities of the people of Ndola are mining, agriculture, manufacturing of industrial products such as juices, fuel fractions, plastics to mention a few. Above 90% of the learners at this school were born in this city because the school receives grade tens from the surrounding compound basic schools.

Most of the learners are aware of the topic on genetics and its applications in life especially in the technological error. As a result of this, the researcher thought that the problematic issues of genetics could be explored and integrated into the instructional activities in order for learners to make connections to the various concepts in genetics.

TARGET POPULATION

The researcher worked with grade 12 classes at Kansenshi secondary school. There are seven (7) grade twelve (12) classes each consisting roughly of 50 students. The reason for choosing grade twelve was because of the nature of the topics that is; types of variation, cell division (mitosis and meiosis), genetic crosses and sex inheritance to be explored which according to the syllabus, these topics are mainly taught in grade twelve. The other reason is that the grade twelve learners are enthusiastic to learn because they wanted to know items for their final examination.

3.5 Sample and Sampling Procedure

Two (2) senior Secondary grade twelve classes were purposively selected. The two classes were assigned to the experimental and control groups by randomisation using odd and even number method where the odd number class become the control group while the even number class become the experimental group.

3.6 Content Preparation

Using the Zambian senior secondary school biology syllabus as a guide, the required content material on genetics was extracted from the essential text books used on the teaching of genetics.

The sub topics studied under this research included the following;

i). Definition of genetics terminologies
ii). Types of variation
iii). Cell division (mitosis and meiosis)
iv). Genetic Crosses

V). Sex inheritance

The extracted material was used to prepare the instructional units which are concept maps and lesson notes on ways of integrating concept maps in group discussion as an instructional strategy on learner achievement in genetics.

RESEARCH INSTRUMENTS

The researcher used an achievement test, 'Genetics Achievement Test'. The test was prepared by the researcher.

PILOT TESTING THE INSTRUMENTS

A pilot study is a small scale preliminary study conducted in order to evaluate feasibility, time, cost, adverse events and improve upon the study design prior to performance of a full-scale research project. It is done to determine whether the methodology, sampling, instruments and analysis are adequate and appropriate (Tichapondwa, 2013). The following are some of the reasons pilot testing was done: Checking clarity of the wording of the question items, instructions and the layout of the items. It eliminates ambiguity in instructions and meanings of some items, check time. Identify redundant questions, misunderstood or non-completed items (Tichapondwa, 2013).A different grade twelve (12) class was used for pilot testing of the instruments.

VALIDITY OF INSTRUMENTS

Validity is the touchstone of all educational research (Cohen et al, 2007). The instructional units and the student performance test was validated and reviewed by an expert (Sighn, 2009) under the direction of my project supervisor. The instrument was taken for expert assessment and approval for appropriateness in terms of content validity, construct validity and face validity. It is important for the researcher to do this in order to make sure that the instrument measured what it was intended to measure and it performed as it was designed to perform. If an instrument does not measure what it is intended to measure then it is termed inappropriate for the research. The researcher was equally concerned with the connectivity of the instrument with the variables being measured. The researcher made sure that the instrument measured the variables set out in the objectives.

RELIABILITY

The achievement test was constructed using standard questions from ECZ past papers. Using already standardised ECZ criteria of questions insures instrument reliability to find out if they consistently measure what they are supposed to measure by pilot-testing. A different grade twelve (12) was used in the study for pilot-testing. This was important in order to eliminate the errors in the construction of the test items. The instrument was also sent for peers review and to the experts.

Administration of the instrument;

The students were numbered and a pre-test with the numbers of the students on them were administered to them. The numbers were given so that the performance of each student in both pre-test and post-test could easily be determined.

Reflection on Ethical Issues

Research involves the collection of data from people and about people, this is according to (Punch, 2005). Therefore, during the study, the following ethical issues were followed;

Before any research was conducted, consent forms were got from the Copperbelt University School of Graduate Studies and the District Education Board Secretary which were presented upon arrival at the selected Secondary school, to the school administrators to get permission. The school administrators were briefed on the research procedures and enlightened on the value of the research to be conducted.

Participation was voluntary and confidentiality was sworn to the participants by using serial numbers instead of actual names. All the participants were only identified by numbers and not by their names. This was done in order to encourage participants to participate freely. The Institution researcher comes from the Copperbelt university

Benefits to participants

- They will learn how research is carried out professionally
- They may develop and appreciate the deeper conceptual understanding in biology
- Research may teach the learners to be objective and truthful in matters of science
- It might ignite learners' interest in biology

Guarantee of confidentiality and anonymity to participants;

- Participants were not allowed to write their names or initials or a mark of any kind for identity on the test papers that will be given to them.
- The interest of the researcher will be the responses to the questions only. - In case of need to name a pupil, true names will be kept in the original data. - After we are done with the research and the researcher is done with the final write-up, he will share the findings with the participants, the school administration and the Copperbelt University only.

- The researcher will make sure that the human rights of the participants are taken care of.
- They have freedoms of choice, expression, conscience etc.
- The researcher will endeavor to carry out the research and report the findings honestly

Data Analysis procedure

The data to be collected will be quantitatively analyzed using the independent t-test analysis. The independent samples T-test is a parametric statistical test that compares two sample means to determine whether the population means are significantly different Sherin (2009). It is used to test the statistical differences between the means of two groups, statistical differences between the means of two interventions and statistical differences between the means of two change scores. The results of this statistical test show whether the two groups are from the same population, if their means are so similar and vice versa. The independent t-test was used to test for significant difference between the student's mean scores in the post test results of the control and experimental groups. This type of test is appropriate in that participants appear in only one group and the two groups unrelated (Coakes et al, 2009). Any significant difference in the mean scores of the control and experimental groups was attributed to the researcher's intervention at 95% significance level and $\alpha = 0.05$

4. RESULTS

Chapter three presented the research design choice, sampling procedures, sample size, instruments for data collection, justifications, instrument validity and reliability and ethical considerations. Chapter four however analyses and presents results of quantitative testing of the conceptual model as presented in the first chapter of this research. The purpose of this study was to ascertain the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of senior secondary students in genetics and to find out if there a relationship between students taught genetics with the integration of concept mapping into group discussion and those taught using group discussion only. . The statistical tests conducted include an independent samples t-test to determine whether the two groups were equivalent before the intervention. The results are based on the genetics achievement test data from 90 pupils in Ndola District of the Copperbelt Province.

