



## Educational Technology

Elixir Edu. Tech. 55 (2013) 12996-13003

Elixir  
ISSN: 2229-712X

# Innovative Practices in Content Presentation of Physics at Secondary Level

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### ARTICLE INFO

#### Article history:

Received: 20 December 2012;

Received in revised form:

2 February 2013;

Accepted: 13 February 2013;

#### Keywords

Concept maps,

Physics teaching,

Science teaching.

### ABSTRACT

Teaching of Physics at secondary level of education is most crucial. Secondary education is a decisive stage of individual's entire academic tenure; at this level any ambiguity regarding concepts may deprive an individual intellectually and potentially. Keeping importance of physics in view this study was intended to develop module based on some innovative practices to teach physics effectively. The objectives of this research were to analyze the current methods of content presentation of physics, commonly used to teach in secondary level classroom and to develop a concept maps for content presentation of physics for secondary level students.

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### Introduction

Man is a social being and his survival without society can hardly be imagined. To enable an individual to develop harmony with social life, expansion of knowledge is very important by equipping him with certain information, skills, attitudes and concepts. Education is an instrument that facilitates expansion of knowledge. According to Mary (2009) it is self enlightening process and an essential component of life that make an individual acquaint with the world around. It provides numerous opportunities in life to excel academically and professionally. It leads the ambitious individuals to the fulfillment of their dreams by inculcating fundamental knowledge to specialize in particular fields of interest by accomplishing required degree courses. Education is equally productive in all aspects of individual's life including academic, professional, social, financial, moral, political aspects etc. education can better train human minds and enable them to utilize their potentials to the optimum level. It develops ability to think logically, rationally and also inculcate decisive power to deal with the matters of personal and social life.

#### Importance of secondary education

Although education is a continuous process that stretches to the entire life span of an individual but it's importance touches it's elevation at secondary stage of academic education as far as further studies and career choice is concerned. at this level students have to make decision that which field is most appropriate for them and which subjects they should pursue for further studies. This is the stage when students passes through *adolescence* stage and enters into the *maturity phase of life*.( Iffat Basit ,2004) At this phase of life students are not only interested in their dressing, grooming, conversational ability, social life, expressing himself, but also worrying about his future, further studies and professional pursuits.. Students of this age are very energetic, enthusiastic, and zealous and want to do something new and surprising every moment to satisfy their innate talent. Successful future life is comprised of proper training of students and inculcation of knowledge by using suitable and appropriate teaching methods.

Formal education process is consisting of three fundamental pillars including *teacher, subject matter and student*. if anyone is weak among these, entire system may collapse.

(Iffat Basit, 2004) Although all the three components have their own importance but teacher has to perform pivotal and paramount role. If teacher is responsible and well aware of his duties he can positively overcome the deficiencies of other two components by adopting innovative and appropriate teaching strategies.

#### Importance of Science Education

Today is the scientific age and nobody can deny the importance of science in education. Comparatively scientific information and knowledge is increasing day by day with great pace and affecting almost all aspects of social life globally. Dr. M. Naseer-Ud-Din et-al (2010) quoted the statement of Saud (1998) that it is a crystal clear fact that scientific development and science based education is very important for any nation for its prosperous survival in 21<sup>st</sup> century. Expertise in science and technology and its application in perspective fields is very important for launching developmental programs in the country like Pakistan. Dr. M. Naseer-Ud-Din et-al (2010) also quoted the statement of Iqbal (2000) who wrote that Pakistan is striving for honorary status among other countries. Recognition of Pakistan as nuclear power is proof of scientific advancement but there are still many areas i.e. energy, food, shelter which require strong basis of scientific and technological based knowledge. These problems can only be resolved through giving enough importance to science and technology in our education system.

Dr. M. Naseer-Ud- Din, Dr. Abdur Rehman Khaleeq, Dr. Javed Iqbal et-al(2010) quoted the words of Quaid-e-Azam Muhammad Ali Jinnah about the importance of science in their article that was published in International Journal of Academic Research in 2010:

"The future of our state will and must greatly depends upon the type of education we give to our children, and the way we bring them up as the future citizen of Pakistan. Education does not mean academic education; there is an immediate need of scientific and technical education to our people in order to

build up our future economic life and see that our people take science, commerce. Trade and particularly well planned industries. We should not forget that we have to compete with the world which is moving very fast.”

Science is very vast subject having several branches. In Pakistan natural sciences are separately taught as an introductory subject at secondary level, before that level an integrated subject is taught named as *general science* so secondary level is first stage of learning natural sciences including biology, chemistry and physics in bit detail. So at this level specialized teachers equipped with innovative techniques and attractive methodology are needed for the inculcation of relevant concepts with clarity, so that students can decide either to pursue these subjects for further studies or not.

#### Importance of Physics Education

Deepak Dayal (2007) wrote that Physics is the branch of natural sciences, deals with the rudimentary components of the universe and their interface and reciprocal action. It also concerned with the analysis of system which can be better understood only in terms of these elementary principles. It endeavors to describe the natural world by using logic and scientific method through modeling by theorists incorporated with observation and experimentations.

#### Teaching of Physics

According to Sharma (2006) quoted by Mohan Cyparsade, Unniswar Chummun, Sandiren Caroppunnen et-al (2009), Physics is considered a master of scientific knowledge so learning of its abstract concepts requires more concretization. A general perception about physics is that it is one of most complicated subject this perception is emerged due to the use of traditional methods of teaching that usually cause boredom and tediousness among students about learning of physics. Surendra Prasad (N.D) described that Science subjects are distinct in nature and due to that reason these subjects are very challenging not only for teachers but also for students. The curriculum of these science subjects including physics keeps on evolving new developments incorporated with technology and research. Teachers have more responsibility to cope up with challenging changes in curriculum by using some different and innovative techniques instead of traditional methods to accomplish their task satisfactorily. Mrs. Sangeeta Arora (N.D) mentioned in her article that Science subjects are considered difficult not because of their conceptually complicated content but also due to traditional, didactic and formal teaching methodologies these methods doesn't seem attractive to student hence they find solution of their problem of passing exams and getting good marks in rote memorization. There are many factors which are responsible of decline of students' interest in science education like physics. Major factor among all is inappropriate, traditional and non effective teaching techniques.

#### Traditional Methods of Teaching Science

In Pakistan teaching method that is commonly used to teach almost all subjects including science subjects, is lecture method. This method provides least chance of students' participation. This method is more popular especially in public schools where strength is very large and it seems difficult rather impossible to teach them through experimentation or hands on approach. Although laboratories are available in almost all public secondary schools but there is lack of separate physics laboratory. Due to over crowdedness of classes only few students can get opportunity to do practical by themselves otherwise students just observe how teacher do it before them.

Science subject teaching cannot be confined to classroom lectures but these subjects also require experimentation and demonstrations with full involvement of students. Students can learn better if they observe things happening before them and by doing them practically. As the Chinese proverb say:

“I listen, I forgot it

I see, I remember it

I do, I understand it”

So lecture method can be made useful teaching method if it is incorporated with experimentation in its true sense. (Mrs. Sangeeta Arora, N.D).

#### Innovative Strategies of Teaching Science

A teaching strategy implies to any method, approach or a carefully and skillfully designed classroom interactive that can facilitate teaching of any concept, idea or a lesson to the students. If any strategy is combined with some new thought, creativity and novelty than it becomes *innovative strategy*. Regina M.O Samba, Emmanuel E.Achor, Josiah A.Ogbeba (2010) quoted the explanation of innovative approach given in Macmillan English dictionary (2007):

“An innovative approach is a design that is full of new or Purposively reconstructed existing idea”.

Innovation in teaching strategies can be taken in two perspectives, one to design some new technique which is different to already existing techniques another meaning of innovation may be to use existing approaches but in different setting and in different style. So strategy may not necessarily be new but its use and implication may be novel. In brief actual purpose is to use various appropriate teaching strategies to ensure better understanding and effective teaching. Following point should be kept in mind while designing innovative strategies:

- Nature of the topic.
- Concepts intended to be taught.
- Learners cognitive readiness
- Skill to be developed in learners
- Time duration
- Teaching approach (learner centered, teacher centered etc)

Teacher can only bring innovations in his teaching when he is well aware of existing developments in educational theory and teaching strategies. Science teachers usually encounter with difficulties in order to transmit knowledge to students most effectively because either they are not acquaint with new and innovative teaching strategies or unable to use them. Another reason of lacking novelty in teaching science may be workload of teachers who are expected to accomplish specific content in a limited period of time and get no time for experimenting new methods. Besides all these constraints it is fact that some methods are better and more facilitative than others and teachers should learn how to incorporate different methods in his teaching according to the nature of lesson. . Inappropriate methods not only harm teaching but also put negative effects on students' learning. Learning difficulties may arise when queries remain unsolved in the minds of students and these gradually become the area of student's weakness, so to overcome these weaknesses and to enable students to excel specifically in science subjects innovative strategies are imperative.(Regina M.O Samba, Emmanuel E.Achor, Josiah A.Ogbeba 2010)

#### New approaches to teaching science

Science education can only be promoted and inculcated among students of secondary level when it will be made simple and understandable. To create attraction for students to learn

science subjects generally and physics specifically, following approaches must be catered:

- Life oriented
- Lecture cum demonstration and activity oriented
- Use of available resources to make teaching interesting
- Developing understanding of concepts rather than rote memorization
- Learner centered
- Care about students needs rather than their interest
- Provoking thought process
- Motivation for participation

So keeping in view the importance of teaching physics, special attention must be given to make it interesting, perceivable, understandable and enjoyable for students by using innovative strategies..(Mrs. Sangeeta Arora, N.D).

Role of science teacher is bit different than of other subjects. He should not have command over subject only but be aware of the techniques to manage the construction of knowledge among students of diverse nature in the classroom.

#### **Advantages of innovative strategies**

It is very boring for learner if teacher enters in the class daily with similar questions, resources, planning, teaching strategies and evaluation techniques. Infact teacher should have variety of resources, teaching and evaluation strategies to select from an appropriate one to teach intended concept.

“It is very important to trial innovative strategies in the teaching and learning of science for several reasons. One of these is the intention of bringing Variety to the classroom practices both for the benefit of the teacher and also the learners.”

(Cyparsade, Moheeputa, & caroopunnen 2009 )

Teaching through only lecture method is detrimental to students. Teachers should choose such methods to teach physics that can help to translate abstract ideas into concrete experiences and attempt to provide those meaningful learning experiences by using economical resources. (Cyparsade, Moheeputa, &caroopunnen 2009)

#### **Novelty in Teaching Physics**

Teaching and learning of science involves transmission of knowledge which developed in result of extensive experimentation so students must comprehend the purpose, nature and necessity of the particular subject. Teacher should make his teaching innovative to fulfill requirements of the subject and to make students understand how the subject is developed and how this development process can be continued.(Surendra Prasad, N.D)

In Pakistan lecture-cum demonstration method is commonly used to teach physics but following methods may also be used which are not new but can bring novelty in teaching physics:

- Demonstration method with collaboration of students
- Experimentation
- Project method
- Induction method
- Deduction method
- Role play
- Use of multimedia and technology
- Discussion method

Another important technique which can help in teaching physics is development of ‘concept maps’. This technique is not used by secondary school teachers so it is intended to develop few model concept maps which may guide teachers how to incorporate this technique in their teaching.