Research Tool

To measure the academic achievement of students in genetics, a genetics achievement test was developed for this study. The genetics achievement test included items from all the areas selected for teaching. The achievement test comprised of 8 open response items with sub questions in each. To ensure accuracy of content and vocabulary, the achievement test was reviewed by subject experts. Pilot testing was conducted on 90 students from a neighbouring school.

Procedures of the Experiment Steps were as follows:

1. Concept maps of topics for the included material were developed by the researcher with consultation of teachers having academic qualification of BSc or higher. These concept maps were used as standard for knowledge retention on the various concepts used in genetics.
2. A genetics achievement test was administered as pre –test
3. Experiment was carried out for a period of three months

i). First, the researcher taught both the experimental and control groups each with their respective instructional strategies. The learners in the experimental group also constructed concept maps as part of the leaning process.

ii. After four weeks of teaching, a post test was administered, there after the groups were swapped not to disadvantage the control group.

4.1: Descriptive statistics of the genetics Achievement test scores in the Pre test

A genetics achievement test was used to measure pupils' understanding of genetic concepts when taught using the integration of concept maps into group discussion and group discussion only. The instrument was constructed by the researcher using grade twelve past examination papers as a guide in the preparation of completely new questions. The instrument was validated by three biology experts.

Descriptive statistics of the pre-test are given according to table 1 below.

Table 1: Control group statistics

Statistics

PTRTEST

N	Valid	45
	Missing	0
Mean		.09
Median		.00
Mode		0
Minimum		0
Maximum		3

Table 2: Experimental group statistics

PRETEST

N	Valid	45
	Missing	0
Mean		.07
Median		.00
Mode		0
Minimum		0
Maximum		1

CONTROL GROUP

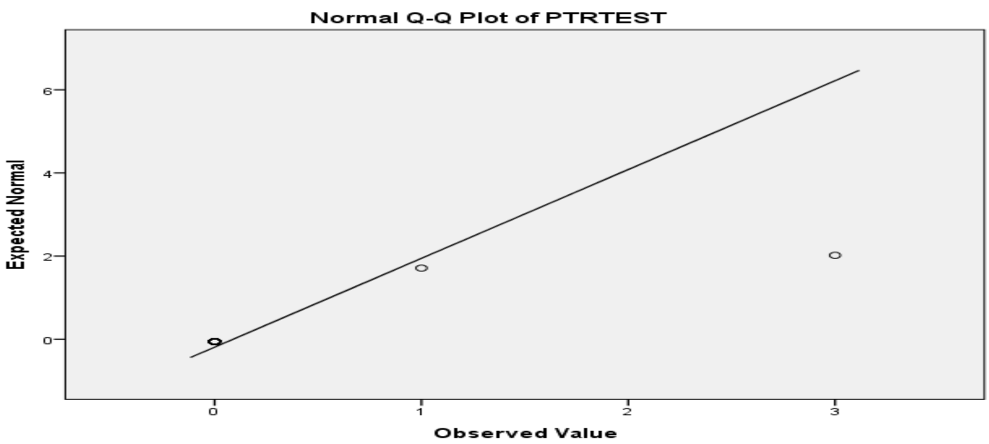


Figure 1: Control group normal q-q plot of pretest

EXPERIMENTAL GROUP

Figure 2: Experimental group normal q-q plot of pretest

The normal Q-Q plots figures 1 ans2 above for the pretest of the control and experimental groups indicate normal distribution performance for both groups. The two groups had the same characteristics.

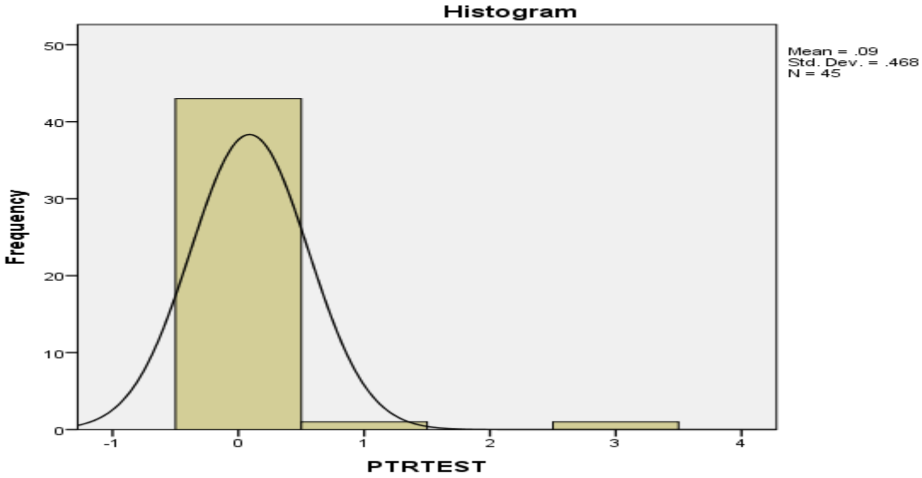


Figure 3: Control group histogram

EXPERIMENTAL GROUP

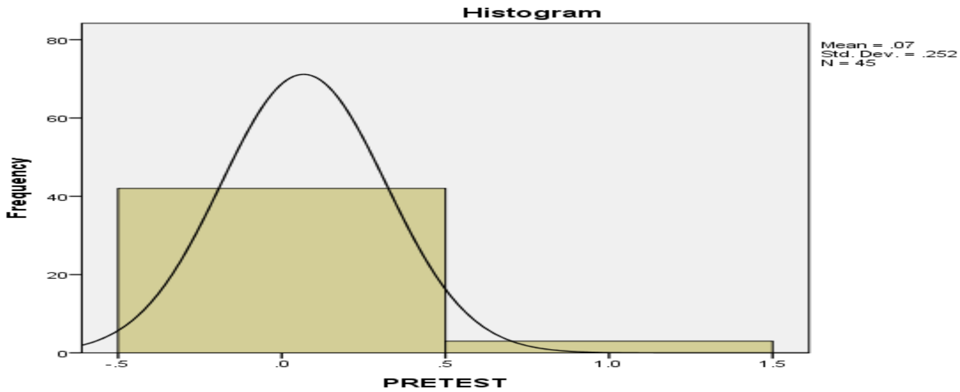


Figure 4: Experimental group histogram

Results for both the control and experimental group figures 3 and 4 during the pretest were normally distributed.

The pretest performance on the genetics achievement test as indicated from above show that the two groups were of similar characteristics as their performance was normally distributed. It was therefore ideal that groups be used in the research. In both graphs above, bell- shaped graphs are an indication of normality.