#### **Concept Mapping**

Novak and Gowin have invented two devices for development of knowledge including concept maps and Vee mapping. Concepts are inferences of an individual’s mind. It refers to abstract thought based on human perception. JazlinV. Ebenezer and Sylvia Conner (1998), pg, 49, quoted the definition of concept given by Joseph Novak (1991) that

“A perceived regularity in events or objects, or records of events or objects, designated by a label”.

Leon Pines (1985) as quoted by JazlinV.Ebenezer and Sylvia Conner (1998), termed it as “the furniture of the conscious mind”.

Concept maps actually correspond to ideas or mental images about any topic and represent not only pictorial image but also helps to comprehend interrelated concepts. A concept map is a device that explains relationship among various concepts but in hierarchal manner.

#### **Concept Mapping For Teachers**

It is very useful strategy for teachers to learn because it facilitates presentation of lecture in a sequence. It is equally beneficial for students and teacher can train them to design concept maps to organize or arrange their own thought. Teachers can make concept maps for teaching physics by following steps, mentioned below;

- Selection of topic from physics text book that require concept map to be taught in class
- Encircle the important points or prominent ideas from lesson.
- Enlist all encircled points on separate paper.
- Write each concept on a separate small piece of paper so that these can easily be moved otherwise teacher can use computer for this purpose also’
- Put the most general concepts on the top.
- Organize all concepts in a vertical order by following general to specific rule.
- Relate concepts to each other by arrows; write appropriate verbs that may guide action needed to be taken.
- Write examples to support the idea or concept.
- If concept maps are drawn by student then these must be critically analyzed by other peers.

These are not hard and fast rules to design concept maps but can definitely be useful if employed. Concept maps are very effective technique that facilitate planning of teaching learning process and also help teacher to understand concepts of students. (JazlinV. Ebenezer and Sylvia Conner 1998, pg 50).

Concept maps provide clear meaning of the concept in reference to particular context because one concept may have different meanings in different perspectives and in result ‘meaningful learning’ occurs. Concept mapping is a beneficial strategy for brainstorming and offer long lasting memory.( N.Kumar,2009, pg 336,337)

#### **Uses of Concept Maps**

Concept maps can be useful in various aspects, few are given below;

A Big Picture Looks At A Science Unit. Through concept maps a teacher can easily teach lengthy chapter in a more understandable and comprehensive way. It can also be used as advance organizer that can help students to link map with the name of the chapter and can understand what is to be taught.

Revealing of Previous Concepts. Teacher can use concept maps to assess students’ prior knowledge about the particular

concept and can judge baseline of students' knowledge. Teacher may use following techniques in this regard;

- He may do some experiment and ask them to recall relevant concepts.
- Teacher may provide a list of concepts to students and ask them to arrange them according to their relation to each other.

Opportunity for Revision. Through concept maps teacher can provide students, an opportunity to revise their conceptual learning by designing maps again on same concept than compare it with those of peers' concept maps or it can be shown to teachers for assistance. This activity helps them to include new and more relevant examples than previous ones.

Development of collaborative relationship .Formulation of concept maps helps to develop good relationship between students and teacher because they are expected to share their scientific ideas. It also develops sound relationship among peers when they share their experiences and ideas to each other.

Assessment of Learners Understanding. Teacher can use various methods to assess the understanding level of student regarding concept maps like students can be asked to present their concept maps in front of class.(JazlinV.Ebenezer and Sylvia Conner 1998, pg 55- 58)

It is an approved fact that education is the only way that leads nation towards progress and development in every field of life. Even a single profession cannot be highlighted which does not require education and keeping in view the demands of present era, science education is the essence of all scientific developments. Science education is an energizing force and backbone of materialistic prosperity and teacher has an exalted and pivotal role to play. Being responsible of building nation, teacher has to modify his teaching in order to inculcate true essence of scientific knowledge. Professional competency of teacher and quality education should always be given utmost priority to ensure the benefits of educational enterprise. Teacher is the most important component of entire education system so he should put his all efforts to improve his teaching strategies, pedagogical skills and also to motivate students to excel. He should try to bring innovation, creativity and modern techniques to his teaching.(Dr.M. Naseer Din,et al 2010)

Concept maps are useful activity but unfortunately it is not being used in Pakistan, especially at secondary level for physics teaching. Few concept maps are developed based on the content of secondary level physics. These concept maps will provide guideline for teachers to embedded their teaching with this innovative technique.

#### Significance of the Study

This study is based on the investigation regarding current methods of content presentation of physics and introducing new innovative strategies to overcome the short comings of traditional methods. This study is significant in three ways:

1. This study will introduce innovative and novel content presentation technique for physics in form of concept maps.
2. It will help teachers to teach respective subject more efficiently with the help of concept map strategy.
3. This innovative technique will help students to learn better and ensure more involvements in learning activities.

So hopefully it will be a worthwhile and significant study as far as teaching of physics is concerned.

#### Materials and methods

##### Research design

This study was of qualitative design. It deals with the current content presentation strategies commonly used for

teaching of physics and to suggest better techniques in the light of prevailing methodologies.

#### Population

Population of the study was all relevant literature available in form of books, periodicals, research papers, research articles, thesis, dissertations, magazines, generals etc, regarding the techniques, frequently used for content presentation of physics at secondary level.

#### Delimitation of The Study

Due to the time and financial constraints, this study was delimited to,

- the qualitative study
- the subject of physics.
- the secondary level only.
- the literature available, consist of teaching content presentation methods of

#### Discussion

After detailed study of literature available and the proposed curriculum for physics of secondary classes, the researchers have developed 20 concepts for 20 chapters. These maps have been named as "Topic maps" as the maps. This is new innovation in the curriculum. The major topics had been broken down into minor topics.

These maps can be helpful for presenting the content. The will be helpful for teachers as well as students. For curriculum point of view, it can be presented at the beginning of the chapter. Teachers can use it at the start and end of lecture. Students can see at one glance the core topics of the chapters. Due to lack of time these "topic maps" have not being tested.

#### Recommendations

These maps can be added in curriculum at the beginning of chapter. These maps can be guidelines for further research. These topic maps can be used as pedagogy for teaching and learning of physics at secondary level.

#### Chapter 1 Physics and Introduction

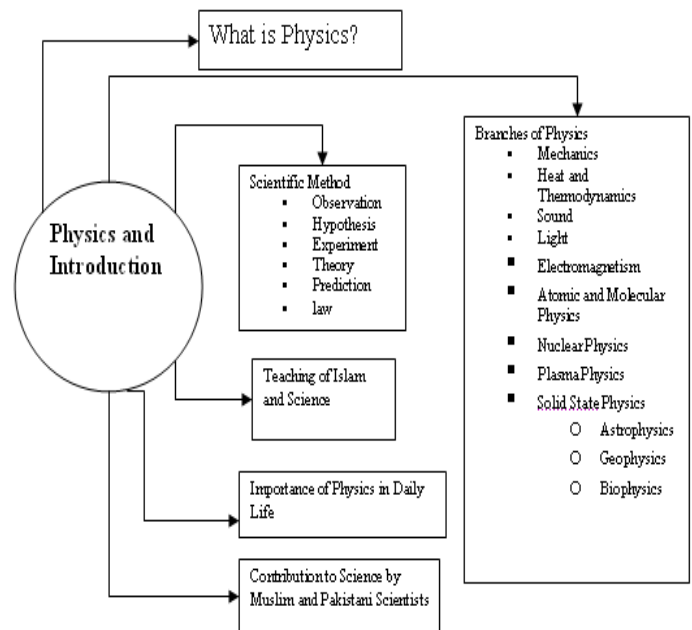
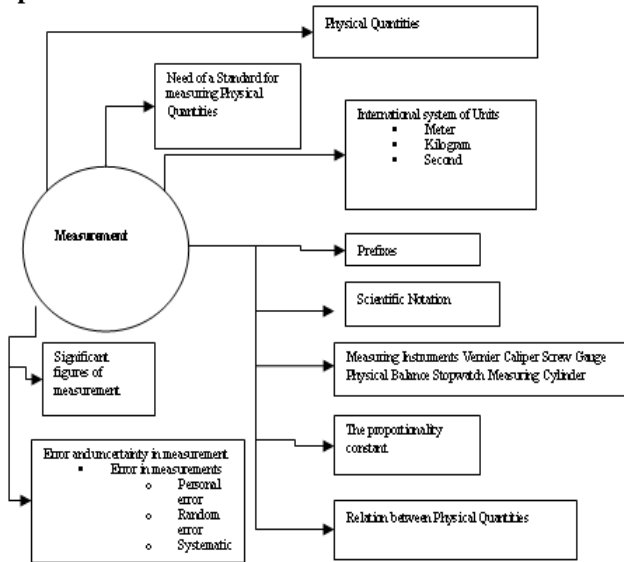
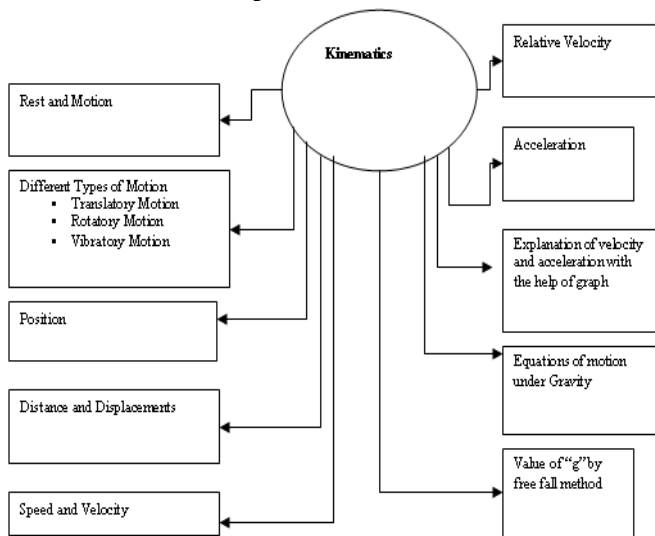