Table 3a below gives a summary of average performance in the genetics achievement test during the pre-test

Table 3a:

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
PRETEST	CONTROL	45	.09	.468	.070
	EXPERIMENTAL	45	.07	.252	.038

It is seen from the Table 3a above that before the instruction the difference in performance between the two groups was minute with the mean difference of 0.02. There was no significant difference between the two groups.

4.2: Independent samples T-Test

An independent samples t-test was conducted on both the control and experimental performance in the genetics achievement test before the instruction to determine whether the average performance of pupils' in the two groups was significantly different or not.

Table 3b below presents the results of the Levene's test for homogeneity of error variances. These results are based on the pre-test of the genetics achievement test to test whether the assumption of equality of error variances was assumed.

Pretest Levene's Test for Equality of Error Variances of Genetics Achievement Test

Table 3b

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
PRETEST	CONTROL	45	.09	.468	.070
	EXPERIMENTAL	45	.07	.252	.038

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PRETEST	Equal variances assumed	.391	.533	.280	88	.780	.022	.079	-.135	.180
	Equal variances not assumed			.280	67.562	.780	.022	.079	-.136	.180

The table 3C above shows that there was no significant difference in the mean performance between the two groups (Control and Experimental) before the intervention. Since variance P-value 0.780 is greater than 0.05 significance level, hence we fail to reject the null hypothesis and conclude that the mean performance for control and experimental before the intervention is not significantly different.

4.3 Descriptive Statistics of genetics achievement test scores in the post-test

This section presents summaries of results of the genetics achievement test scores after the intervention. In the pretest performance on the genetics achievement test as indicated from table 1d above. The results from t test in table 3b indicate that the two groups were of similar characteristics as their performance was normally distributed. It was therefore ideal that the groups be used in the research.

Table 4a: Experimental group Statistics

Statistics

POSTTEST

N	Valid	45
	Missing	0
Mean		63.04
Median		66.00
Mode		80
Skewness		-.569
Std. Error of Skewness		.354
Minimum		20
Maximum		91
Percentiles	25	49.50
	50	66.00
	75	75.00

Table 4b: Control group Statistics

Statistics

POSTTEST

N	Valid	45
	Missing	0
Mean		37.93
Median		39.00
Mode		29[a]
Skewness		-.143
Std. Error of Skewness		.354
Minimum		6
Maximum		69
Percentiles	25	26.00
	50	39.00
	75	51.00

a. Multiple modes exist. The smallest value is shown

The statistics of table 4a and table 4b are used to describe the data sets after the intervention using the box plots of figure 5 below.

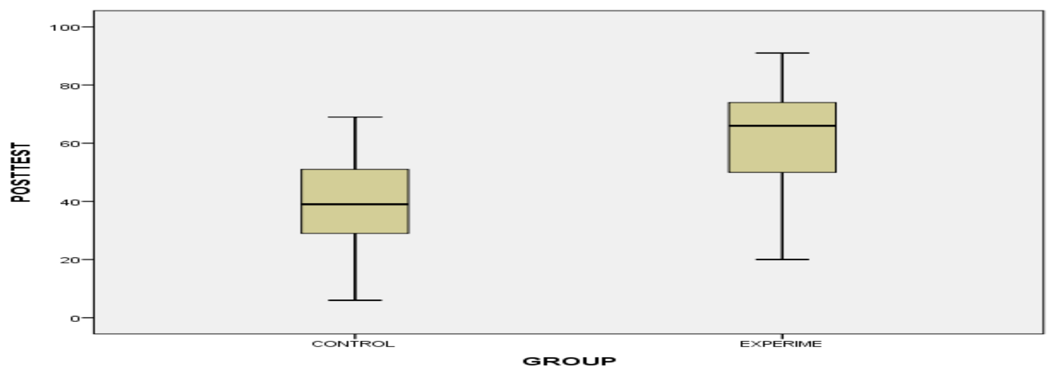


FIGURE 5: Box plots for control and experimental groups

From the control group Q_1 = 26 with Q_2 =39, Q_3=51 which is different from the experimental group. The mean score of the control group was 37 while the median was 39. The mean score of the control group being 37 is just below the median value of 39 and this indicates a negatively skewed data set. The distribution of scores in this data set was such that most of the students scored below the median score 39 during the posttest.

In the experimental group, Q_1 =49.5 with Q_2 =66, Q_3 for the experimental group was 75 which is not the same for the control group. The mean score of the experimental group was 63 while the median was 66. The mean score of the experimental group being 63 is just below the median value of 66 and this indicates a negatively skewed data set. The distribution of scores in this data set was such that most of the students scored lower than the median score which was recorded as 66 during the pretest. Considering the information from the box plots, the two groups were significantly different after the intervention.

Experimental group whiskers are not the same as the control group.Median line is not the same in both groups. The Spread of observations is greater in experimental than control group.Figure 5 above shows the box plots of the experimental and control groups. If the variances were indeed equal, we would expect the total length of the box plots to be about the same for both groups. However, from this box plot, it is clear that the spread of observations for the experimental group is much greater than the spread of observations for the control group. Already, we can estimate that the variances for these two groups are quite different after the post test.

Table 3a below depicts the results of genetics achievement test scores to the method of teaching during the post-test.

Table 3a: Control and Experimental group statistics

Group Statistics

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
POSTTEST	CONTROL	45	37.93	16.221	2.418
	EXPERIMENTAL	45	63.04	16.242	2.421

Table 3b: Post-test independent samples test (control and experimental groups)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
POSTTEST	Equal variances assumed	.032	.859	-7.338	88	.000	-25.111	3.422	-31.911	-18.311
	Equal variances not assumed			-7.338	88.000	.000	-25.111	3.422	-31.911	-18.311

Table 3b above shows that the average performance among the learners of the experimental group who were involved in the learning with the use of concept maps in group discussion performed higher than their counterparts taught with the use of group discussion only which was the control group. The mean difference of 25.111 indicates a statistical significant difference in the experimental and control groups.