Figure 1 Concept Map of Chapter 1

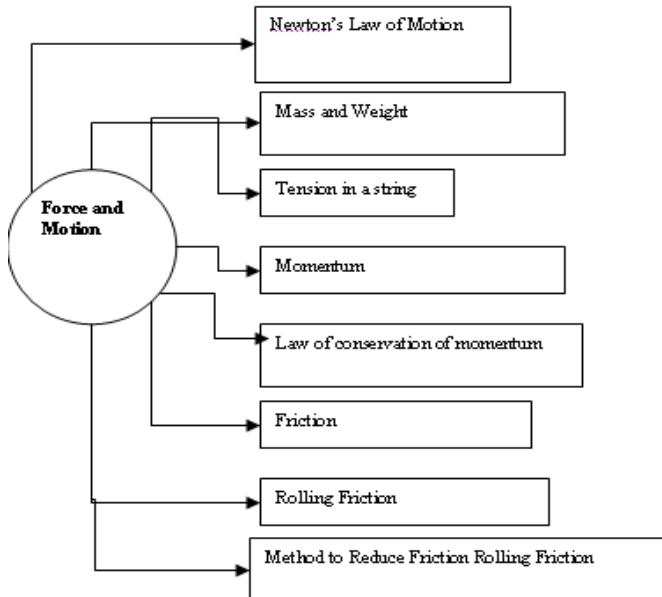
**Chapter 2 Measurements**



**Figure 1 Concept Map of Chapter 2  
Chapter 3 Kinematics**

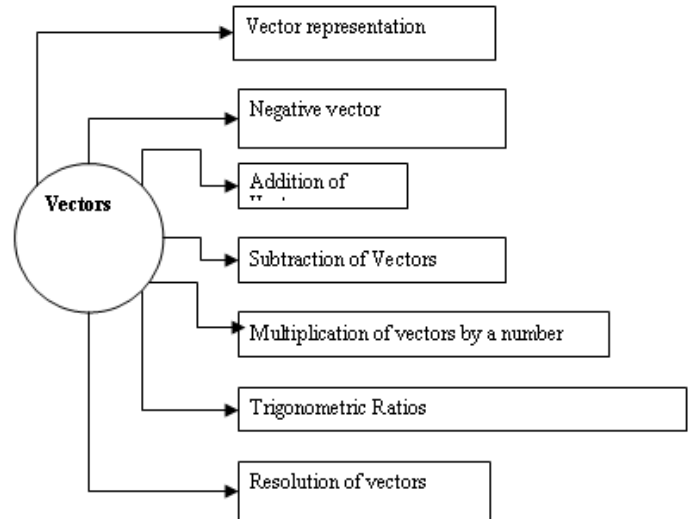


**Figure 3 Concept Map of Chapter 3  
Chapter 4 Force and Motion**

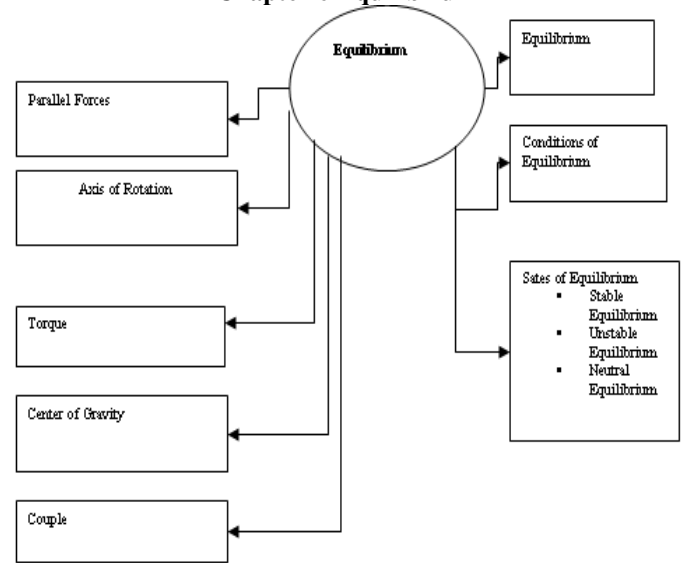


**Figure 4 Concept Map of Chapter 4**

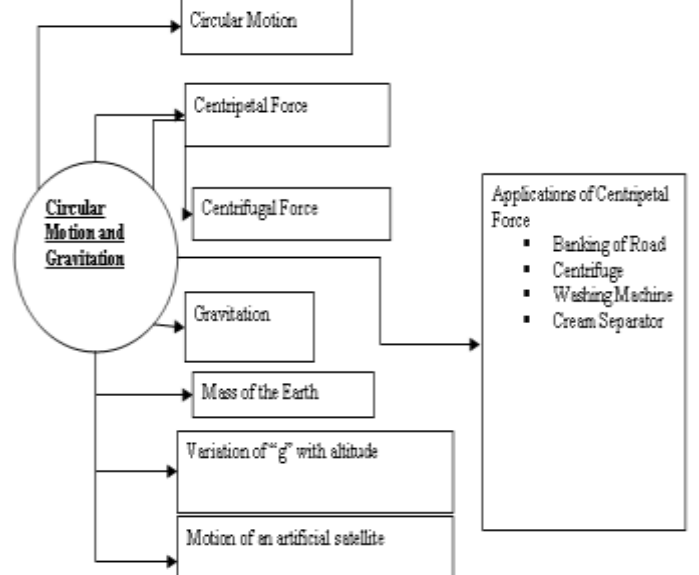