Table 3a gives information that the mean score of the experimental group is 63.04 while tha of the control group was 37.93 in the genetics achievement test. On statistical application of a t-test by use of spss, table 3c was obtained which was a table of independent samples t-test. Table 3c revealed the two tests by levene. Levene's two tests are the test of equality of variance and the test for the equality of means. Contained in the table are the two sets of analyses, the first one being the assumption of equal variances in the groups i.e the control and experimental groups while the second assumption is for unequal variances. From table 3b, the F value is 0.032 while the P value P= 0.859 is non- significant at alpha = 0.05 (P › 0.05). Since P value is greater than the alpha level, the two groups are of equal variances assumed. The statistics associated with equal variance assumed was considered for use in the test for equality of means. From the equal variances assumed, the t-test results reviewed that t- value was 7.333 with 88 degrees of freedom. The P – value shown from table 3b with equal variances assumed is P= 0.00 which is less than the alpha level of 0.05. From the comparison of the two values therefore, the null hypothesis is rejected meaning that the learners in the experimental group and the control group differ significantly in the genetics achievement test. The experimental group's mean achievement is 63.04 while that of the control group is 37.93.

PERFORMANCE BY GENDER

Table 4a: Control group females pre test statistics

Statistics

PRETEST

N	Valid	16
	Missing	0
Mean		.06
Median		.00
Mode		0
Minimum		0
Maximum		1

The number of girls in the control group table 4a above was 16 with a mean score of .06 the median being .00 and the maximum score was 1.

Table 4b: Control group males pre test statistics

Statistics

PRETEST

N	Valid	29
	Missing	0
Mean		.14
Median		.00
Mode		0
Minimum		0
Maximum		3

The number of boys in the control group table 4b above was 29 with a mean score of .14 the median being .00 and the maximum score was 3.

FEMALES PRETEST HISTOGRAM

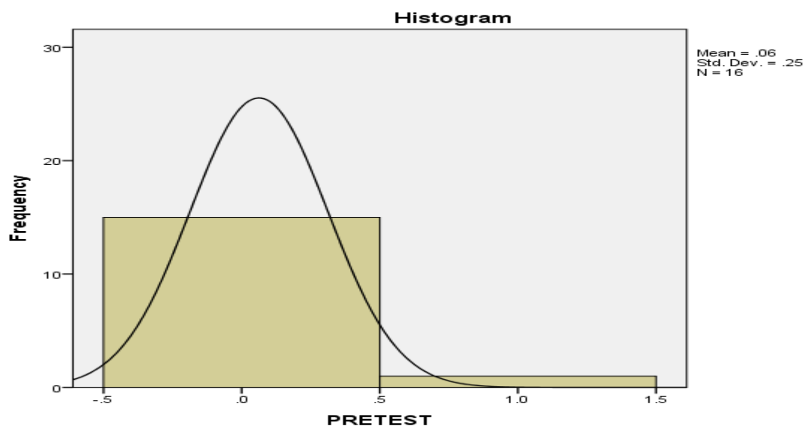


Figure 6: Females Pre-test histogram

MALES PRETEST HISTOGRAM

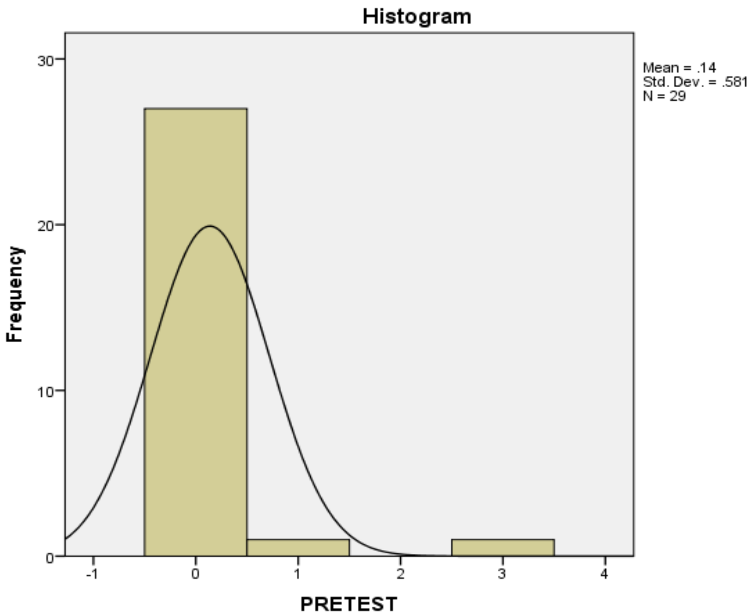


Figure 7: Males Pre-test histogram

Results for both male and female groups in figures 6 and 7 of the control group during the pretest were normally distributed.

The pretest performance on the genetics achievement test as indicated from above show that the two groups of the males and females were of similar characteristics as their performance was normally distributed. It was therefore ideal that groups be used in the research. In both graphs above, bell- shaped graphs are an indication of normality.

Table 5a; Control group female post-test statistics

Statistics

POSTTEST

N	Valid	16
	Missing	0
Mean		35.13
Median		34.50
Mode		29[a]
Skewness		.024
Std. Error of Skewness		.564
Minimum		11
Maximum		57
Percentiles	25	29.00
	50	34.50
	75	41.75

a. Multiple modes exist. The smallest value is shown

Table 5b: Test of Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
POSTTEST	.135	16	.200*	.960	16	.664

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The normality test table 5b from Shapiro-wilk shows a p-value of .664 which is greater than alpha level of 0.05. The null hypothesis is not rejected. Therefore there is not enough evidence to conclude that the data is non-normal in the control female group.