**Chapter 5 Vectors**



**Figure 5 Concept Map of Chapter 5  
Chapter 6 Equilibrium**



**Figure 6 Concept Map of Chapter 6  
Chapter 7 Circular Motion and Gravitation**



**Figure 7 Concept Map of Chapter 7**

Chapter 8 Work Power and Energy

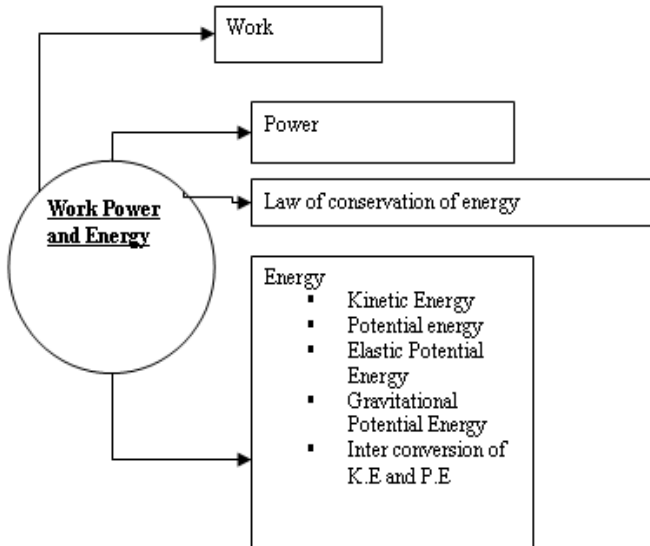


Figure 8 Concept Map of Chapter 8 Chapter 9 Simple Machines

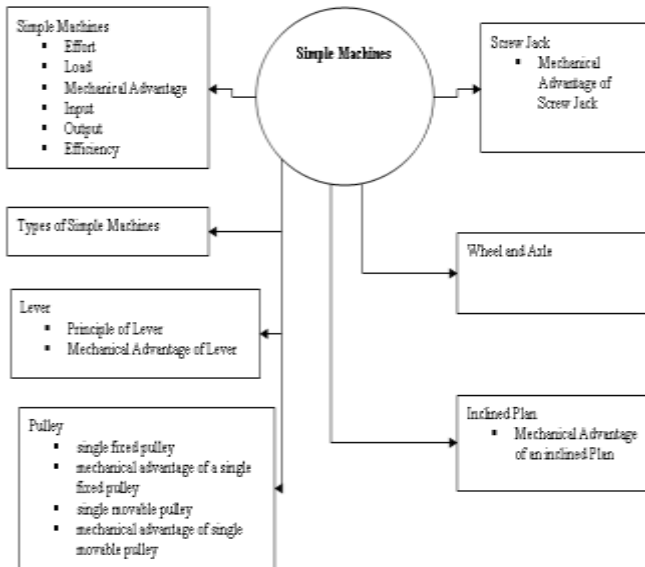