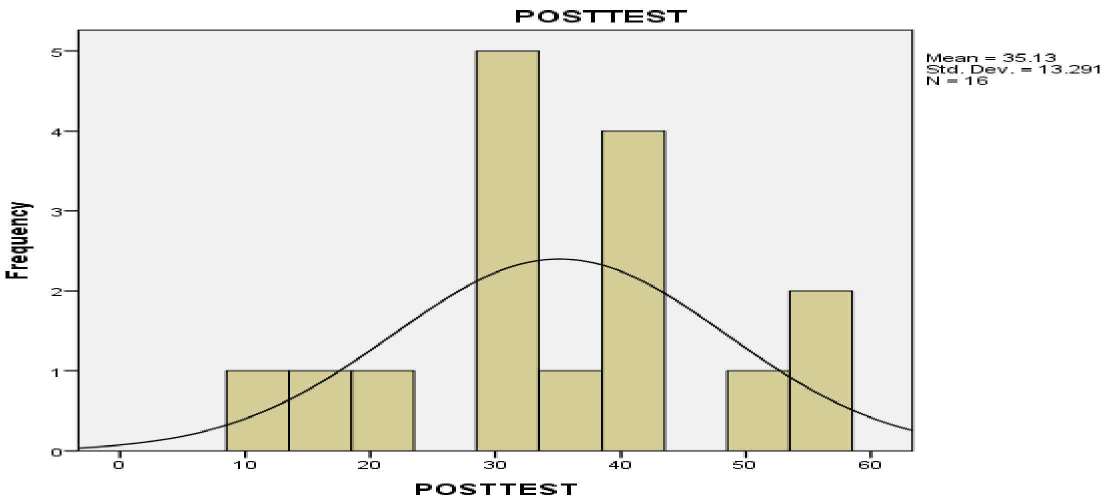


Figure 8: Control group Female posttest histogram

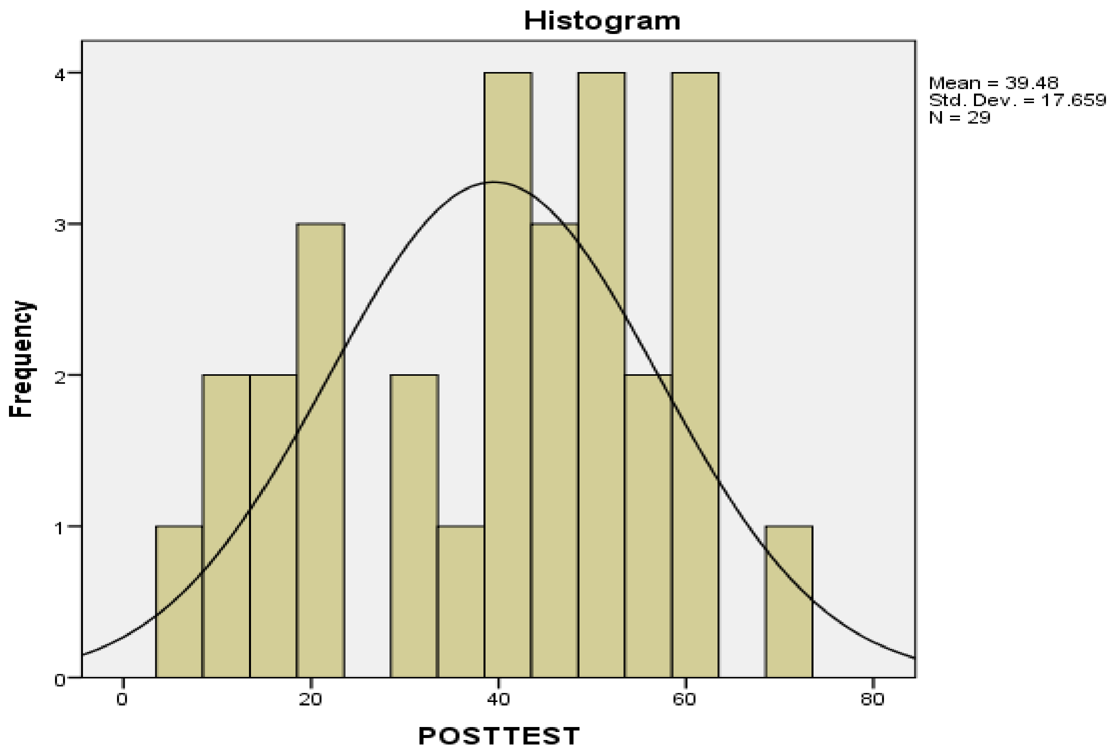
Post test performance on the genetics achievement test as indicated from figure 8 above show that the group was normally distributed. It was therefore ideal that groups be used in the research. In the histogram above, the bell- shaped nature of the graph is an

Statistics

POSTTEST

N	Valid	29
	Missing	0
Mean		39.48
Median		40.00
Mode		39
Skewness		-.309
Std. Error of Skewness		.434
Minimum		6
Maximum		69
Percentiles	25	23.00
	50	40.00
	75	55.00

CONTROL GROUP MALE POSTTEST HISTOGRAM



Post test performance on the genetics achievement test as indicated from figure 9 above show that the group was normally distributed. It was therefore ideal that group be used in the research. In the histogram above, the bell- shaped nature of the graph is an indication of normality.

Figure 9: Control group male post test histogram

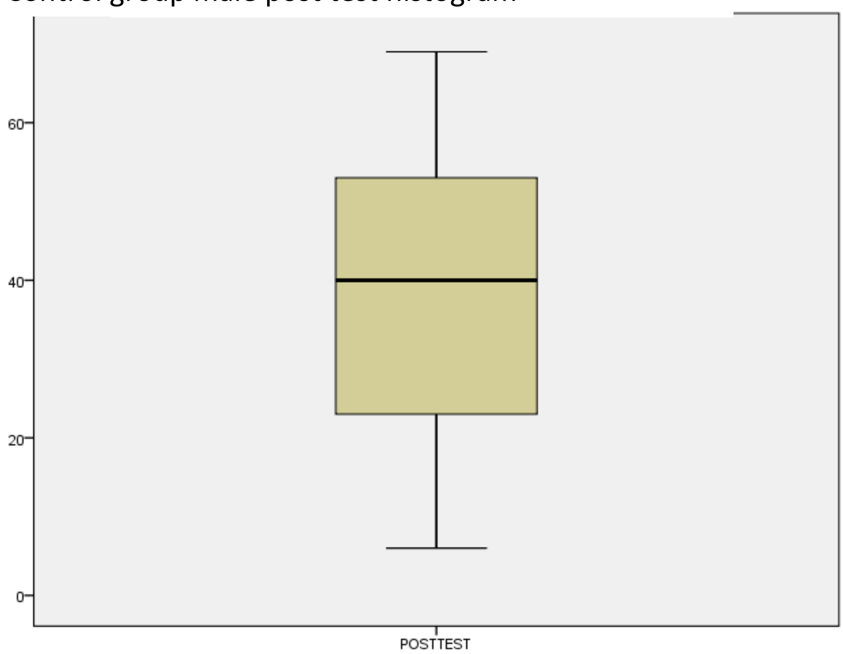


Figure 10: Control group male post-test box plot

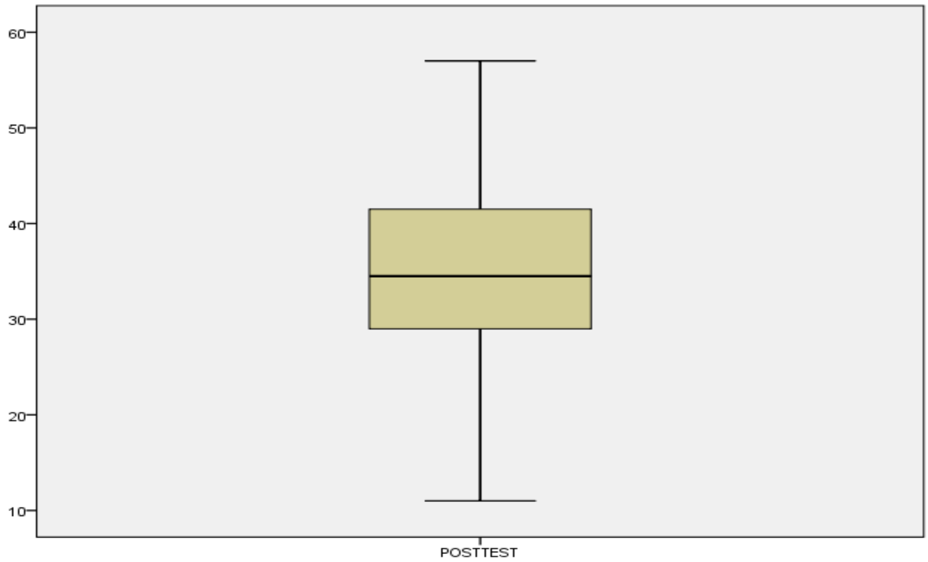


Figure 11: Control group post-test Female box plot

Considering the information from the box plots figures 10 and11 above, whiskers are about the same length in both males and females.The Median line is about half way in both cases. The Spread of observations is similar in the experimental and control groups.Already, we can estimate that the variances for these two groups are quite similar after the intervention.

Table 5d: Gender group statistics for control group

Group Statistics

	GENDER	N	Mean	Std. Deviation	Std. Error Mean
PRETEST	FEMALE	16	.06	.250	.062
	MALE	29	.14	.581	.108
POSTTEST	FEMALE	16	35.13	13.291	3.323
	MALE	29	39.48	17.659	3.279

Table 5e: Post test independent samples t test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PRETEST	Equal variances assumed	1.048	.312	-.493	43	.625	-.075	.153	-.384	.233
	Equal variances not assumed			-.605	41.273	.548	-.075	.125	-.327	.176
POSTTEST	Equal variances assumed	2.289	.138	-.860	43	.394	-4.358	5.066	-14.575	5.860
	Equal variances not assumed			-.933	38.753	.356	-4.358	4.668	-13.802	5.087

In the control group, Levene's test for homogeneity was conducted in the performance between females and males and p= 0.312 was greater than the significance level $\alpha = 0.05$, hence the null hypothesis of Levene's test was not rejected and equal variance was assumed.From the independent t test above for the control group, P › 0.05 is greater than the chosen significance level α = 0.05, we fail to reject the null hypothesis and conclude that the mean achievement in genenetics between females and males is significantly not different.

EXPERIMENTAL GROUP MALE

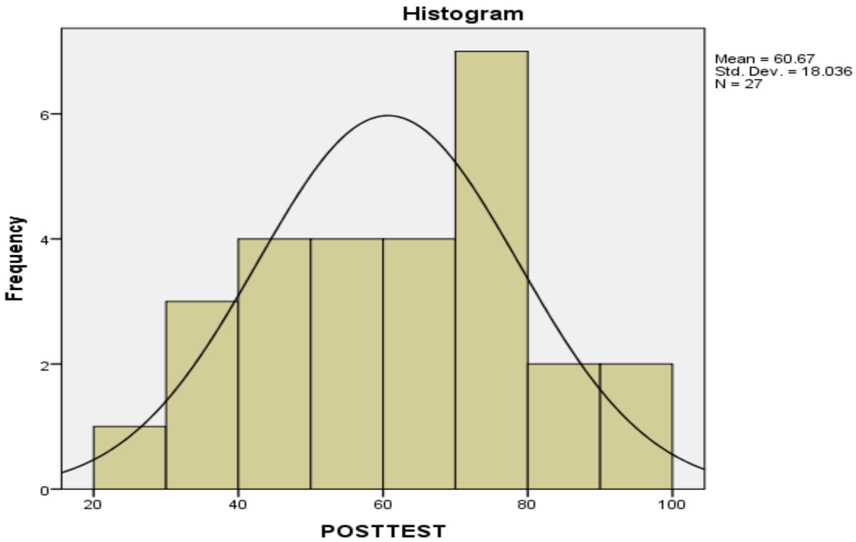


Figure 12: experimental group male histogram

Post test performance on the genetics achievement test as indicated from above figure 12show that the group was normally distributed in terms of the performance.

Table 6a: Experimental group post test statistics

Statistics

POSTTEST

N	Valid	27
	Missing	0
Mean		60.67
Median		62.00
Mode		57[a]
Skewness		-.399
Std. Error of Skewness		.448
Minimum		20
Maximum		91
Percentiles	25	46.00
	50	62.00
	75	74.00

a. Multiple modes exist. The smallest value is shown

Table 6b: Test of normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
POSTTEST	.123	27	.200*	.970	27	.604

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The normality test table from Shapiro-wilk table 6b shows a p-value of .604 which is greater than alpha level of 0.05. The null hypothesis is not rejected. Therefore there is not enough evidence to conclude that the data is non-normal in the experimental male group.

Experimental male group box plot

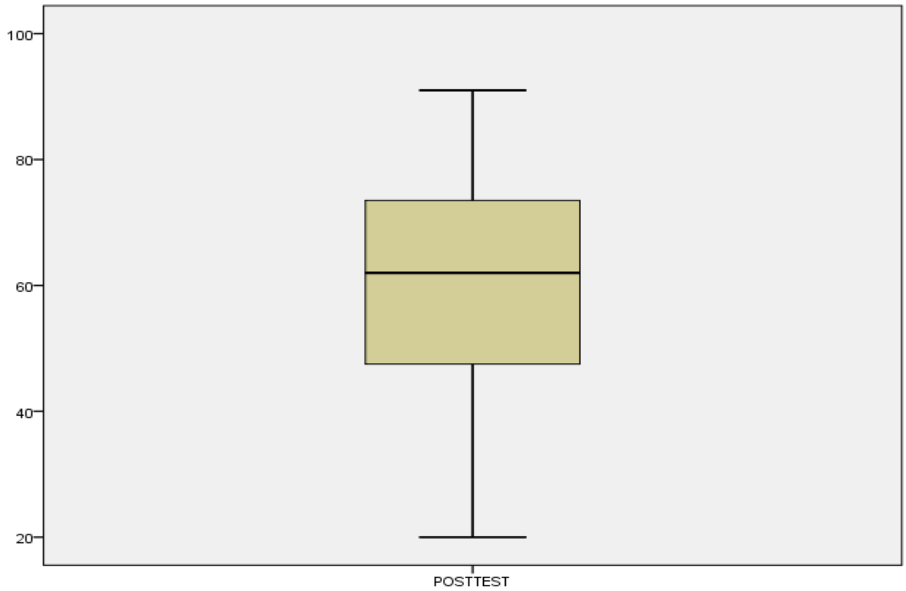


Figure 13: experimental female group box plot

The box plot figure 13 above shows the Spread of observations in the experimental male group.Already, we can estimate that the observations were quiet similar by the same size of whiskers and an equally dividing median line.