Figure 9 Concept Map of Chapter 9 Chapter 10 Properties of Matter

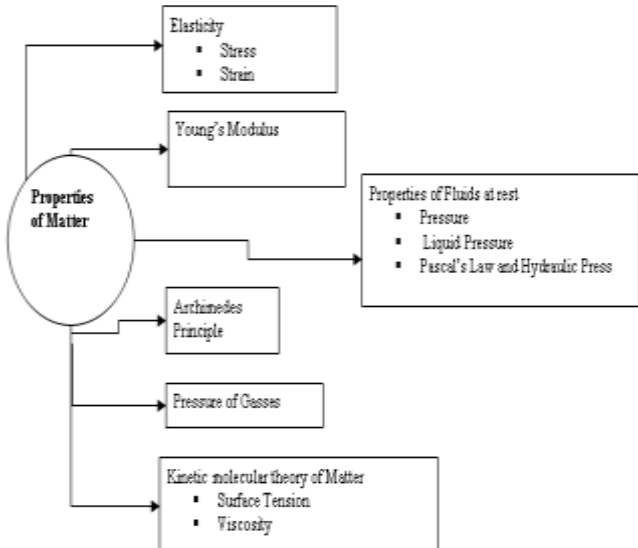


Figure 10 Concept Map of Chapter 10

Chapter 11 Heat

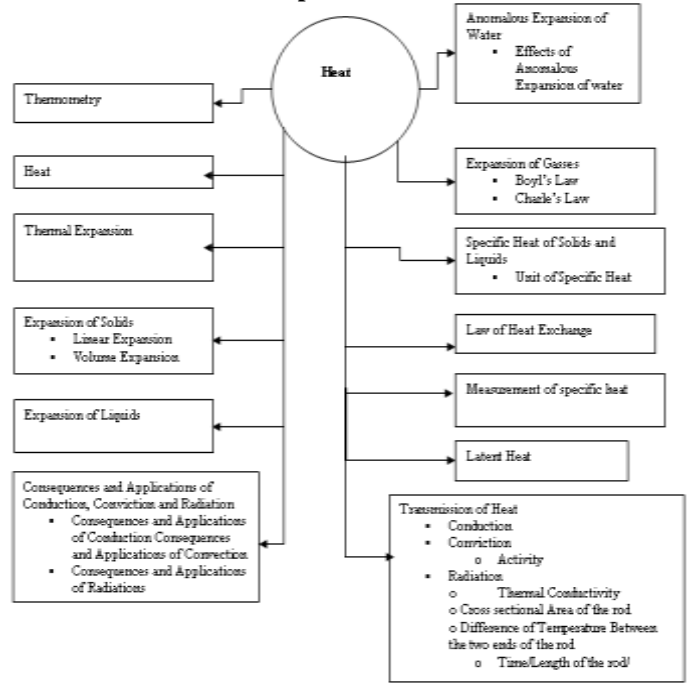


Figure 11 Concept Map of Chapter 11 Chapter 12 Wave Motion

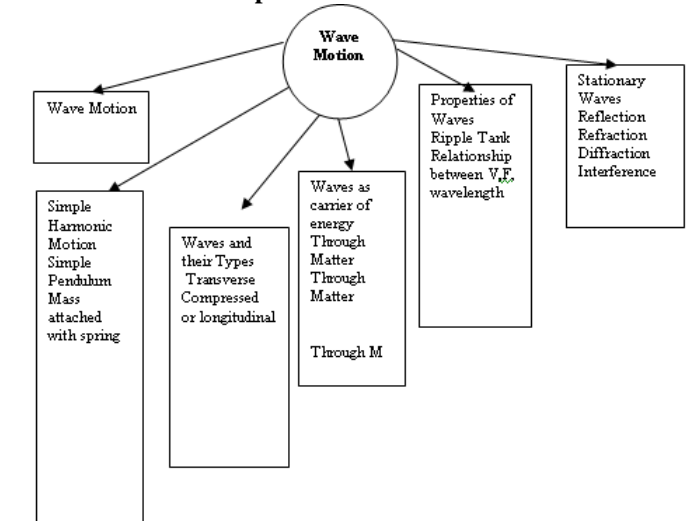


Figure 12 Concept Map of Chapter 12 Chapter 13 Sound

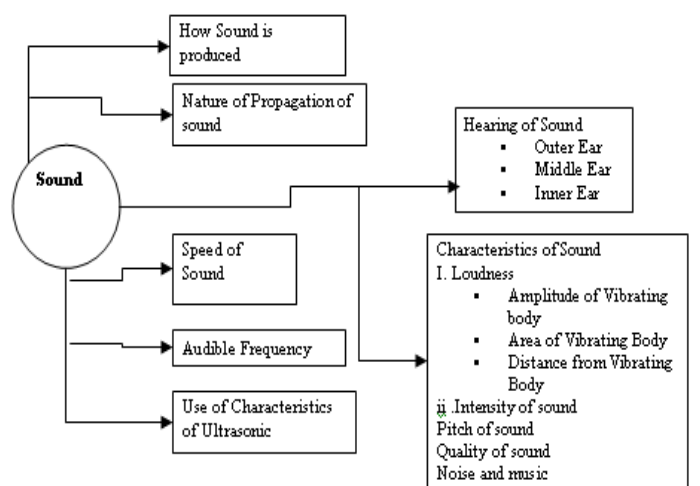
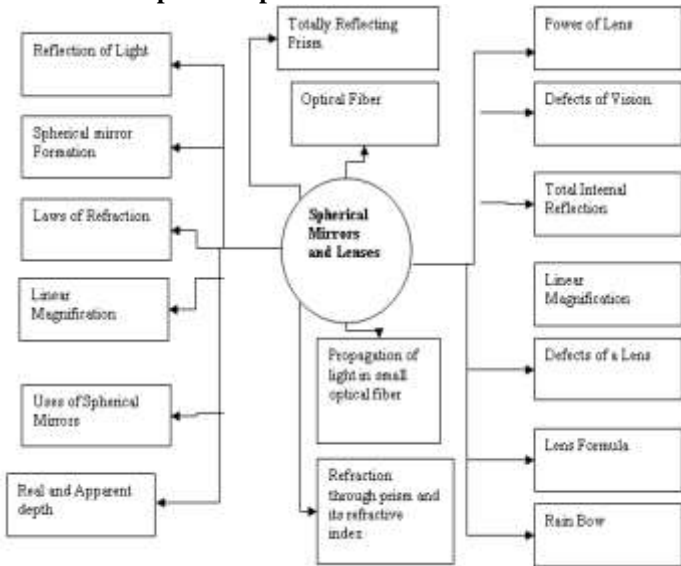