Table 6c: experimental group female post test statistics

POSTTEST

N	Valid	18
	Missing	0
Mean		67.17
Median		68.00
Mode		68
Skewness		-.282
Std. Error of Skewness		.536
Minimum		44
Maximum		89
Percentiles	25	55.25
	50	68.00
	75	80.00

The statistics table 6c above gives a summary of the experimental group for the females.

Experimental group female post test histogram

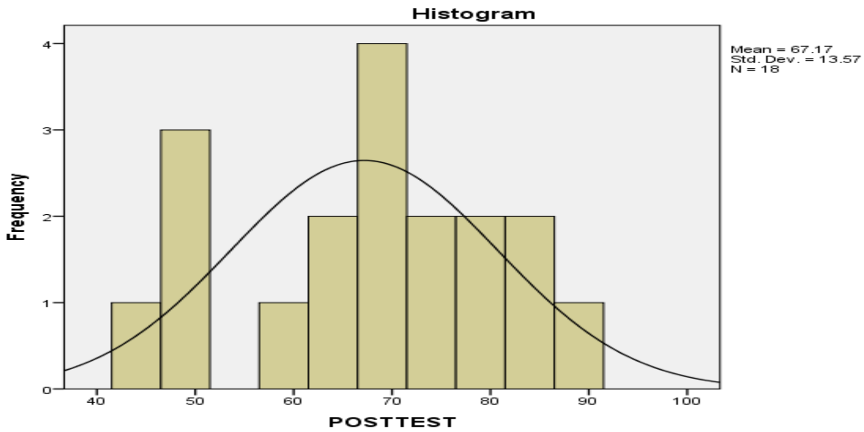


Figure 14 Experimental group female post test histogram

Post test performance on the genetics achievement test as indicated from figure 14 above show that the terms of its performance.

Table 6d: Test of Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
POSTTEST	.132	18	.200*	.945	18	.352

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The normality test from Shapiro-wilk table 6d shows a p-value of .352 which is greater than alpha level = 0.05. The null hypothesis is not rejected. Therefore there is not enough evidence to conclude that the data is non-normal in the experimental female group.

Experimental female group box plot

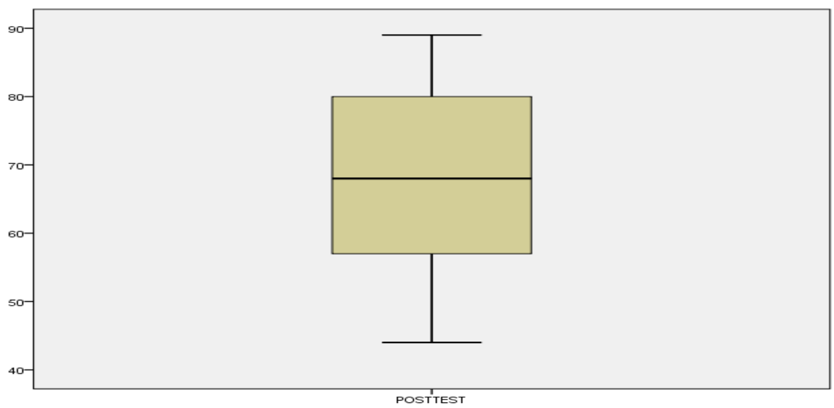


Figure 15: Experimental female group box plot

The box plot figure 15 above shows the Spread of observations in the experimental female group.Already, we can estimate that the observations were quiet similar by the same size of whiskers and an equally dividing median line.

Table 7a: Gender group statistics

Group Statistics

	GENDER	N	Mean	Std. Deviation	Std. Error Mean
PRETEST	FEMALE	18	.17	.383	.090
	MALE	27	.00	.000	.000
POSTTEST	FEMALE	18	67.17	13.570	3.198
	MALE	27	60.30	17.506	3.369

Table 7b: independent samples t test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PRETEST	Equal variances assumed	32.250	.000	2.272	43	.028	.167	.073	.019	.315
	Equal variances not assumed			1.844	17.000	.083	.167	.090	-.024	.357
POSTTEST	Equal variances assumed	1.471	.232	1.405	43	.167	6.870	4.889	-2.988	16.729
	Equal variances not assumed			1.479	41.914	.147	6.870	4.645	-2.505	16.246

In the eperimental group, Levene's test for homogeneity was conducted table 7a, in the performance between females and males and p= 0.000 was less than the significance level α =0.05, hence the null hypothesis of Levene's test was rejected and equal variance was not assumed.

From the independent t test above for the experimental group, P › 0.05 is greater than the chosen significance level α = 0.05, we fail to reject the null hypothesis and conclude that the mean achievement in genenetics between females and males is significantly not different.

5.0 DISCUSSION AND INTERPRATATION OF RESULTS

Chapter five discusses the relationship between the research findings and the problem statement, by providing some solutions to the research questions. This was done by interpreting the research findings in light of the research problem and research questions.

The Research Findings in relation to the Research problem

The study to critically investigate the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of secondary school students in genetics was undertaken against the research problem that; The amount of information students are expected to master is too large and this leads to limited learning strategies available for students in mastering the huge volumes of information required to succeed. Due to the large volumes of information, most students resort to passive learning, a phenomenon that has been shown to increase the risk of academic difficulty (Dolan et al…2002). A learning strategy that emphasizes memorization without an attempt to connect and understand information is termed "passive" learning. There is no cognitive stimulation among passive learners to attempt forming connections between units of information. In contrast, active learning encourages interconnectivity of units of information and encourages the learner in activities that promote meaningful leaning (Gage and Berliner, 1998). Genetics receives less attention as it is taught towards the end of the year just before the summative examinations, followed by the inappropriate teaching methods, makes it difficult for the learners to fully comprehend the concepts. Genetics connects secondary to tertiary education especially for all those that go to the field of biological sciences. Terminological aspects of genetics have made it somewhat difficult for the learners to engage into meaningful understanding of the subject matter (Baseline study report 2002).