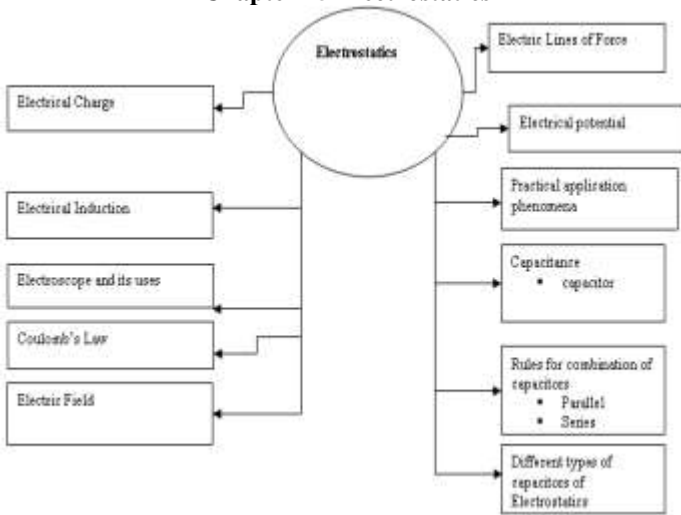
Figure 13 Concept Map of Chapter 13

**Chapter 14 Spherical Mirrors and Lenses**



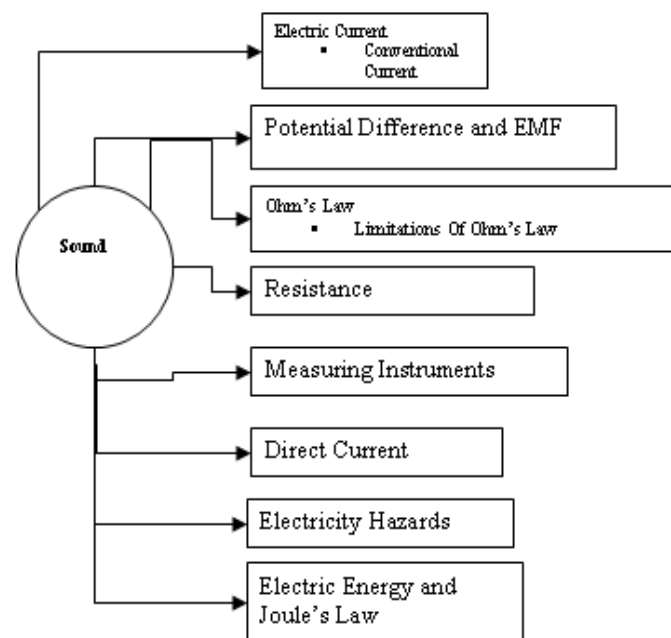
**Figure 14 Concept Map of Chapter 14**

**Chapter 15 Electrostatics**



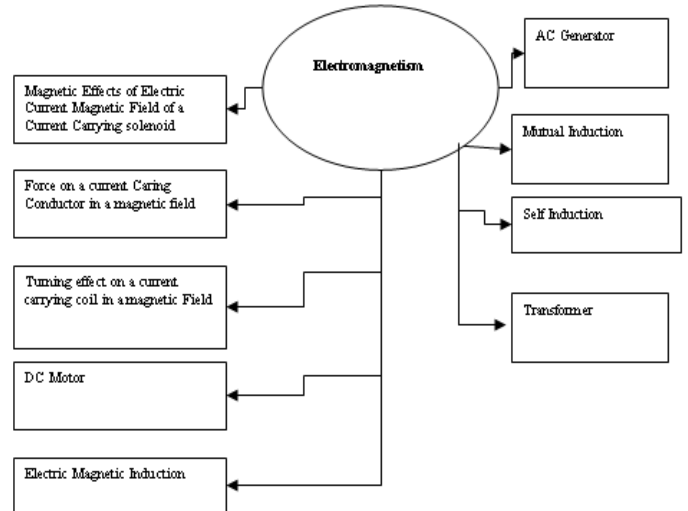
**Figure 15 Concept Map of Chapter 15**

**Chapter 16 Current Electricity**



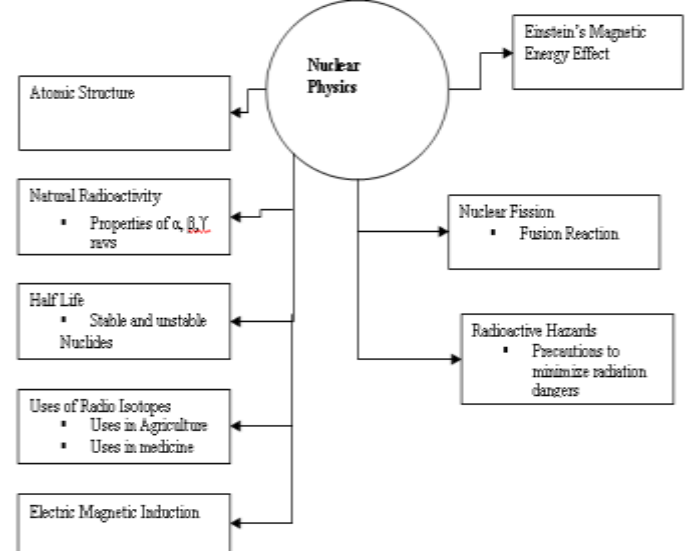
**Figure 16 Concept Map of Chapter 16**

**Chapter 17 Electromagnetism**



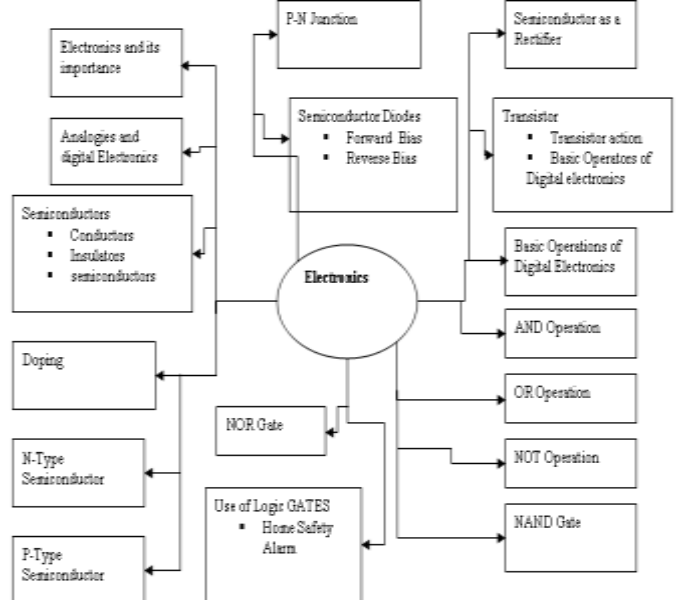
**Figure 17 Concept Map of Chapter 17**

**Chapter 18 Nuclear Physics**



**Figure 18 Concept Map of Chapter 18**

**Chapter 19 Electronics**



**Figure 19 Concept Map of Chapter 19**

## Chapter 20 Information Technology

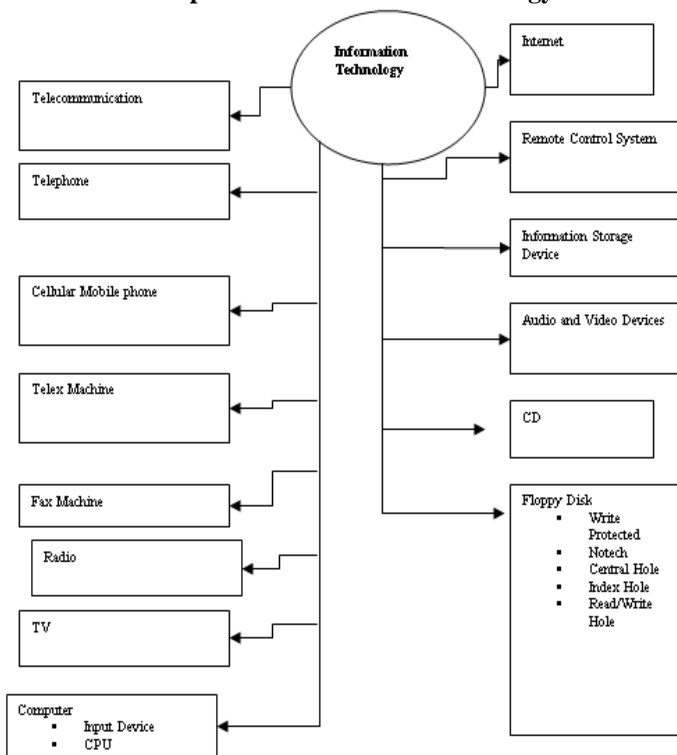


Figure 20 Concept Map of Chapter 20

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