Strong empirical evidence is that some fundamental concepts on which scientific understanding is built, are commonly not well understood by learners and that there are patterns in the difficulties learners experience (Shipstone1984).

The main problem investigated in this study was the failure by the majority of biology students at Kansenshi secondary school to critically understand the terminologies used in genetics and apply them in handling examination questions. In addressing the highlighted problem, the study critically investigated the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of secondary school students in genetics and whether gender had an effect on performance in genetics. The study was done on two grade twelve classes of Kansenshi secondary school of Ndola. In the study one class was taught using the integration of concept maps into group discussion. While the other class was taught using discussion method. The outcomes of the study showed that the integration of concept maps into group discussion had a significant impact on learners in genetics while gender had no effect on performance. The comparison was done with the aid of the t-tests in SPSS. The outcomes of the tests clearly indicated that the class taught using the integration of concept maps in group discussion had a significant higher level of achievement while analysis on gender showed no effect.

Research Questions in relation to the Research Findings

The overall target of the analysis of data in this study was to find answers to the research questions. In this study, two research questions needed to be answered. The findings in response to the research questions were as follows:

- What is the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of senior secondary students in genetics?

In this first research question, the research wanted to determine the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of students in genetics.

In determining this, two classes of Kansenshi secondary school were taught; one through the integrating concept mapping into group discussion as an instructional strategy on the academic achievement of students in genetics and the other through group discussion. The classes were tested on achievement after the instruction process was over. The class taught using the integration of concept maps had a higher achievement mean score. Following the results of the analysis, it was concluded that integration of concept maps into group discussion had a positive impact on learners' achievement. Therefore, if learners are taught using the integration of concept maps into group discussion, it is expected that they would have a higher and better achievement in their academics.

- Does mean achievement in genetics vary with gender?

In the second research question, the researcher wanted to determine the effect of gender on the academic achievement of learners in genetics. The process to determining the effect involved teaching two classes of Kansenshi secondary school using the integration of concept maps into group discussion and the other using group discussion only. The groups wrote both the pre-test and the post-tests. In both cases, there was no significant difference in the mean performance for both groups. It was concluded that gender had no effect on the academic achievement of learners in genetics.

6. CONCLUSION AND RECOMMENDATIONS

In this chapter, a summary of the findings is highlighted, and the recommendations are made.

The Findings

This study was done with the aim of critically investigating the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of learners in genetics. In addition, the study sought to determine whether mean achievement in genetics varied with gender.

The study was guided by two research objectives. The first objective was to investigate the effect of integrating concept mapping into group discussion as an instructional strategy on the academic achievement of learners in genetics; the second was to investigate the effect of gender on the academic achievement of learners in genetics.

The overall picture of the findings was that the integrating of concept mapping into group discussion as an instructional strategy on the academic achievement of learners in genetics had an impact on learners' achievement, while gender showed no significant difference in the mean achievement. Learners are therefore, expected to have a higher achievement if taught with the integration of concept maps into group discussion.

The evidence to the overall picture was as outlined below in the major research findings. The major research findings were as well evidenced by the two hypotheses tests.

The first hypothesis was tested with a view of determining if there was any statistically significant difference in achievement between learners taught by discussion method and those taught using the integration of concept maps into group discussion. The hypothesis on concept maps was tested, the p-value for the t-test was compared to the level of significance which was set at 0.05 and p-value was less than the level of significance. Thus, the null hypothesis was rejected in favor of the research hypothesis. The conclusion of the test was that there was a statistically significant difference in achievement between learners taught by discussion method and those taught using the integration of concept maps into group discussion.

The second hypothesis was tested with a view of determining whether there was any statistically significant difference in mean achievement by gender between learners taught by discussion method and those taught using the integration of concept mapping into group discussion. Again the t-test was used as before, the p-value was compared to the level of significance. The p-value was found to be greater than the level of significance. Thus, the null hypothesis was not rejected. The conclusion of the test was that there was no statistically significant difference in gender between learners taught by discussion method and those taught using the integration of concept mapping into group discussion.

COMPARATIVE STUDIES

This study showed that concept mapping is more effective teaching learning strategy than the group discussion method, to improve academic achievement of the students in Biology. The results of this study extend the findings of Namdi, Okoye & Okechukwu, (2006)revealed that students exposed to the concept mapping strategy while studying genetics achieved significantly higher than those students exposed to the traditional lecture method. This implies that concept mapping when incorporated into teaching, improves the students' performance in genetics. Namdi and Okechukwu further revealed that there research was in line with the findings of Ige (1998); Okebakola (1997and 1998); Osisioma (1996) and Wandersee (1990).

The most important reason relating to the findings is that the use of concept maps amongst the learners will provide for them an opportunity to get involved in the given assignments. For this reason, the learners enhance their mental skills as the closely examine and seek solutions to the presented problems. Apart from scope widening, concept maps also facilitate and increase the imaginative ways of the participants in this case the learners that are involved in the learning process with the integration of concept maps. This is according to (Mc Aleese 1999). Freeman (2004), states that the presentation of concept maps among learners themselves will enhance conceptual clarity. Misconceptions are some of the awareness that learners are able to identify when they get into group discussions and this helps them learn better. Under several circumstances, the misconceptions of learners go unchecked if the use of concept maps is not encouraged. Use of concept maps will therefore enable the teacher to compare and make corrections on the various misconceptions the learners may have. A conclusion can therefore be made that the use of concept maps improves the academic achievement of learners in genetics because of their active involvement in the process of learning.

Recommendations

The findings of this research showed that concept inclusion in the group discussions yielded positive results with the learners that got involved. I therefore recommend the following;

1. Guidelines need to be incorporated by all developers of the educational curriculum on the use of concept maps as a means of promoting meaningful learning.
2. Writers of educational text books need to incorporate material that encourages the use of concept maps. Being a primary source of information that learners come across,

textbooks need such information on the use of concept maps which call for practical activities as well as having assessment exercises for testing the ability of the learners on the use of concept maps which may widen the scope of the learners.

3. Examining bodies such as the examinations council of Zambia does not assess learners on the use of concept maps in the summative examinations; I therefore recommend the inclusion of examination questions that involve the use of concept maps.
4. Teacher training colleges and universities need to incorporate concept maps in their curriculum as a way of facilitating and encouraging the would be teachers have a philosophical background on the usage of concept maps for an improved academic achievement of learners.

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